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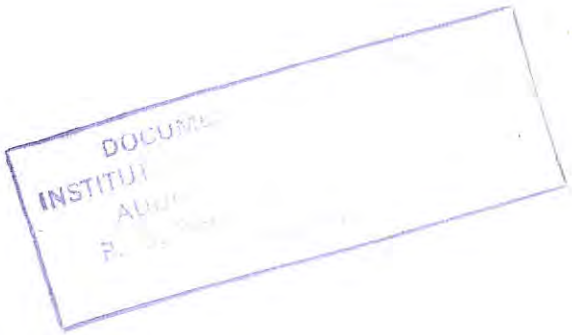

LEVELS, TRENDS AND DIFFERENTIALS IN INFANT MORTALITY IN RURAL ETHIOPIA

Final Draft

by

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MAY 1997

ADDIS ABABA UNIVERSITY

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Levels, Trends and Differentials in Infant Mortality In Rural Ethiopia

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Levels, Trends and Differentials in Infant Mortality In Rural Ethiopia

A Thesis Presented to the School of Graduate Studies

Addis Ababa University

In Partial Fulfillment of the

Requirements for the

Degree of Master of Science in Demography

By

Meaza Bekele

May 1997

ACKNOWLEDGEMENT

First, I would like to extend my sincere gratitude to my research advisor Dr. GABREMASKAL HABTEMARIAM for his valuable comments, suggestions, encouragement and supervision of my research throughout.

I am also thankful to Dr. ASSEFA HAILEMARIAM, Coordinator of DTRC, for his advice, encouragement and support throughout my study. My thanks goes also to Mr YUKHIN for his help in getting the data and briefing me on its nature.

I owe a special debt to my friend ENDALKACHEW ALAMNEW for his whole hearted cooperation, moral support, technical assistance especially for his painstaking work in processing the data (using IMPS), and for giving his precious time while preparing his own research paper. Without his help the completion of this research would have been difficult...

My thanks goes also to the Urban Development and Works Bureau of Region 14 for sponsoring me to join the graduate school.

I am likewise grateful to my brother Mr. ARAYA-YOHANNES BEKELE for allowing me to use his computer and my sister Ms. FIKERTE BEKELE for her help in typing the manuscript.

Lastly, I want to thank members of my family for their cheerful support and others who have helped me in one way or another.

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ABSTRACT

This study examines the differentials in infant mortality in rural Ethiopia. It is based on data (birth history data) from the National Family and Fertility Survey carried out by the Central Statistical Authority, in 1990.

Emphasis is made on the rural part of the country in the belief that the knowledge of infant mortality differentials will contribute to the amelioration of the welfare of the largest proportion of the population of the country. Applying bivariate as well as multivariate methods of data analysis the study examines infant mortality among different socio-economic, demographic and environmental categories in the study population.

The risk of infant death is shown to vary by ethnicity, religion, educational status, work status and marital status of mothers. Greater infant survival among Amhara ethnic group over that of Oromo and others, Christians over Muslims, currently married over other marriage categories and working over non-working mothers is observed.

Father's education and occupation are among the most important determinants. Regional variation is observed and lowland areas show higher infant mortality risk than highland areas. Among environmental variables source of water is found to be the main factor. With regard to demographic factors, the study replicates findings documented else where except that higher order births (5 and above) did not emerge as having higher risk of dying than intermediate order births.

Preceding birth interval is the most significant determinant followed by birth order and survival of preceding child. Short preceding birth interval (less than 2 years) is found to be harmful to the survival of infants. However, lower risk of death is observed when the preceding sibling is alive. The study also revealed that the effect of short birth interval persists whether preceding child is alive or dead.

Results of the study reveal that amelioration of the overall socio-economic condition of the rural Ethiopia population is needed and particularly, improvement in the health services availability, introduction of health education for the youth (especially female). Introduction and/or strengthening of family planning programmes and services as well as improvement of the educational opportunity of the population and provision of safe water will go along way in reducing infant death in Ethiopia.

Chapter 1: INTRODUCTION

1.1 Problem and significance of the study

Overall mortality rates as well as infant and child mortality rates have declined steadily in Africa over the past several decades (UN, 1993). Africa's average infant mortality rate fell by 38 infant deaths per thousands births from 1970-1975 to 1990-1995; the largest absolute decrease among all major areas in the world (UN,1995b).

However, Africa has still the highest infant mortality rates in comparison to other regions of the world. In 1988 for instance, infant mortality rate in Africa was about seven times that of the more developed regions (UNECA, 1989).

Ethiopia is one of those countries with high mortality levels; which reflects its low position on the world development scale. As in many countries, in Ethiopia, also, some decline in mortality level has occurred in the population in the last two decades. The crude death rate declined from 20 deaths per 1000 population in 1970 to 16.4 in 1990 and infant mortality rate declined from 153 deaths per 1000 live births in 1970 to 110 in 1990 (Assefa, 1994).

Both urban and rural areas experienced some decline. During the 1970s and 1980s infant mortality declined by about 28 percent in rural areas and by 30 percent in urban areas (Assefa, 1994) and life expectancy at birth increased by about 22 percent in both urban and rural areas during the period.

However, Ethiopia has still a very high level of infant mortality (110 per 1000 live births) and is among the countries with the highest mortality rates. For several countries infant mortality has reached half the level registered for Ethiopia (Assefa, 1994).

As to the 1984 census results, infant mortality accounted for nearly a quarter (23.4%)

of all deaths, and deaths to children one to four years of age accounted for a little over a quarter (26.7%) implying that more than 50% of all deaths occurred to children under 5 years of age. This evidence shows that an appreciable further decline in general mortality level will not be possible without a simultaneous decline in infant and childhood mortality rates.

Other than the very low Socio-economic development and poor quality of life of the population, high fertility is believed to be the major cause for the high rates of morbidity and mortality especially among mothers and children in Ethiopia.

The Ethiopian Government, aware of the whole problem of high fertility and mortality has issued and is currently implementing a National Population Policy. One of the major objectives of the policy is - *reducing maternal, infant and child morbidity and mortality rates as well as promoting the level of general welfare of the population* (OPM, 1993).

Besides, the international population consensus is - *to reduce mortality levels particularly infant mortality levels, to the maximum extent possible...- and to reduce high levels of infant, child and maternal mortality so as to lessen the need for high fertility and reduce the occurrence of high-risk births (United Nations, 1995).*

The prevailing high rate of infant and child mortality and poor child survival prospects are serious obstacles to Ethiopia's future economic development. Adequate knowledge of the levels, trends, differentials and determinants of infant and child mortality in the country is of paramount importance for the improvement of the health of the population and for further reduction of infant and child mortality.

In line with these goals, the present study attempts to identify the major determinants of infant survival in rural Ethiopia. The findings can be valuable for policy formulation and for the identification of priority areas for program implementation, in order to improve chances of infant survival as well as the well-being of the society as a whole.

The emphasis in this paper is on infant mortality for several reasons. First, available evidence shows that deaths of infants in Ethiopia account for nearly a quarter of all deaths which implies that significant further decline in general mortality level will not be possible without a simultaneous decline in infant mortality rate.

Secondly, through the study of infant mortality it is possible to identify and measure the difference of quality of life between population groups. As Newland (1981) has explained, "as a social indicator, infant mortality level illuminates much that a measurement of the gross national product obscures". It reflects not simply per capita stocks of food, clean water, medical care, and so forth, but the actual availability of such amenities to all segment of the population (Newland, 1981).

In addition, the occurrence of death during early ages is a wastage of human resource and thus needs to be studied.

Different studies were done on the levels and differentials of infant and child mortality using multivariate approach, in Ethiopia (Yohannes, (1990); Assefa, (1991); Gabremaskal, (1994); Mulugeta, (1995)). Most of these studies, have focused on under five mortality and especially on the socio-economic, environmental and cultural differentials of mortality. Mekonnen (1993) had done his study on Sebeta town on infant and early childhood mortality focusing, in addition, on demographic determinants.

The 1990 Fertility Survey permits us to study, among others, the demographic factors which influence infant mortality using birth history data. Therefore the present study seeks to fill some gaps by conducting a study on rural Ethiopia.

1.2 Objectives of the study

The objectives of the study are:

- to investigate the determinants of infant deaths and determine the relative importance of these variables (socioeconomic, demographic and environmental variables) in explaining infant mortality in rural Ethiopia;
- to estimate the level and trends of infant mortality in rural Ethiopia; and
- to suggest policy measures for infant health and survival prospects.

1.3 Literature Review

Various studies have shown that the levels and trends of infant mortality vary from country to country, depending on the Socio-economic development of each country. In fact, infant mortality is widely used as a summary measure of Socio-economic well-being of a nation (Davanzo, et. al., 1983; Gubhaju, 1991).

Furthermore, studies have also revealed that infant mortality differs by Socio-economic status of parents within countries (Caldwell, 1979; Hobcraft et. al., 1984) by demographic factors (Gubhaju et. al., 1991; Hobcraft et. al., 1985) and by environmental factors (Gubhaju et. al.).

However, the relative importance of socioeconomic, demographic and environmental factors on infant mortality varies with the level of socioeconomic development of the nation. Kim (1988), reviewed by Gubhaju et. al., observed that in a traditional society, demographic factors affect infant mortality more than socioeconomic factors.

The different socioeconomic, environmental as well as demographic factors affecting infant survival are identified and studied by various researchers. Literature related to the correlates of infant death considered in this study are reviewed in this section.

1.3.1 Socioeconomic factors

Among the socioeconomic factors, identified by different studies; mother's education, father's education, place of residence (mainly mother's), mother's ethnic and religious affiliation, work status and occupation of parents are considered to be important.

A central finding of various studies on the socioeconomic determinants of infant mortality has been the importance of maternal and sometimes paternal education in reducing a child's risk of dying (Caldwell, 1979; Hobcraft et. al., 1984; Gubhaju et. al., 1991). Socioeconomic determinants can be analysed at individual and at household level.

a) At individual level

Mother's Education

Studies on infant mortality have shown that children of educated parents have higher chance of survival than those of the uneducated. And in particular, differences in infant survival have been found to be highly associated with maternal education (Hobcraft et. al., Tabutin et. al., 1992).

In his Nigerian study, Caldwell (1979) has shown that mother's education plays an important role on infant survival. Among various other studies, studies in China (Dankert et. al., 1991), in Bangladesh (Gubhaju et. al.; Pant, 1991), Kenya (Kibet, 1987) and Sri Lanka (Meegama, 1980) confirm the findings of Caldwell. The negative relationship between the extent of mother's education and infant and child mortality was also confirmed by studies in Ethiopia (Yohannes, 1990; Assefa, 1991; Mekonnen, 1992), the strong effect of mother's education is found to be maintained even after controlling other variables.

As the survival prospects of children during infancy and childhood depend on the level of nutrition, hygiene and health care, educated mothers are likely to provide better services

and care than uneducated mothers (even if both have the same economic resources) (Pant, 1991; Gubhaju et. al., 1991) for education provides the mother with the necessary skills for child care (Caldwell, 1979).

Father's Education and occupation

Hobcraft, McDonald & Rutstein (1984) in their study on data from 28 WFS studies have shown that in terms of magnitude of effect, mother's education is the more decisive factor as compared to father's education. In fact, according to their findings, at higher education levels, the estimated net effect of maternal schooling is about twice as large as that of paternal education.

However, among various studies, studies in Nepal (Pant, 1991; Gubhaju et. al.' 1991) and in Kenya (Kibet, 1987) have shown that Infant and child mortality is lower among children where fathers had some education than among those where fathers had no education.

Father's education is usually considered as a proxy for the standard of living/economic status of a household because educated fathers are likely to earn more than uneducated ones and thus be able to provide better services and care to their children (Kibet, 1987; Pant, 1991; Gubhaju et. al, 1991; Tabutin et. al.).

Father's occupation is also used in some studies as a proxy for socioeconomic status, income and living condition (Hobcraft, 1984) which indirectly affect infant mortality. Usually, the occupation of the father is dictated by the type of education he has acquired. Thus strong association between education and occupation can be established.

Kibet (1987) in his study in Kenya using WFS data has shown that it is not the type of occupation but the educational attainment of the father that has an influence on the survival of his offsprings. Paternal education exerts a more important influence on child survivorship than occupation per se (Kibet, 1987).

Mother's Occupation and Work Status

In the demographic literature the discussion of the relationship between women's work and infant/child mortality has always focused on paid employment outside the home, which is believed to be a possible cause of child neglect and child malnutrition due to abandonment of breastfeeding (Ware, 1984).

However, mother's occupation is not of importance, but the circumstances in which it is carried out are (Ware, 1984). Women's economic activities will have a negative impact on child care only where the activity is incompatible with simultaneous childbearing or where the mother lacks access to another person able to care for the child (Ware, 1984).

Besides, the work status of the mother can be an important determinant of mortality at early years of life. The need to work, especially outside the home , may affect survival chances directly, simply by preventing the mother from caring for the infant (Hobcraft et. al., 1984). This may have substantial effects through lack of proper feeding and particularly breastfeeding early in life.

Work outside the home is likely to be associated, on the other hand, both with modernity and with higher family income, both of which probably increase chances of survival (Hobcraft et. al., 1984). For instance, Ogunlade et. al. (1987) on their study in Nigeria have found out that children whose mothers work away from home have the lowest infant and child mortality rates, as they are likely to be better educated and have jobs in the modern sector. Similar result was also obtained in the study done in Sebeta town by Mekonnen (1993).

However, work status of the mother as compared to father's and mother's education is not found to be an important explanatory variable in a socioeconomic study of infant and child mortality in 28 countries (Hobcraft et. al. 1984).

Marital Status

In general, literatures on marital status of woman in relation to infant and child mortality have revealed that children of married persons have better chance of survival than others.

Behn (1983), in his study in Bangladesh, has shown that the mortality of children of widowed or divorced mothers is higher than that of the currently married (cited in UN, 1985). This is usually explained as being the result of higher economic hardship on children of broken families. The study of Assefa (1991) in Shewa Region has also confirmed the favorable mortality advantage enjoyed by children of currently married mothers over those of children of widowed, divorced and separated. Mortality risk is reported to be 20 percent higher for the latter group.

Ethnicity and Religion of mother

Studies have revealed that infant mortality varies significantly among religious and ethnic groups. In Nigeria for instance, Ogunlade and Mezue (1987) have shown that there is a wide mortality gap between Christians and Muslims with for Muslims about 50% more likely to die than Christians. Lower infant and child mortality among Christians was also observed in studies done in different regions of Ethiopia (Gabremaskal, 1994; Mekonnen, 1993; Assefa, 1991).

Regarding ethnicity, the United Nations (1985) (as reported in Assefa, 1991) in its study in eleven developing countries has observed a substantial variation in child loss across ethnic groups.

The variations are usually said to be the result of different cultural practices in child care beyond the different access to Socio-economic advantages. In this line, findings in

Ethiopia too (Tesfayesus, 1985; Kassahun,1986; Genet, 1987 as cited in Assefa, 1991) showed that an Oromo mother had a higher child mortality than her Amhara compatriot.

Region of Residence

Studies in different countries have shown the existence of regionally differentiated risk of infant and child mortality [Farah and Preston (1982), UN (1985), Kibet (1987)].

As argued by the UN (1973) the pattern of variation in the less developed countries appeared to be different from that of the developed regions where the geographic variation may simply reflect the geographical distribution in socio-economic factors [cited in Assefa (1991)]. In developing nations, regional differences in child mortality are not entirely explained by socio-economic, inequalities alone (UN, 1925). Climatic and ecological conditions associated with disease environment (where major disease vectors flourish) are suspected to be the other causes for the variation in infant and child mortality.

Other than the regional variation differential of mortality risk by variation of altitude is also confirmed by the study of Gabremaskel (1994) done on Showa and Arsi province. Child mortality is found to be higher in lowland areas than in highland areas.

b) At household level

Household socio-conomic characteristics such as toilet facility, access to electricity, number of rooms in the household and source of drinking water are, as to various studies, indicators of the socioeconomic status of the family which indirectly influence infant survival (Gubhaju et. al., 1991; Hobcraft et. al., 1984).

Access to electricity

Access to electricity can be used as an economic variable (Gubhaju et. al., 1991) which affects child survival. It is used as an economic variable, rather than an environmental one, because the poor strata of the society may not be able to afford electricity in the household (Gubhaju et. al., 1991). Studies have shown that infant and child mortality rate was significantly low among children from household which had access to electricity compared with those from households which had no access to it. For instance, in urban Nepal (Pant, 1991) in 1986, it was found that infant mortality among those who had access to electricity was 52 per thousand live birth while it was 89 per thousand live birth among those households who had no access to it.

In urban Ethiopia also, significantly lower (52.2% lower) infant and child mortality rate was observed among children from households which had access to electricity compared to those from households which had no access to it (Mulugeta, 1995).

However, significant effect of this variable may not be observed in rural areas (Gubhaju et. al., 1991). The remaining household facilities are usually used as environmental measures affecting infant survival (Gubhaju et. al., 1991; Meegama, 1980; Mosley, 1984).

1.3.2 Environmental Factors

One subset of the set of intermediate/proximate determinants through which socioeconomic factors influence early mortality is environmental contamination. And environmental contamination refers to the transmission of infectious agents to children (Mosley and Chen, 1984).

Levels of potential exposure to disease can be approximated and scaled by using a series of simple physical indexes that are known to be strongly correlated with the levels of

biological contamination of the environment (Mosley and Chen, 1984).

Environmental variables considered to be important in influencing infant survival include, source of drinking water, availability of toilet facility and housing structure.

Housing Structure

The relationship between infant mortality and the quality of construction materials used for walls, floors and roofing is found to be significant. For instance, with respect to roofing construction material, Mulugeta (1995), in his study in urban Ethiopia, has reported that mothers living in corrugated iron roofed houses have a child mortality advantage of 58.6 percent over those living in thatch roofed houses. But on the other hand, a study in low income areas in Amman, by Deeb (1990) (as cited by Mulugeta, 1995) has found out that type of roof construction had no effect on child mortality.

Flooring of a housing unit is one of the best indicators of housing quality and there by indicates the economic well being of the owner. In his study, Mulugeta (1995) has observed higher child mortality among those families living in earth floor compared to those living in wood floor or cement floor housings. A possible explanation for these differences would be the nature of flooring materials that allows easy access to cleanliness.

Toilet Facility

Access to toilet facilities lowers the risks of environmental contamination (Meegama, 1980; Pant, 1991) and thus increases the probability of infant and child survival. For instance, in urban Nepal (Gubhaju et. al., 1991) the net effect of probability of dying of children belonging to households which do not have their own toilet facility was found to be 64% higher than that of those belonging to households which have their own toilet facility.

Similar result was also obtained in studies done in Ethiopia (Yohannes, 1989; Assefa, 1991; Mekonnen, 1993). Furthermore, Assefa (1991) and Mulugeta (1995) in their study in Shewa and urban Ethiopia, respectively, have shown that the type of toilet facility in a household affects significantly the survival chance of children. As to their findings, children born in households with flush toilet were found to have higher chances of survival compared to those born in households with dry pit latrines or no toilet facility.

Source of drinking water

In various studies, source of drinking water was found to have a significant influence on infant and child mortality. In urban Nepal, for example, the probability of dying during infancy of children born to households which use drinking water from a river or a lake etc. is found to be 44% higher than the probability of dying of children born to households which use piped/tube-well drinking water as their source (Gubhaju et. al., 1991). Besides,in the context of Ethiopia , Yohannes (1990) (as cited in Mekonnen (1993) has reported that, in Addis Ababa, women who use tap water in their house or within their compound experience lower child mortality than women who use tap water outside their compound.

As to previous studies, environmental factors like, access to safe water, electricity and toilet or latrines are important for infant and child survival in urban areas rather than in rural areas. Moreover, Meegama (1980) in her study in Sri Lanka, Gubhaju et. al., (1991) and Pant (1991) in their studies in Nepal have shown that environmental factors are not important for infant survival particularly in the rural areas.

1.3.3 Demographic Factors

As to various research studies, sex of the child, birth weight, maternal age at birth of child, previous birth interval and survival of preceding child among others, are considered to be important in influencing infant and child survival.

The demographic determinants can be broadly divided into maternal and child factors. The first group referring to those factors which affect the health of the mother to the extent of exposing her offspring to a higher risk of infant mortality, Meegama, (1980).

a) Maternal Factors

Birth Order

Birth order influences neonatal mortality much more than post-neonatal mortality (Davanzo et. al., 1983; Meegama, 1980). Studies have revealed that infant mortality rate is higher for first and higher birth orders (Davanzo et. al., 1983; Meegama, 1980; Majunder, 1991; Gubhaju et. al., 1991). The negative effect on first order and higher order (above 5) births is also confirmed in the study done in Sebeta town (Mekonnen, 1993).

The higher risk of dying of first order births is usually explained by the mother's inexperience in child care or childbearing. And the elevated risk of dying of higher birth orders is usually attributed to the enfeeblement of the mother which affect the infants health.

Preceding birth interval

Preceding birth interval is considered as one of the most proximate correlates of mortality (Davanzo et. al., 1983). Various studies have demonstrated that the length of interval since previous birth influences significantly the probability of infant survival. Among others, studies in Malaysia (Davanzo et. al., 1983), Bangladesh (Majunder, 1991; Ahmed, 1991),

Kenya (Kibet, 1981) and in Nigeria (Ogunlade et. al., 1987) have shown that infant born after a relatively short interval (generally less than 2 years) experience considerably higher mortality than those born after long intervals. Birth interval of 2 or 3 years are found to be associated with lower mortality rates.

Further more, length of the preceding birth interval is found to be the most important variable affecting infant mortality as compared to maternal age or birth order (Davanzo et. al., 1983; Majunder, 1991).

Survival of Preceding child

Studies highlighted the effect of previous child mortality on the subsequent children. In Bangladesh for example, as reviewed by Gubhaju (1985), previous child mortality experience was clearly shown to be crucial in determining the mortality of subsequent children. Neonatal and post-neonatal mortality was found to be lower if the previous child survived at least to one year of age than if it had died during infancy (Gubhaju, 1985).

Besides, in the case where previous child is alive the next child born within a short interval (i.e. less than 18 months) is found to have a higher risk of dying than in the case where the previous child had died (Gubhaju, 1985; Gubhaju et. al., 1991). The study by Mekonnen (1993) also revealed that the negative effect of short preceding birth interval on infant mortality persists whether preceding child survived or not.

b) Child factor

Sex

Infant mortality is generally higher for males. The mortality of male infants is higher throughout their first year, and especially during the second to sixth months (Davanzo et. al., 1983).

Higher infant mortality of boys has been recorded nearly everywhere, except where girls are discriminated against (UN, 1985, reviewed by Davanzo et. al., 1983). Studies in Ethiopia (Assefa, 1991; Mekonnen, 1993) also confirm the general findings. The higher mortality of boys is generally ascribed to biological factors.

In general, biological factors, especially maternal ones, are likely to affect neonatal deaths than post-neonatal deaths which are much more affected by exogenous (environmental) factors Meegama (1980). Exposure to exogenous and environmental hazards after birth have been found to play some role, but often a minor part on neonatal deaths (Meegama, 1980; Davanzo et. al., 1983).

1.4 Hypothesis to be tested

Based on previous studies and on the objectives of the study, it is hypothesized that:

1. First order and higher order (above 5) births have lower chance of surviving than intermediate order births.
2. The higher the length of preceding birth interval the higher is the chance of surviving.
3. Male infants are likely to experience higher mortality than their female counterparts.
4. The risk of dying of infants is lower among literate mothers.
5. Infants of working women are likely to experience higher mortality than those of non- working mothers.
6. The risk of dying during infancy of children born to families who have no access to toilets is higher than those who have access.

7. Access to safe drinking water reduces the risk of infant mortality.

8. Mortality level varies from one region to an other and is likely to be higher in the lowland areas than in the highland areas.

9. Socio-economic and demographic factors, in general, affect the chances of infant survival more than environmental factors.

1.5 Data and Method of Analysis

Data

The data used for this analysis is obtained from the National Family and Fertility Survey (NFFS) carried out in 1990, by the Central Statistical Authority (CSA) which, was a nationally representative sample survey of 9414 households. A total of 9104 currently married women aged 15-49 from these households were identified as eligible for individual interview and of these 8757 were successfully interviewed.

For the survey, the country was divided into eight sampling domains: two urban and six rural (urban and rural areas are defined as in the 1984 Census: localities with 2000 or more inhabitants and, all administrative capitals (regional,awraja and wereda) and localities in which Urban Dwellers' Associations were established, irrespective of population size, are considered as urban areas. The rest are categorized as rural areas). The urban domain included Addis Ababa and other urban areas. And, the latter, based on their population size, were further classified into three group of areas. The rural domain was classified into six domains based on the geographical location of the rural areas; five of them covering the highland areas and the remaining one covering the low land areas.

However eventhough the survey was designed to be nation wide, nomadic areas, Tigray, Northern and Southern Wello, Northern and Southern Gondar were not covered due to security and other reasons (CSA, 1993).

The sample design for the survey was a self weighting, multi-stage stratified sampling design. The smallest sampling area unit was the kebele and the peasant association in urban and rural areas, respectively, and the smallest sampling unit was the household.

The present study uses data from rural areas. These data include a total of 5913 women aged 15-49. Along with the socioeconomic and demographic characteristics the survey gathered detailed information on family planning and fertility history of individual women. The incorporation of a complete maternity history of women aged 15-49 years collected in the survey facilitates analysis of infant and child mortality and its determinants.

In addition, information on education of parents and household socioeconomic characteristics such as toilet facility, source of drinking water, number of rooms in the households, type of houses, is also available. Thus, variables which can be used for socioeconomic and environmental measures are available.

Method of analysis

The 1990 National Family and Fertility Survey permits the analysis of infant mortality levels, trends and differentials in relation to a wide range of background variables.

First, as the original data file is women based, the data file is converted into a flat file format using the IMPS package. The levels and trend are estimated, based on the birth history data, using the direct estimation method.

The analysis of differentials is done using uni/bivariate techniques to assess the relative importance of each explanatory variable affecting infant survival and to select the variables to which multivariate analysis is applied. The logistic regression method is used. The model assumes that each one in the group has some probability of success on a given independent variable. In the analysis of differentials of the present study the unit of analysis is the individual infant, and the dependent variable is a dichotomy denoting whether or not the child survived through infancy. The logistic regression can be expressed as:

$$\text{Ln } (P_i/1\text{-}P_i) = B_o + B_1X_{i1} + B_2X_{i2} + \ldots\ldots + B_kX_{ik}$$

and the corresponding multiplicative model for the odds is

$$P_i/(1\text{-}P_i) = e^{b0}\, e^{B1Xi1}\, e^{B2Xi2}\, e^{B3Xi3} \ldots e^{BkXik}$$

Where: Ln $(p_i/(1\text{-}P_i))$ = the log odds of being in the category of interest (i.e. dead infant)

$P_i/(1\text{-}P_i)$ = the odds of being in the category of interest

$X_{i1}, X_{i2}, \ldots, X_{ik}$ = a set of k continuous categorical and/or dummy predictor variables

B = regression coefficient.

1.6 Analytical framework and operational definitions

Analytical framework

Factors which can influence and determine the level of infant and child mortality are known to be several, complicated and interrelated. However, they can be roughly divided into socio-economic factors and biomedical factors (UN, 1985). Because death is a biological process, factors affecting infant and child mortality in the most direct manner are biomedical (Mosley and Chen, 1984).

Mosley and Chen, in an attempt to develop an analytical framework of the study of infant and child mortality demonstrated that all social and economic variables operate through some biological mechanisms (proximate determinants) that enhance or, in contrast, reduce the child's biological responses to adverse elements or conditions endangering its chances of survival.

According to them, the proximate determinants can be broadly grouped into fours categories related to, namely:

- maternal factors (age at maternity, birth order and birth spacing),
- environmental contamination (contracting a disease through air, water, food, etc...),
- availability of nutrition to the foetus, and
- personal illness control (preventive and curative).

The main characteristic of proximate variables is that they influence mortality risk and outcome of the disease process directly (Mosley and Chen). Thus socio-economic factors can only affect infant mortality indirectly by modifying the risk factors.

Most demographic surveys lack relevant information that would make possible investigation of both socio-economic and biological variables. However, the 1990 National Family and Fertility Survey permits us to undertake such analysis. The present study is, thus, done taking into consideration the framework proposed by Mosley and Chen (1984).

Operational definitions

. Infant mortality:- refers to the death of children before exact age of one. It is measured by infant mortality rate. This rate is the number of dead infants (under one year of age) per thousand live births per year.

. Neonatal death:- is the number of infants who died during the first month of life, and neonatal mortality rate is the ratio of the number of infants who died in the first month of life to the number of live births in a year.

. Post-neonatal death:- refers to the infants who survived the first month of life but died within their first year of life. The post-neonatal mortality rate is defined as the ratio of the infants who died between 1 and 11 months of life among live births in a year.

1.7 Limitations of the study

This study has the following limitations:-

. as the study has used birth history data, omission of births or deaths as well as misreporting of age at death may influence the estimated levels of mortality;

- the data did not permit the inclusion of important variables such as birth weight and maternal age at the time of birth of the child;

- the population of rural Ethiopia tends to be homogenous with regard to some variables. This hampered detailed categorization and analysis of variation in infant death;

- Community variables which could have explained mortality differentials especially between regions were not available; and

- as any other research study the present study is not exhaustive and the 1990 NFFS which provides a wide range of variables can be used for further studies.

Despite these limitations, this study is a useful addition to knowledge about levels, trends and differentials in infant mortality in rural Ethiopia.

1.8 Organization of the paper

The present study, including this introductory chapter, is composed of six chapters. The first chapter deals with the objectives of the study, the hypothesis to be tested, the data, the method of analysis and the literature review. Chapter two discusses the quality of the data used for the analysis. Background characteristics of the study population is described in the third chapter. The fourth chapter presents the levels, trends and differentials of infant

and child mortality in rural Ethiopia, through univariate and bivariate analysis. The determinants of infant mortality, using multivariate approach are examined in chapter five. Finally, summary of major findings as well as conclusion and recommendations are presented in the last chapter.

Chapter 2: DATA QUALITY

It is well known that survey as well as census data may be full of errors and biases, specially in developing countries. Since errors and biases may create significant distortions in the results of any demographic analysis, it is essential to evaluate or appraise the quality of and/or limitations of the data in order to explain some of the irregularities that may arise. Besides, evaluation of the data helps us choose the most appropriate analytical method (Gabremaskal, 1994).

In view of this, before moving into any detailed analysis and estimation of the levels and trends of infant mortality a brief assessment of the quality of the data is carried out. The types of data that are evaluated include birth, death and age data.

The household schedule was administered before the individual questionnaire. It contains a list of all household members along with their age, sex, marital status and other relevant information. Eligible women, for the individual interview, were identified at this stage. A brief evaluation of the general quality of reporting of the eligible women, is in order.

2.1 Quality of household data

2.1.1 Evaluation of age data

Misreporting of age is a common problem in developing countries and Ethiopia is no exception. In a situation where the absolute majority of the respondents are illiterate (CSA, 1993), very few can report their exact date of birth.

In the absence of significant reduction in mortality, increased mortality to selected ages, significant migration of population, and given that age is accurately reported, the

expected age distribution is one which has a descending pattern as age advances.

However, the data for the present study deviates from the general trend due to marked heaping at ages ending in "0" and "5" which is clearly seen in figure 1. The heaping is also observed, though at lesser extent at ages ending in even numbers.

In general, the peaks observed at any age are at the expense of under-reporting in adjacent ages. For example, the peak at ages ending in "0" is at the expense of ages ending in "9" and "1".

In order to quantify the extent of digit preference as well as the poor quality of the data the Myers' index is applied (refer table 2.1). Severe heaping is observed on ages ending with "0" and "5" and ages ending with "1", and "9" are avoided by most respondents. Besides, the summary index of digit preference indicates that at least 17 percent of the reported ages are incorrect and, the Myers' Blended Index shows a total deviation of 34.7 from zero. This score shows that the age reporting is highly inaccurate. This may be explained by the high level of illiteracy in rural Ethiopia.

Figure 1: Percentage distribution of rural population by single years of age, Ethiopia, 1990.

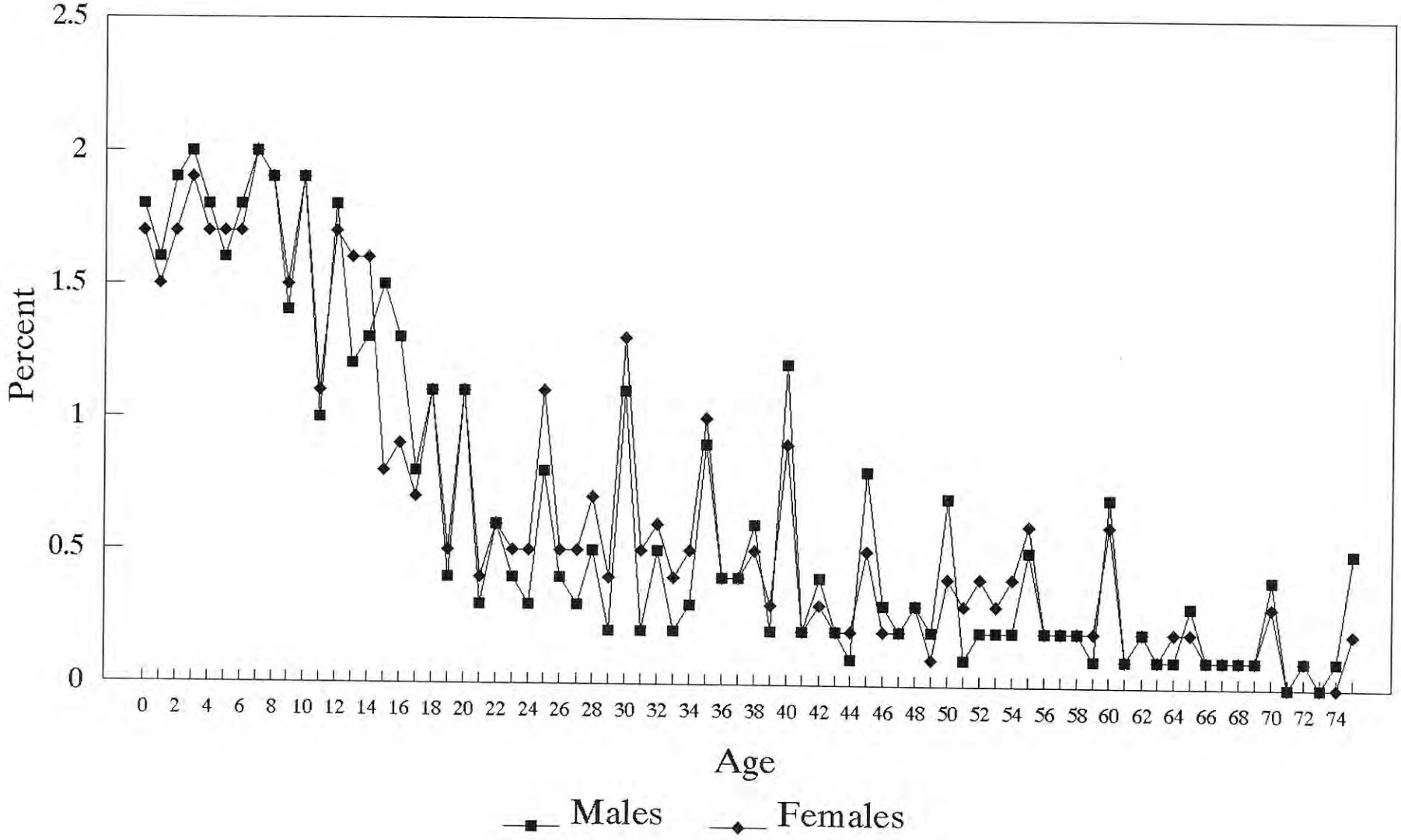


Table 2.1: Myers' Blended index of terminal digit preference by sex, Rural Ethiopia, 1990

Terminal digit	Deviation from 10		
	Male	Female	Both
0	+11.9	+8.8	+10.3
1	-5.3	-3.4	-4.3
2	0.0	+0.4	+0.2
3	-3.6	-1.6	-2.6
4	-3.0	-0.5	-1.8
5	+7.7	+5.2	+6.4
6	-1.0	-1.8	-1.4
7	-2.8	-3.1	-2.9
8	+0.6	+0.2	+0.4
9	-4.5	-4.1	-4.3
Sum (regardless of sign)	40.4	29.0	34.7
Summary index (sum/2)	20.2	14.5	17.4

Source: Computed by the author based on the 1990 NFFS rural data.

2.1.2 Sex ratio

An examination of the sex ratios shows that the overall sex ratio of the population was 1.01. Analysis by single year age groups of the sex ratios shows highly erratic pattern especially after age 12. For most ages and particularly between 24 and 35 years of age the ratios drop well below 1. And in most age groups where the sex ratio is above unity, the values are very high and out of the expected range. This indicates over-reporting of males in some age groups and under-reporting in others. Analysis by 5-year age groups also revealed under-reporting of males in age groups 20-24 to 35-39 and in age groups 50-54 and 55-59.

In the remaining age groups, except in the first, younger two age groups, the sex ratios are found to be extremely high. This may indicate, as explained in some previous Ethiopian studies, (e.g. Gabremaskal, 1994) that male ages have been pushed upwards outside the military service eligibility boundary which was 30 years. Thus this test shows a clear deficiency in the data. However, this artifact may be for males only as female counts decline regularly with increasing age as shown in table 2.2.

2.1.3 Enumeration of eligible women

In the household schedule a total of 6092 women were identified as eligible for the individual interview. Under normal circumstances, the number of women population decreases with the increase of age of women. As it can be seen in Table 2.2, a consistent decrease in the number of women across age groups is observed except for the age group 30-34 which appeears over-represented.

Table 2.2: Distribution of women aged between 15 and 49, rural Ethiopia, 1990.

Age group	Number of women	Percent count
15-19	1223	20.1
20-24	1006	16.5
25-29	996	16.3
30-34	1044	17.1
35-39	826	13.6
40-44	572	9.4
45-49	425	7.0

Source: computed by the author from the 1990 NFFS rural data.

2.2 Quality of reporting by individual women

2.2.1 Age data

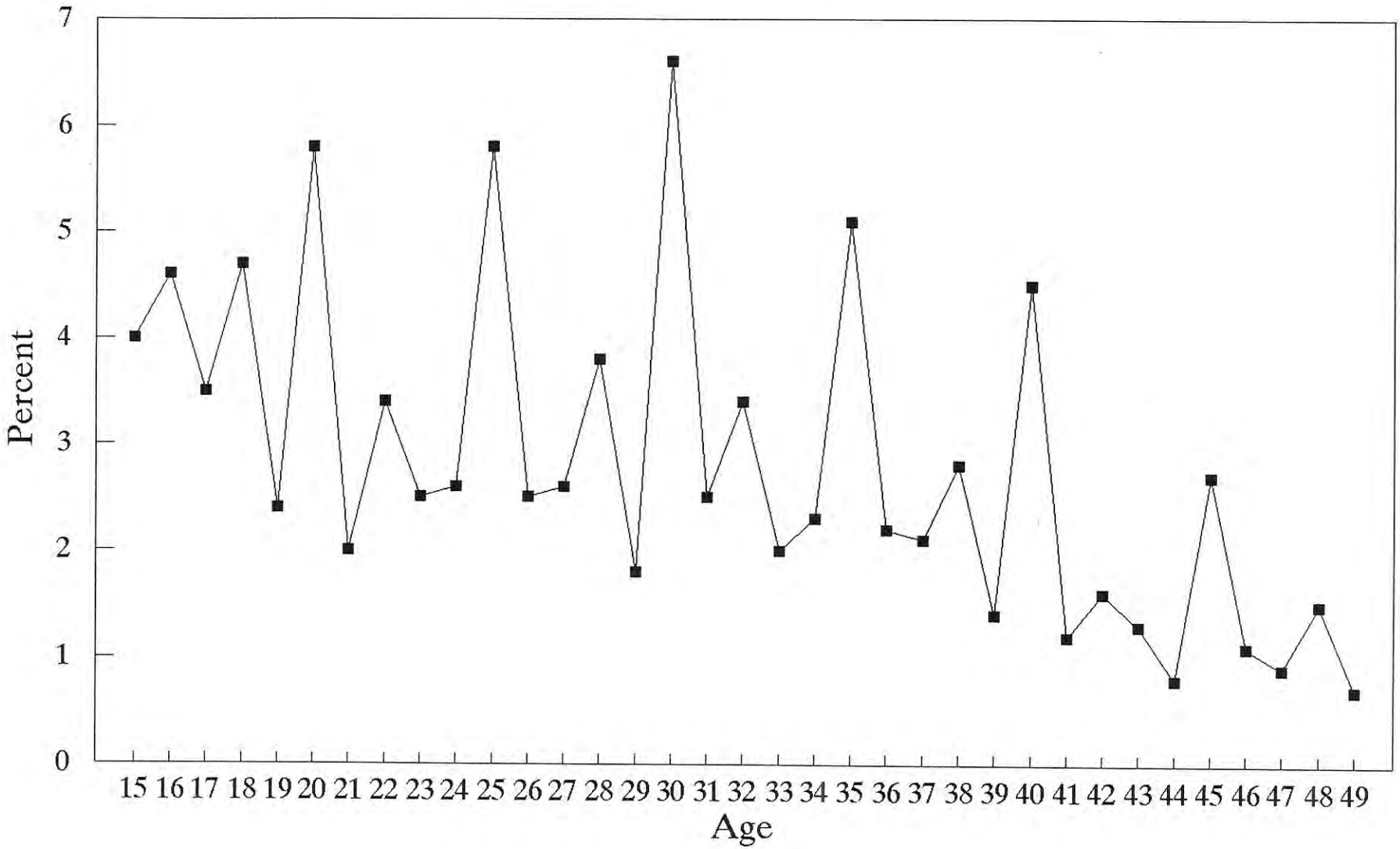
In this survey only 4.7% of the respondent women were able to report their year of birth. Figure 2 shows the single year age distribution of the women in the reproductive age group 15-49. As for the total population, the figure shows that the age data deviates from the general trend, some irregularities associated with age misstatement are observed. Errors in the age data are manifested in the clustering of ages ending in some digits and deficiencies at ages ending in others. Marked heaping at ages ending in "0" and "5" with corresponding deficiencies at ages ending with "9", "1" and "4" are observed. Though to lesser extent, here also, heaping is observed at ages ending in even numbers.

Moreover, the Myers' Blended Indices presented in Table 2.1 also showed that the age reporting is subject to digit preference while the summary index of digits preference indicated that at least 14 percent of the reported ages on female population are incorrect.

However, there is no evidence in the available literatures that age error had any systematic relation with parity, fertility or proportion of children surviving. Furthermore, inaccurate reporting of age would not have major effect on the estimates of qx when age is grouped (Brass & Coale 1968 as cited by Mulugeta, 1995).

Therefore, it is usually advisable to group the data into 5 year age groups as misreporting and/or heaping would be much reduced in the latter compared to the figures in the former (Shryock et. al, 1976).

Figure 2: Percentage distribution of women by single years of age, rural Ethiopia, 1990.



2.2.2 Quality of birth history data

Reporting of birth and death

Individual women had also reported on the births they had and survival status of their children no longer alive. The common type of errors documented in literatures in such data is the omission of births and deaths especially by older women. Omission can create false impressions not only on the level of mortality but also on trends, since typically births which occurred in the more remote past are more frequently omitted. However, in studies on more recent periods, the extent of omission is known to be lower.

In the 1990 National Family and Fertility Survey, when a woman failed to report a specific date of birth of her offsprings, the season of birth instead of the month of birth, and the number of "years ago" when the event occurred instead of the year of birth was registred. In general, one can say that the age reporting is satisfactory as all were reported - 57.4 percent of the births were reported in year of birth while 42.6 percent reported the age of their children (in "years ago"). On the other hand, the months of birth were reported for 68.9 percent, while for the remaining, the seasons of birth were reported.

The consistency of reporting can be checked using the sex ratios at birth and the reported deaths. Table 2.3 shows that the sex ratios at birth was somewhat high in the second and third period showing under-reporting of female births, and low for births in the fourth period, revealing male under reporting. But in the more recent 10 years period the sex ratio of the reported births are in the expected range.

Table 2.3: Number of births, deaths and sex ratios of children by birth cohort, rural Ethiopia, 1990.

Birth cohort	Births		Sex ratio	Deaths		Sex ratio
	Male	Female		Male	Female	
1986-90	3185	2968	107.3	443	393	112.7
1981-85	3119	2943	106.0	808	635	127.2
1976-80	2332	2358	98.9	671	578	116.1
1971-75	1558	1232	126.5	536	375	142.9
1966-70	754	649	116.2	318	224	142.0
1960-65	313	300	104.3	123	111	110.8

Source: Computed by the author based on the 1990 NFFS rural data.

Regarding mortality, higher male mortality is observed which is common in most societies. For better check of data on mortality the evaluation of reporting data on age at death is in order.

Evaluation of age at death data

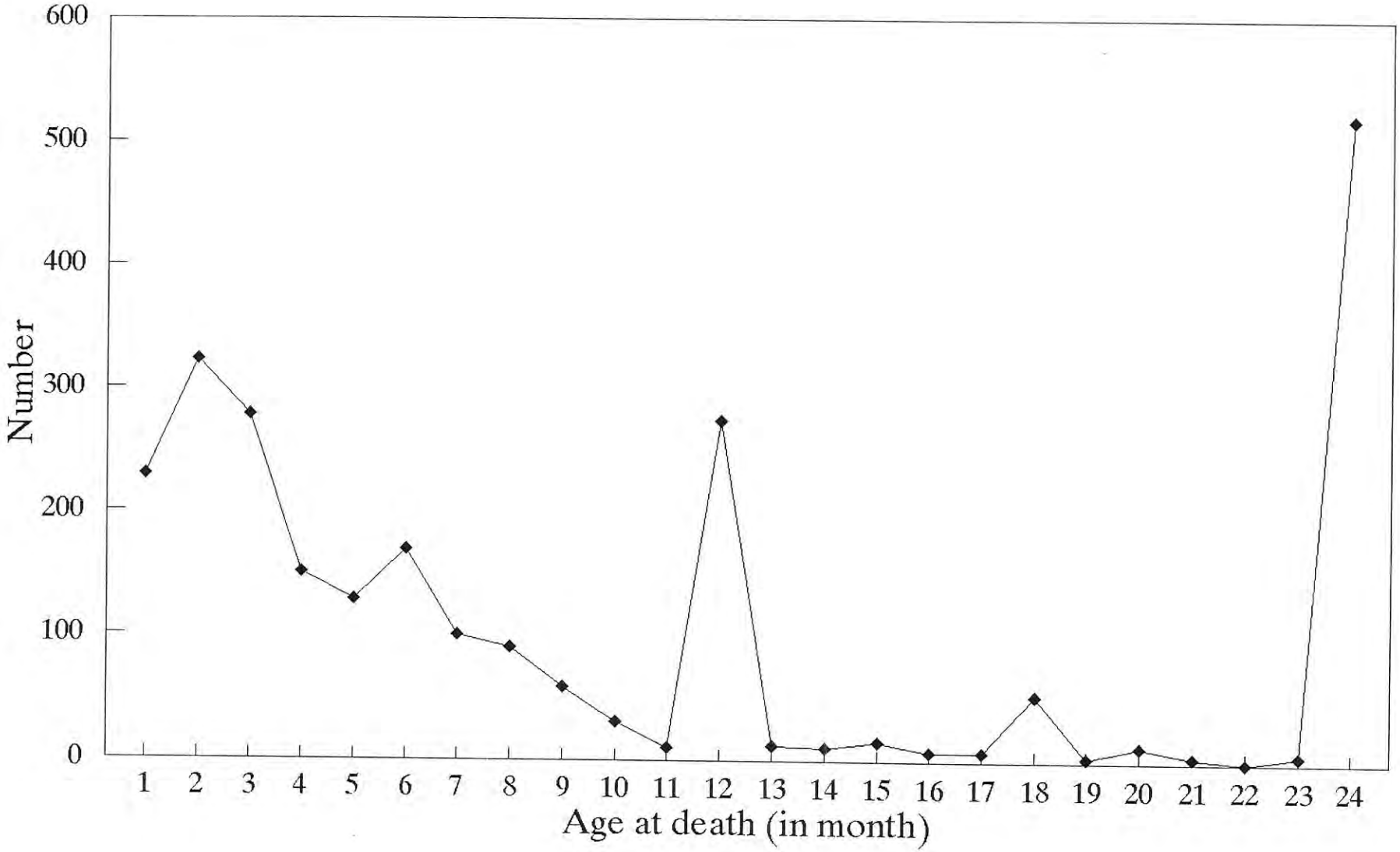
According to various countries' survey experience, infant death is subject to omission and misplacement. Misreporting of age at death of dead children often results from ignorance, recall lapse or preference of certain digits (UNECA, 1987).

The preference for digits leads to a concentration of deaths at certain ages. Figure 3 clearly shows the extent of heaping in our study area. A high concentration of deaths at 12 and 24 months are observed. The heaping are also noticed though to lesser extent, at 6 and 18 months. In contrast, very few deaths are reported at ages 10, 11 and 23 months of age.

This concentration or misplacement of deaths would seriously bias post-neonatal as well as infant mortality estimates. One method of correcting this defect would be to assign half of the deaths at 12 months to the infancy period (UNECA, 1987).

In summary, assessment of quality of data indicates that the data on age reporting, number of births and children dead is not of a bad quality even if it is somewhat affected by under reporting of births, omission of deaths and misreporting of ages. The age reporting especially of births from birth history data appears satisfactory but omission of births and deaths might have occurred especially for the distant past. Reporting of age at death suffers from misplacement/misreporting. However, the birth history data permits us to study infant mortality using direct method and thus will be used for the present study. As the data quality is better for the recent years, the analysis of differentials of infant mortality will be based on the data from the most recent years before the survey for two important reasons. One is, in order to lower the extent of omission and obtain better estimates, and secondly, to avoid using covariates from too distant past which may have changed by the time of the survey.

Figure 3: Distribution of deaths by month, rural Ethiopia, 1990.



Chapter 3: BACKGROUND CHARACTERISTICS OF THE STUDY POPULATION

In this chapter some socioeconomic and demographic characteristics of the study population are discussed.

3.1 Population characteristics

This part of the study is based on results drawn from the household schedule. As explained earlier, the household schedule is prepared mainly to identify eligible women for individual interview.

3.1.1 Age-sex distribution of the rural population

The total population of the covered areas of rural Ethiopia in 1990 was 27,114,371 out of which 13,576,966 (50.1%) were males and 13,537,405 (49.9%) were females. Consequently the sex ratios for the whole population was 100.6.

Classification of the population in broad age groups as shown in table 3.1 reveals that the population was quite young with children under age 15 constituting half of the population and the share of the old i.e. those 60 years and over was only 6.2. Thus, the dependency ratio, which is the ratio of the population age 0-14 and 60 years and above to the working-age population 15-59, is high. The young and old dependency burden was 116 and 14 respectively which means that, on the average, one hundred working people should support about 130 dependents on top of sustaining themselves.

Table 3.1 **Distribution of the population by broad age groups and sex, rural Ethiopia, 1990.**

Broad Age Group	Male		Female		Total	
	Number*	Percent	Number*	Percent	Number*	Percent
0-14	8,112	50.2	8,089	50.4	16,201	50.3
15-59	6,911	42.8	7,079	44.1	13,990	43.5
60+	1,126	7.7	883	5.5	2,009	6.2
TOTAL	16,149	100	16,051	100	32,200	100

* unweighted number

3.1.2 Marital structure

The percentage distribution of the population aged 10 and over by marital status is presented in table 3.2. The data revealed that at the time of the survey about 39 percent of the rural population were single and about 65 percent of females and 54.4 percent of males were ever married. The singulate mean age for females was reported as 15.6 (CSA, 1993). This shows that marriage is early in Ethiopia. Beesides it is universal as at the age of 25-29 only 3.2 percent of rural women were found to remain single (CSA, 1993).

Table 3.2 Percentage distribution of the population age 10 and over by marital status and sex, rural Ethiopia, 1990.

Sex	Marital Status				Total
	Never Married	Married	Widowed	Divorced/ Separated	
Male	4718 (45.6%)	5126 (49.6%)	194 (1.9%)	305 (2.9%)	10343
Female	3397 (32.5%)	5493 (52.5%)	971 (9.3%)	597 (5.7%)	10458
Both Sexes	8115 (39.0%)	10619 (51.1%)	1165 (5.6%)	902 (4.3%)	20801 (100%)

Source: Computed by the author based on the 1990 NFFS rural data.

3.2 Selected characteristics of individual women aged 15-49 years

In addition to the information collected on children ever born, survival status of children, socio-economic characteristics of interviewed individual women in the reproductive ages were also collected. Thus in this section an attempt is made to present a brief analysis of background characteristics of those women covered in the study. Detailed distribution is displayed in table 3.3.

3.2.1 Education and literacy

As the United Nations definition (1980), a person is literate if he/she can with understanding, both read and write a short, simple statement in his/her every day life. According to table 3.3, the overwhelming majority (92.9) of the interviewed women are illiterate. Observation of the distribution of interviewed women by different categories of education level reveals that, 3.8% had primary education and only 0.1% had attended higher education.

The educational distribution of husbands shows that men had better education than women - 24.4% of husbands are literate compared to 7.1% of the interviewed women. However, 75.6% of the husbands were illiterate, 1.7% had secondary education and 0.1% only had education beyond secondary level.

The results indicate that the rural population in general, and women especially have very low educational attainment.

3.2.2 Work status and occupation

At the time of the survey, most of the women (62.3%) were working and 37.7% were not working. The distribution of husbands of currently married women by occupation reveals

that a sizeable proportion (78.5%) of them were in agriculture and related works; 16% were in sales or commerce; 3.5% were in production, transport and other related categories; and only 0.2% were in the professional and technical, administration and management streams.

3.2.3 Ethnicity and religion

In the questionnaire more than 30 ethnic groups were identified. However, the ethnic composition of the study population is such that the Oromo followed by the Amhara represent about two third of the women. The third main ethnic group was the Gurage with only 6.6% of the women followed by the Sidama, the Hadiya and Kembata with 5.8, 4.5 and 3.5% respectively.

The distribution of the women by religious group reveals that Christianity is the dominant religion with more than 60% of the population followed by Islam with about 30%. Among the Christians 48% were orthodox and 12.1% were protestants. The other Christians were found to be small in number and formed the "other Christians" category. The atheist, the traditional religion etc...were put in the "others" category.

Table 3.3: Percentage distribution of women aged 15-49 by selected socio-economic characteristics, rural Ethiopia, 1990

Variable	Percent Count	Number
Education of Women		
Illiterate	92.9	4690998
With non-formal education	0.8	40960
Elementary (1-6)	3.8	193607
Junior Secondary (7-8)	1.4	72317
Senior Secondary (9-12)	0.9	47252
Above Secondary	0.1	3227
Not stated	0.0	1142
Education of Husband		
Illiterate	75.6	3275089
With non-formal education	9.5	411157
Elementary (1-6)	10.7	461355
Junior Secondary (7-8)	2.4	102432
Senior Secondary (9-12)	1.7	74892
Above Secondary	0.1	4720
Not stated	0.0	780
Work Status of Women		
Working	62.3	3144585
Not Working	37.7	1904918
Occupation of Husband		
Professional and technical	0.2	5458
Administrative and managerial	0.0	1259
Clerical and related	0.2	5993
Sales workers	16.5	518834
Social service	0.9	27429
Agricultural and related	78.5	2466985
Production transport and related	3.5	110930
Not stated	0.2	7696
Ethnicity of Women		
Amhara	20.4	1027906
Oromo	42.1	2127690
Gurage	6.6	334098
Sidama	5.8	295420
Hadiya	4.5	225375
Kembata	3.5	174702
Others	16.9	853366
Not stated	0.2	9898
Religion of Women		
Christians		3166587
- Orthodox	47.7	2409667
- Protestant	12.1	612791
- Others	2.9	144129
Muslim	30.1	1521590
Others	7.1	360090

Source: The 1990 National Family and Fertility Survey Report, CSA, June 1993.

3.2.4 Access to safe water, toilet and electricity

Table 3.4 presents the distribution of interviewed women aged 15-49 by access to some household amenities, housing condition and housing ownership.

In the survey, the source of drinking water supply at household level was collected. Four types of sources were identified namely tap, protected well or spring, unprotected well/spring, and, river or lake. The data reveals that the absolute majority of the population had no access to clean water. Four fifth of the study population get water from river/lake and unprotected well/spring and only 14% of the population get water from tap or protected well/spring.

Concerning access to toilet, the data reveals that the majority of the population (75%) had no access to any type of toilet facility, 16.8% and 8.5% of the population had access to private and shared pit latrine respectively.

With regard the availability of electricity, the table also shows that the absolute majority of the study population (98.1%) had no access to electricity.

3.2.5 Possession of specified items

Information on the availability of specified items in the household of interviewed women were collected in the survey as a proxy measure of household income. The items and percentage of ownership are presented in table 3.4. The data clearly reveals that very few households possess durable goods. Seven out of the fourteen items are owned by less than 1% of the households. The items owned by the highest proportion of the rural households is bed with only 33.7% of the households, followed by chair, clock/watch, table and radio respectively. Items such as telephone, refrigerator or television are almost non-existent.

3.2.6 Housing condition and ownership

The housing quality can be evaluated by the quality of the material used in the construction of walls, roofs and floors.

As the data reveals, the absolute majority of the housing units had thatched roof (81.2%) followed by those with corrugated iron sheet with about 13%. In addition, the data shows that 80% of the housing units in the study population had walls made of wood and mud, and 98.2% had earth flooring. Furthermore, with regard to housing ownership, table 3.4 shows that the absolute majority of the housing units are private owned and only 0.8% are rented.

Table 3.4 Percentage distribution of women aged 15-49 by access to some household amenities and housing condition, Ethiopia 1990.

Variable	Percent Count	Number
Access to Water		
Tap	6.4	323168
Protected well/spring	7.4	373663
Unprotected well/spring	37.3	1883465
River/lake	48.5	2449009
Others	0.3	15148
Not stated	0.1	5050
Access to Toilet Facility		
Private pit	16.8	848317
Shared pit	8.5	429208
In the open	71.6	3615444
Others	3.1	156534
Availability of Electricity		
Yes	1.9	95941
No	98.1	4953562
Household Possession (proxy to income)		
Tape recorder	2.0	100990
Radio	8.6	434257
Television	0.2	10099
Telephone	0.2	10099
Refrigerator	0.1	5050
Electric stove	0.3	15149
Gas stove	0.6	30297
Electric "Mitad"	0.6	90891
Kerosene stove	1.8	90891
Table	14.4	727128
Chair	27.7	1398712
Sofa set	0.6	30297
Bed	33.7	1701683
Clock/watch	15.5	782673
Housing Condition		
- Material used for the roof		
Corrugated iron	13.6	686732
Wood/mud	0.9	45446
Thatch	81.2	4100196
Others	4.3	217129
- Material used for the floors		
Earth	98.2	4958612
Cement/tiles	1.2	60594
Stone/brick	0.1	5050
Wood	0.1	5050
Others	0.4	20198
- Housing ownership		
Owned	98.4	4968711
Rented	0.8	40396
Others	0.8	40396

Source: The 1990 National Family and Fertility Survey Report, CSA, June 1993.

Chapter 4: LEVELS, TRENDS AND DIFFERENTIALS IN INFANT MORTALITY

4.1 Levels and trends of infant mortality

In this section, the levels of infant mortality are estimated using the birth history data. The data is collected from women aged 15-49 years and spans a time period of 35 years which consist of seven five year cohort births. However, as the numbers of births in the earlier cohorts are few, and data relating to them are probably less reliable (because of recall lapse of those in the earliest 5-year cohort of births) are not included for the estimation of levels and trends of infant mortality.

Although the subsequent analysis of differentials and determinants of infant mortality will be restricted to the data of the most recent five years, the level and trends are analysed on 30 years time period. Besides, the data from the survey year are not included believing that the recently born infants have not finished their exposure and their inclusion may affect the estimates.

As the data quality assessment in chapter 2 revealed there is a high concentration of deaths at 12 months; in order to adjust for this, half of the deaths at 12 months are considered for the calculation of infant death rates.

Table 4.1 shows the distribution of births by five year cohorts along with the corresponding neonatal, post-neonatal deaths as well as the mortality rates. It is evident from the results that infant mortality rates were extremely high for the cohort 1960-64 and have been declining since. The earliest rates may have been still higher because of the possibility that some of the deaths occurring during that period may have been omitted.

The overall picture (figure 4) is one of declining infant, neonatal and post-neonatal mortality, the post-neonatal being always higher than the neonatal mortality.

Table 4.1: Number of births, deaths and sex ratios of children by birth cohort, rural Ethiopia, 1990.

Birth group	Births	Deaths		Mortality rates per 1000		
		< 1 month	1-11 months	Neonatal	Post-neonatal	Infant
1960-64	474	49	50	103.4	105.5	208.8
1965-69	1155	99	127	85.7	110.0	195.7
1970-74	2535	219	270	86.4	106.9	193.0
1975-79	4234	313	364	73.9	86.0	159.9
1980-84	5987	362	496	60.5	82.8	143.3
1985-89	6205	304	411	49.0	66.2	115.2

Source: Computed by the author based on the 1990 NFFS rural data.

Although the estimates have shown a declining trend the infant mortality level of 115 per thousand births referring to the birth cohort 1985-89 is still very high.

Annual rates of mortality for the most recent years are computed and presented in table 4.2. The estimates show that there is a decline in the mortality level from one year to the other. Also, small fluctuations are observed especially in the neonatal rates.

Within 30 years infant mortality has fallen by about 45 percent which is on the average 1.5 percent reduction per annum. The mortality change seems very rapid, higher change in mortality levels are observed in the annual infant death rates presented in table 4.2. For instance from 1986 to 1987 and from 1987 to 1988 the mortality levels have declined by more than 10 percent, with an average decline of over 5% per year over the past five years. There are no strong evidnces of concurrent changes in living standard or public health services of similar magnitude to explain this sharp fall in infant mortality rate. Further studies are warranted.

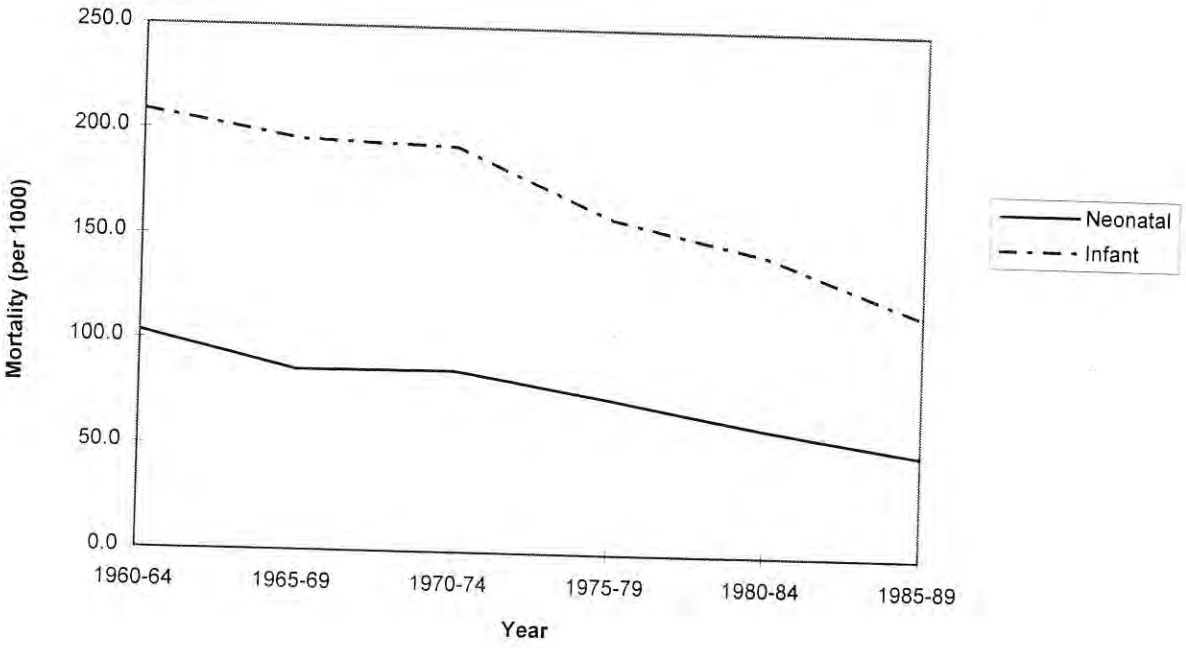
Table 4.2: Neonatal, post-neonatal and infant mortality rates from 1985 to 1989, rural Ethiopia, 1990.

Year of birth	Births	Mortality rates per 1000 live births		
		Neonatal	Post-neonatal	Infant
1985	1229	52.1	80.6	132.6
1986	1273	58.9	71.5	130.4
1987	1369	48.2	68.7	116.9
1988	1242	39.5	57.2	96.6
1989	1092	45.8	51.3	97.1

Source: Computed by the author based on the 1990 NFFS rural data.

As a whole, infant mortality has shown a declining trend, although its level remains still high particularly as compared to other African countries like Kenya, Zimbabwe, Zambia, etc... where infant mortality is reported to be less than 70 per thousand births (UN 1993b, UN 1987).

Figure 4: Levels and trends in neonatal and infant mortality from 1960-64 to 1985-89.



4.2 Differentials of infant mortality

In this section uni/bivariate relation between infant mortality on the one hand and socio-economic, demographic as well as environmental variables on the other hand will be examined.

In order to minimize errors in the estimates and to analyze recent mortality differentials, this section deals with infants reported within 1985 and 1989 i.e. 12 to 71 months before the survey. Infants born in 1990 are excluded, due to incomplete exposure of the births to the risk of mortality, as explained earlier. The universe of births for this study is 6205.

In this particular analysis the death rate is computed for each category of a variable of interest and compared with each other. In general about 25 explanatory variables expected to be the correlates of infant mortality are considered in the uni/bivariate analysis. They are analysed and presented in five broad groups for practical purposes.

* The first group comprises covariates that present the child bearing characteristic of the mother, i.e. the demographic factors, namely birth order, birth interval and survival of preceding child, and the sex of the child.* The second group incorporates variables that represent cultural/economic characteristics of the mother that are of more permanent nature such as ethnicity, religion, region of residence, and altitude which represents the ecological features of the place of residence.* The third group comprises socio-economic factors such as literacy/education (mother's as well as her husband's), marital status, work status, husband's occupation, access to electricity, listening to radio and possession of modern goods.* The fourth group includes variables on housing structure and the last one constitutes hygienic and environmental variables represented by the use of soap, source of drinking water, availability and location of toilet.

4.2.1 Demographic characteristics and infant mortality

Birth order

Studies have revealed that, generally, mortality rates by order of birth assume a J-shaped pattern indicating greater risk to first and higher order births than births of intermediate group. Table 4.3 shows that birth order exerts a significant influence on infant survival. The result also shows that the expected high infant mortality rate for first order births is evident, but that of higher birth order (5 and above) is absent. The absence of excess mortality associated with higher birth order births could reflect omission of children of higher birth order who have died soon after birth. On the other hand, this can be explained by the higher experience in child care of older women.

Birth order 4 followed by birth order 3 have the lowest death rate. The higher mortality among first born children is usually associated with maternal young age and inexperience. However, as data on maternal age at the birth of the child is not available this hypothesis was not tested.

Birth Interval

It is well documented that the length of the interval between births has a great influence on infant mortality. Short birth intervals are associated with high rates of infant deaths.

In this study also, preceding birth interval is found to have a significant influence on infant mortality. The expected high risk of infant mortality for births with short birth interval (i.e. less than 2 years) is clearly observed (in table 4.3). A preceding birth interval of less than two years raises the risk of infant death by more than 2.2 times as compared to infants born after a birth interval of 3 years. The risk of death is reduced to 73 percent for infants born after an interval of 2 to 3 years. Thus, the risk of dying declines consistently as the preceding birth interval increases from less than 2 years to more than 3 years.

Table 4.3: Infant mortality by maternal demographic factors and sex of the child.

Background variable	Infant death rate per 1000		significance at
	Births	death rate	
Birth order			P<.01
1	849	199.1	
2	908	180.6	
3	905	162.4	
4	882	153.1	
5+	2661	152.2	
preceding birth interval			P<.001
< 2 years	1459	241.9	
2 to 3 years	2841	148.2	
> 3 years	1689	109.5	
Survival of preceding child			P<.001
alive	3858	152.7	
dead	2347	183.6	
Sex of the child			P>.10
boy	3197	169.5	
girl	3008	158.9	

Source: Computed by the author based on the 1990 NFFS rural data.

The two mechanism that cause poorer survival chances for children born after short birth intervals are maternal depletion syndrome and competition between siblings (Hobcraft et. al (1985); Winikoff (1983), reviewed by Majumber (1988)).

It is also argued that this relation is a reflection of factors like age at maternity, education of mother and death of older sibling. In this line some researchers argue that the survival status of the previous child can be confounded with the effect of short preceding birth interval.

In order to test this altercation, an attempt is made to examine the effect of preceding birth interval controlling for the survival status of the older child.

Results in table 4.3 show that there is a high correlation between survivorship of successive births. Mothers whose previous child has died experience about 1.2 times higher risk of death of subsequent child compared to those whose previous child has survived. In

table 4.4 an interesting finding is that the negative effect of short preceding birth interval on infant mortality persists whether the preceding child survived or died. Such result was also found in a study done in Sebeta Town (Mekonnen, 1993). The data further illustrates that the correlation between survival of preceding child and a short previous birth interval has significant effect on infant death.

The effect of preceding birth interval is also re-examined controlling for birth order. As the data in table 4.4 exhibits, infant deaths decline consistently with the increase in the length of the birth interval. This trend persists for every birth order. The strong effect of short birth interval persists at all birth orders. However, the gap in infant mortality between short and long preceding intervals declines with the increase in the birth order.

Table 4.4: Infant mortality by length of preceding birth interval, survival status of preceding child and mother's education.

Variable	**Previous birth interval**		
	< 2 years	2-3 years	> 3 years
Birth order			
2	266.4 (214)	160.2 (412)	128.9* (256)
3	248.8 (201)	131.3 (419)	132.0* (250)
4	216.5 (194)	151.8 (415)	87.1* (241)
5+	220.1 (636)	141.3 (1203)	89.3* (717)
Survival of preceding child			
alive	203.9** (922)	140.7 (1749)	118.3 (1048)
dead	307.3** (537)	160.3 (1092)	95.2 (641)
Maternal education			
none	248.5* (1344)	149.4 (2630)	111.0 (1585)
some	165.2* (115)	132.7 (211)	86.5 (104)

* significant at .05 level; ** significant at <.001 level.

Note: Figures in bracket are number of births.

Table 4.4 also shows the results obtained from the effect of preceding birth interval after controlling for maternal education. The strong effect of the short birth interval persists. However, the mortality gap between short and long preceding birth intervals is found to be higher for mothers with no education than those with some education.

Sex of the child

The excess male over female infant mortality presented in table 4.3 does not show any peculiar feature beyond the general pattern observed in most societies. Female infants have about 6.7 percent lower mortality than their male counterparts in rural Ethiopia. However, the effect of sex of the child on infant mortality is not statistically significant.

4.2.2 Maternal background characteristics and infant survival

Maternal ethnic affiliation

Table 4.5 shows that the probability of infant survival varies with mother's ethnic origin. Among the four major ethnic groups considered here, the Gurages have the lowest mortality rate followed by the Oromo and the Amhara mothers. Here, it is preferred to compare the three main ethnic groups as the "others" category is the aggregate of the remaining multiple small size ethnic groups. The disparity in infant mortality between the lowest (Gurage) and the highest (Amhara) group is approximately 13 percent. In other words, the Gurage have 13 percent lower infant mortality risk than the Amhara, and the Oromo have 1.2 percent lower mortality risk than the Amhara ethnic group. This difference is believed to be the result of the difference in cultural practices, however, due to the rather small number of cases for Gurage infants the result should be interpreted cautiously.

Table 4.5: Infant mortality by some maternal background characteristics, rural Ethiopia, 1990.

Background variable	Infant death rate per 1000		significance at
	Births	death rate	
Ethnicity			P>.100
Amhara	1021	160.6	
Oromo	2899	158.7	
Gurage	275	141.8	
Others	2002	178.3	
Religion			P<.05
Orthodox Christ.	2637	151.7	
Other Christian	873	150.1	
Muslim	2153	181.6	
Others	304	174.3	
Area of residence			P<.001
Highland	5601	159.3	
Lowland	604	211.9	

Source: Computed by the author based on the 1990 NFFS rural data.

Besides, as revealed in various literatures this difference in level of mortality among the ethnic groups may be the reflection of mothers' socio-economic status such as education. In order to test this hypothesis, attempt was made to control the effect of mothers' education. Indeed education of mothers seems to explain some of the observed variations in infant mortality among ethnic groups. As it is shown in table 4.6, for mothers with some education, the infant mortality of Amhara mothers exhibits lowest level followed by the Gurages. For mothers with no formal education, the original relation persists. However, the effect of ethnicity on infant mortality is not statistically significant.

Table 4.6: Infant mortality by mother's education, ethnicity, religion area of residence and husband's education.

Variable	**Mother's education**	
	None	Some education
Ethnicity		
Amhara	164.9 (946)	106.7 (75)
Oromo	160.1 (2729)	135.3 (170)
Gurage	143.4 (258)	117.6 (17)
Others	181.6 (1817)	145.9 (185)
Religion		
Christian	155.1* (3166)	116.3 (344)
Muslim	181.28* (2081)	194.4 (72)
Others	180.0* (511)	193.5 (31)
Area of residence		
highland	161.8 (5205)	126.3 (396)
lowland	213.4 (553)	196.1 (51)
Husband's education		
never attended	174.9 (4797)	150.4 (113)
primary	128.3 (842)	145.8 (192)
grade 7 and above	109.2 (119)	105.6 (142)

* significant at < 0.05 level.

Note: Figures in bracket are number of births.

Maternal Religion

Religion is strongly associated with infant mortality. As it can be seen in table 4.5, in general Muslim mothers have a significantly higher infant mortality than Christian mothers'. On the average, the risk of dying is 20 percent lower for the offsprings of Christian mothers than for the Muslims. Moreover, little variation in infant mortality is observed between Orthodox Christian and Other Christians mothers (i.e. Catholic, Protestant, etc...). Mothers of other religious group are also found to experience 15 percent higher infant mortality risks than Christian mothers and 4 percent lower than Muslim mothers.

The reasons for this difference may be related to cultural practices and religious taboos. Ethnicity and religion are correlated in Ethiopia, for instance, the Amhara are predominantly christian and a high proportion of Oromo are muslim. It is therefore expected that a portion of the differentials in religion are due to differences working through ethnicity. Accordingly, in table 4.7 the relationship between infant mortality and religion is examined controlling for ethnicity.

Table 4.7: Infant mortality by religion and ethnic group of mother.

Variable	**Religion of mother**		
	Christian	Muslim	Others
Ethnicity			
Amhara	150.4* (838)	207.6 (183)	-
Oromo	132.5* (1275)	184.4 (1540)	83.3 (84)
Others	169.2* (1395)	161.6 (427)	200.0 (455)

* significant at < 0.05 level.
Note: Figures in bracket are number of births.

Marked differences in the mortality levels are noted among Christians and Muslims. The Muslims have consistently higher mortality and the highest rate is observed for the Amhara ethnic group. The importance of religion persists even after taking into account the effect of ethnicity. Muslims have the highest rates and among the ethnic groups Amhara has the highest rates.

There is also a growing argument that differential in mortality by religion is the result of socio-economic differences. Table 4.6 reveals that after controlling for the effect of maternal education, infants born to Muslim women continue to have the higher mortality rate than their counterparts born to Christian women or women of other religious group.

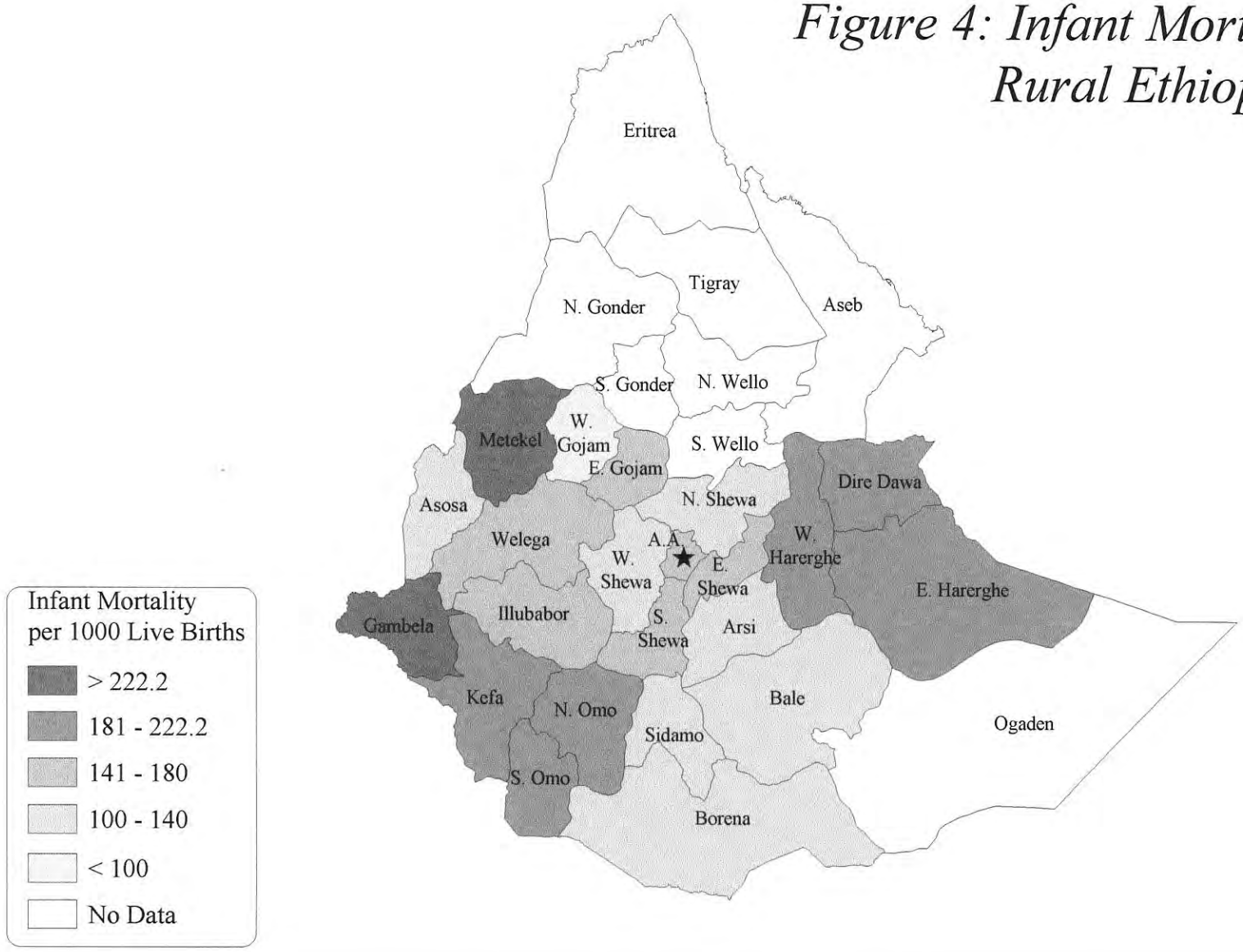
However, the variation in mortality among the religious groups has not reduced when controlling for maternal education. The hypothesis could have been tested, better, using more maternal educational categories but the data do not allow us to do so.

Region of residence

The effect of region of residence is strongly associated with mortality. Figure 5 and table in Annex I show that there is substantial regional disparity in infant mortality in rural Ethiopia. The lowest death rate is observed in West Godjam followed by Borena, Bale, Asosa and Sidamo, while the highest is observed in Gambela followed by Metekele, Dire Dawa, Keffa and East Hararge. But here note should be made that the rate for West Godjam is unexpectedly low.

The disparity between the region with the lowest mortality (West Godjam) and the one with the highest (Gambela) mortality is approximately 2.8 times, and it is more than 1.8 times higher as compared to that of Borena region. Thus, the existence of regionally differentiated risk of mortality documented by other studies (Farah and Preston, 1982), (UN, 1985; Abate, 1993) is also ascertained in this study. However, the above mentioned studies attributed the differential of socio-economic standards such as mothers' education, general level of development, cultural factors and to ecologial factors such as climate and disease prevalence. The differential observed in this study does not show such relationship and therefore could be reporting problem. An attempt was made to control for maternal education to see whether some of the regional variations can be explained by this variable. But due to the small number of educated women in rural Ethiopia, and due to the small number of the reported deaths in each category, most of the computed death rates are found to be misleading and thus are not presented. Nonetheless, in some regions like the rural part of Addis Ababa and South Shoa, where relatively higher number of cases were reported and relatively higher number of women had some education, lower mortality rates were observed compared to those who were illiterate.

Figure 4: Infant Mortality by Region; Rural Ethiopia, 1990



Altitude

Altitude appears to be one of the most important influences on infant mortality. As table 4.5 reveals, mortality risk in the highland areas is 33 percent lower than in lowland areas. It is known that the lowland areas are disease environments and are less populated, whereas, the highland areas, where the majority of the rural population lives have better climatic condition, and may be relatively better equipped in terms of health services and other infrastructures. When controlling for maternal education (as it can be seen in table 4.6) although lower mortality rates are observed for women with some education the variation of infant mortality among highland and lowland areas persists with higher mortality in the lowlands.

4.2.3 Socio-economic characteristics and infant mortality

Maternal Education

There is ample evidence that maternal education exerts a very significant and independent negative impact on the levels of infant and child mortality. Table 4.8 shows infant mortality rates classified by educational status of mother. Here, the variable is represented by ever attendance, never attendance of school and attendance of literacy program or any other non-formal education. The latter category is included because it represents more than 40% of all women.

It is well known that the number of women who ever attended school, in rural Ethiopia is small. Though the data on the level of achievement in education were collected a more detailed classification could not be adopted.

However, the expected pattern is also observed in the table; maternal education and infant mortality have indeed inverse relationship. The excess mortality of those infants of mothers with no schooling over that of children whose mothers have some schooling is

approximately 28 percent. Women who attended any non-formal education or literacy program have infant mortality experience more akin to illiterate than to the literate women. It may be the case that traditional education or literacy program alone has little impact in the reduction of infant mortality.

The higher chance of infant survival of educated mothers may be because they are better placed to know the importance of hygiene and nutrition to identify themselves with modern outlook of life and thus to give better care for themselves and their children than illiterate women.

Husband's education

Results in table 4.8 confirm previous research findings that infant mortality varies inversely with fathers education. Infant mortality for those women whose husbands have higher education is lower. Infants whose fathers have grade seven and above of schooling have 53 to 69 percent lower mortality than those children with non educated fathers. Furthermore, the same table reveals that the move from primary to grade seven and above exerts lower influence on infant survival than the move from no education to primary education (1-6 grades).

Table 4.6 further shows infant mortality rates by mother's and father's education. Higher risk of infant death is observed when husband and wife are both illiterate and, when the wife has some education the risk of infant death is reduced by 16 percent. The influence of the father's education varies according to the mother's educational status. When the mother has some education whether the father has attended primary shool or not does not fundamentally alter infant mortality. Lower infant death is observed when the mother has some education and the father has seven or more years of schooling. On the other hand, when the mother is illiterate, risk of infant death decreases with an increase in education of father.

Table 4.8: Infant mortality by socio-economic characteristics, rural Ethiopia, 1990.

Background variable	Infant death rate per 1000		significance at
	Births	death rate	
Maternal education			P<.10
none	3144	171.8	
one year or more	447	134.2	
literacy prog./non-formal educ.	2614	160.7	
Husband's education			.001
never attended	1955	163.7	
primary (1-6 grade)	1034	131.5	
grade 7 and above	261	107.3	
literacy prog./non-formal educ.	2955	181.4	
Marital status			<.100
married	5802	164.1	
widowed/div./sep.	403	168.7	
Work status (mother's)			>.100
working	3912	163.3	
non-working	2293	166.4	
Place of work			>.10
home	480	147.9	
away from home	3429	165.1	
Husband's occupation			<.001
prof./tech./admin.	52	38.5	
agriculture & related	5777	167.7	
others	303	128.7	
Possession of goods (radio, watch, table)			<.001
at least one of them	1601	134.9	
none of them	4586	174.7	
Listening to radio			.10
yes	478	136.0	
no	5723	166.9	
Access to electricity			.05
yes	82	85.4	
no	6116	165.5	

Source: Computed by the author based on the 1990 NFFS rural data.

Marital status

The mortality advantage enjoyed by children of currently married mothers over those children of other marital categories is confirmed by the results in table 4.8, eventhough the difference is not significant. Infants born to women currently in union have about 3 percent lower mortality than those born to widowed, divorced or separated mothers. It is usually

argued that this differential in child mortality is due to the relatively higher economic status enjoyed by the women in union.

Work status and place of work of mother

As table 4.8 shows, both variables are not statistically significant. In this study, those women who usually perform other activities than domestic ones are categorized as "working" and those who perform only domestic activities are termed as "non-working".

According to the general findings documented in various countries, working mothers have higher infant and child mortality than non-working mothers because they are likely to give less care and have less opportunity to breast feed their children. However, the anticipated higher infant mortality for working women is not found in the present study. On the contrary, non-working women, even if not very high, show higher mortality risk over their working counterparts. Such results were also obtained by Assefa (1991) in his study on Shewa region.

Furthermore, the mortality of infants varies in accordance with the place of work of the mother. Mortality of those infants born to mothers working away from home is about 11 percent higher than that of infants of mothers working at home. This finding is in accordance with the expectation.

Husband's occupation

This variable is classified into three main occupational groups, namely: professional/ technical/ administrative/ managerial; agricultural and related; and others. Table 4.8 shows the consistent results with the empirical generalizations in the literature that infant and child mortality varies with socio-economic status, for which the father's occupation is a common proxy.

Infants of fathers engaged in professional, technical, administrative or managerial activities enjoy a mortality advantage of more than 4.4 and 3.3 times over infants of fathers engaged in agriculture and related activities and "others" categories respectively. However, other than the real difference by occupation of fathers', such high magnitude of difference may be due to the very small number of workers in the professional/ technical/ administrative category.

Possession of selected durable goods

This variable is used as a proxy for income and is believed to be a reasonable indicator of relative economic status (UN, 1985). Therefore, possession of table, clock/watch and radio is assumed to reflect high level of household economic status followed by those who have at least one of them and those who do not have any of them. Accordingly, table 4.8 shows that households with at least one of these goods enjoy 30 percent more mortality advantage over those with none of the goods. Households with all the specified three categories of goods are almost non-existent.

Listening to radio

This variable is used assuming that women who listen to radio have access to information on child care and other health messages. Accordingly, as it can be observed in table 4.8 those women who listen to radio have about 23 percent lower infant mortality than those who do not listen to radio.

Access to electricity

Lack of electricity is documented to be as one of the risk factors for child survival (UN, 1985 and Mulugeta, 1995). When we examine infant mortality differential with regard

to this variable, lower infant mortality is observed in households where electricity is available. The mortality advantage enjoyed by them is about 94 percent. However, due to the extremely skewed distribution of households by access to electricity it may be difficult to take the result at face value.

4.2.4 Housing structure and infant mortality

The characteristics of the dwelling - place have long been recognized as an important influence on infant and child mortality (UN, 1985).

The type of building materials used in a house is also said to be a good indicator of the quality of a house. Consequently, in this study an attempt is made to see the variation of infant death by type of roof, wall and floor of the house. As it can be seen in table 4.9, lower infant mortality is found among infants of women living in housing units having corrugated iron sheet roofs. Living in a housing unit with corrugated iron sheet roof has an advantage of reduced infant mortality of 9 percent than those children living in a house with thatched roof.

Lower mortality is also observed for those women who live in housing units with wood/wood and mud walls than those made of bamboo or any other material. Infants living in houses having wood and mud walls have 13 percent lower risk of death than those infants living in housing units made of bamboo and mud. Moreover, higher infant death is observed among those women living in housing units where the floor is made of earth. Infants born in a housing unit with a floor building material other than earth is found to have 63 percent lower mortality risk than those born in a housing unit with earth flooring.

However, it is worth noting here that the majority of the dwelling units in rural Ethiopia are made of thatch roof, wood and mud walls and earth flooring.

Table 4.9: Infant mortality by housing structure, rural Ethiopia, 1990.

Background variable	Infant death rate per 1000		significance at
	Births	death rate	
Type of roof			>.10
corrugated iron sheet	832	152.6	
thatch	4979	166.7	
others	391	158.6	
Type of walls			<.10
wood, wood & mud	4787	158.8	
bamboo & mud/reed & mud	401	179.6	
others	1014	184.4	
Type of floor			.10
earth	6113	165.2	
others	89	101.1	

Source: Computed by the author based on the 1990 NFFS rural data.

4.2.5 Environmental sanitation and infant mortality

Source of drinking water

Source of drinking water is one of the most important environmental variables that can influence infant mortality. Studies have revealed that those families with better facility tend to have the lower mortality. Nevertheless, results obtained in this analysis are contrary to one's expectations. Children of women living in a housing unit with tap water are found to have extremely higher infant mortality as compared to families who use protected well/spring water, unprotected well/spring or river or lake water. Such unexpected results were also observed in Sri Lanka and Ghana (UN, 1985). As argued by the UN (1985), this may be the result of a poor maintenance of the water supply system, or tap water may not mean safer water but piped water in which case it may be as polluted as open sources.

An attempt was made to see the variation in infant mortality by type of source of water and season (dry or rainy). But the variation was similar for both seasons.

Availability of toilet

Availability of toilet is another very important environmental variable that can influence infant survival. The availability of unsanitary toilets can also be the major sources of environmental pollution and contamination.

Results in table 4.10 are contrary to one's expectations. Mortality rate of infants born in households without toilet facilities is 13 percent lower than that of infants born in households having these facilities. This high mortality rate observed in these families may be due to the lack of proper use of toilets which causes environmental contamination. As argued by Meegama (1980), if a child is born in a dwelling with poor or no toilet facilities, infections could be transmitted to the new born by flies or, for that matter, through the mother who in all probabilities would also have unhygienic habits.

Soap

Soap is one of the sanitation variable which can have an impact on infant survival. A simple hand washing is known to be effective in preventing daily infection and a mother who has hygienic habits is likely to experience lower infant mortality.

Table 4.10 reveals that infants of women who do not use soap have 12 percent higher risk of dying compared to infants of women who use soap. Similar results were also reported by Mulugeta (1995) in his study in urban Ethiopia.

Table 4.10: Infant mortality by environmental variables, rural Ethiopia 1990.

Background variable	Infant death rate per 1000		significance at
	Births	death rate	
Source of water			<.001
tap	456	254.4	
protected well / spring	398	133.2	
unprotected well/spring	1984	165.8	
river, lake, pond	3364	154.9	
Toilet			.04
available	1738	179.5	
not available	4464	158.4	
Use soap			.07
yes	1874	151.1	
no	4321	170.1	

Source: Computed by the author based on the 1990 NFFS rural data.

Chapter 5: DETERMIANTS OF INFANT MORTALITY: MULTIVARIATE APPROACH

In the previous chapter the effect of each demographic, socio-economic as well as environmental variable on infant mortality was examined factor by factor. In addition, an attempt was made to consider the effect of two variables, simultaneously, on infant mortality.

However, because of the complex and multi-faceted association of infant mortality with the various factors and the complex interrelationship among the factors themselves, (socio-economic, demographic, environmental variables)the independent effect of one variable on infant death can only be studied through multivariate analysis controlling for the effects of the other variables simultaneously.

Therefore, in this section, the individual effect of each independent variable on infant survival will be re-examined using the logistic regression. The dependent variable is a dichotomy denoting whether or not the child survived through infancy. The model defines the odds of infant death with different demographic, socio-economic and environmental characteristics.

Based on the results obtained in previous analysis some of the independent variables are regrouped. The independent variables considered for the analysis are:

- **among demographic variables:**

  birth order: which is entered into the model as a categorical variable representing births of order 1, 2, 3, 4, and 5 or above. Birth of order 4 which has the lowest death rate serves as a reference category.

  preceding birth interval: three categories are considered. They are less than 2 years, 2-3 years and 3 years and above. The last category is used as a reference category.

survival of preceding child: is used as a dummy variable (dead or alive).

sex of the child: is entered as a dummy variable.

- **socio-economic and environmental variables**: are all treated as categorical or dummy variable. Education of mother and father are entered as no schooling and some schooling. The no schooling category is used as reference category for both. For father's occupation, three categories were considered and the agriculture and related works category is considered as a reference category because it has the largest number of cases.

Maternal work status, place of work, possession of modern goods, listening to radio and access to electricity are all treated as dummy variables.

Religion and ethnicity, the two cultural variables are treated as categorical variables. The two major ethnic groups Oromo and Amhara and all others are compared together. The Oromo ethnic group is used as a reference category because it has the higher number of cases. Religious affiliation of the mother is grouped into Christian, Muslim and others. The Christian category is used as base.

Area of residence (altitude) is used as an agro-ecological variable and is treated as a dummy variable. The highland which showed the lower infant mortality as compared to the lowland areas is used a reference category.

Environmental contamination was examined using source of drinking water and availability of toilet. The first variable is categorized as tap, protected well/spring, unprotected well/spring and river/lake/pond; the latter serving as a reference category as it has the highest number of cases. Availability of toilet is treated as a dummy variable.

The models were fitted in four stages. First, the effect of demographic variables known as proximate determinants of infant survival are considered. In the second and third stage socio- economic and environmental variables are regressed, respectively. In the final

stage, socio-economic and environmental variables which have proved to have significant effect on infant mortality together with the proximate determinants are examined.

5.1 Demographic determinants

Table 5.1 shows the result of the regression where all the demographic variables are considered. First and second order births, as compared to birth order four, show an increase in the risk of infant death while those of third and higher order births show lower risk. The effect is significant only for first and higher order births. The Beta coefficient suggest that when an infant is of first birth order the log odds of the infant death increases by a factor of 0.2075 as compared to birth order 4. Also, the multiplicative estimate indicates that first order births have odds of dying at infancy that are 1.2306 times higher than the odds for infants of fourth birth order. Similarly, the result shows that the increase in birth order, for example up to birth order 3, is worth a reduction in the odds of infant death by a factor of 0.9647.

In general, the result obtained in the univariate analysis, for birth order, persists even after the effect of other demographic variables is taken into account.

Table 5.1: Logistic regression estimates of demographic variables on infant mortality, rural Ethiopia, 1990.

Variable	Beta coefficient	Exp (Beta)
Birth order		
1	0.2075***	1.2306
2	0.0895	1.0936
3	- 0.0359	0.9647
5+	- 0.1529***	0.8582
Preceding birth interval		
< 2 years	0.5226***	1.6864
2 to 3 year	- 0.0877*	0.9160
Survival of preceding child		
alive	-.1046**	0.9007
Location of toilet		
outside dwelling	1297	175.8
elsewhere	438	191.8
Sex of the child		
male	0.0364	1.0371

*** significant at 1 % ** significant at 5 %
* significant at 10 %

Preceding birth interval is also found to be a significant predictor variable of infant mortality. Short birth intervals (i.e. less than 2 years) as compared to higher birth intervals (3 years and above) show high risk of mortality while 2 to 3 years birth intervals show less risk of mortality. The estimated coefficient of short birth interval suggests that compared to birth interval of 3 years or more, the short birth interval increases the likelihood of infant mortality by more than 68 percent.

The regression result shows that there is an inverse relationship between survival of preceding child and survival of subsequent infant. The relation is statistically significant at 0.05 level. The multiplicative estimate indicates that the odds of infant deaths is reduced to about 90 percent when the preceding sibling is alive as compared to the odds of dead preceding sibling.

Survival differential by sex of the child is not statistically significant. However, it is found that the odds of dying for male infants is higher by a factor of 1.0371 than the odds of female infants.

Furthermore, in order to assess the significance of the contribution of the variable and to determine their order of importance the log likelihood tests are applied. Starting from birth order the variables are added sequentially to the model and the increment in fit of model (X^2 = difference in log likelihood) are computed. Consequently, preceding birth interval is found to have the highest contribution to the model followed by birth order and survival of preceding child, respectively. Sex of the child is found to be the least important variable, in fact it has no significant effect on infant mortality (refer table in Annex II for the results).

5.2 Socio-economic determinants

Among the twelve variables included in the model, only five have shown significant effect on infant mortality. This result confirms that the outcome of the uni/bivariate analysis.

Infants of fathers' with some education have shown lower risk of death as compared to those infants whose fathers' have no education. The effect of father's education is statistically significant at 0.01 level. The estimated coefficient of fathers's education suggests that some education decreases the likelihood of infant mortality by 13 percent. The result underscores the importance of fathers' education for the reduction of the risk of infant death.

Mothers' education is not found to be a significant predictor of infant death. Besides, it shows an association with infant death in the opposite direction than expected. The logodds of infant mortality increases by 3 percent for those mothers with some education as compared with those with no education or with non-formal education. As explained earlier this is due to the small number of women with some education.

The result further shows that fathers working in professional, administrative and management have lower infant mortality risk as compared to those working in agriculture or related works. This relation is found to be significant. The odds of infant mortality among fathers working in professional/technical and administrative management is reduced by 61 percent in comparison with those working in agriculture and related works.

Altitude is also found to have significant effect on infant mortality at 0.01 level. The likelihood of death of an infant in lowland areas increases by 23 percent compared to an infant in the highland areas.

Ethnicity did not show significant effect on infant mortality. Infants of Amhara women have shown almost equal mortality risk compared to infants of Oromo women. Whereas, the odds ratio of infant mortality of other ethnic groups is over 9 percent higher than for Oromo women.

With regard to differential in infant death by religion, Muslim mothers show 13 percent higher infant death as compared Christian mothers. Marital status as in the univariate analysis shows that divorced, widowed or separated women are more likely to have higher infant mortality. The estimated coefficient suggests that the risk of mortality increases by 5 percent, for non-working compared to working mortality is higher by 6.6 percent and for working at home compared to working outside home mortality is lower by 8.2 percent. Listening to radio versus not listening has an advantage of only 1 percent and access to electricity has a negative relationship with infant mortality by about 25 percent. Possession of at least one modern good, reduces the odds of infant death by about 8.7 percent compared to those households that do not possess any modern good.

Table 5.2: Logistic regression estimates of socio-economic variables on infant mortality, rural Ethiopia, 1990.

Variable	Beta coefficient	Exp (Beta)
Ethnicity		
Amhara	0.0002	1.0002
Others	0.0902	1.0944
Religion		
Muslim	0.1255*	1.1338
Others	- 0.0011	0.9989
Area of residence		
lowland	0.2037**	1.2259
Maternal education		
some	0.0307	1.0313
Father's education		
some	- 0.1363**	0.8725
Marital status		
widowed/div./sep.	0.0493	1.0505
Work status (mother's)		
non-working	0.0643	1.0664
Place of work		
home	- 0.0859	0.9176
Husband's occupation		
prof./tech./admin.	- 0.9477*	0.3876
others	0.3880	1.4740
Possession of goods (radio, watch, table) at least one of them	- 0.0905*	0.9134
Listening to radio		
yes	- 0.0112	0.9889
Access to electricity		
yes	- 0.2882	0.7496

** significant at 1 % * significant at 5 %

5.3 Environmental determinants

With regard to housing variables, as in the uni/bivariate analysis, the result in table 5.3, show that none are statistically significant. However, corrugated iron sheet roofed housing show some reducing impact on infant mortality as compared to a house with thached roofing, lower risk of death is also observed for infants living in a housing unit with wood and mud walls than those living in a housing with reed/bamboo and mud walls. Likewise lower risk is observed for those infants born in a housing unit with a flooring made of the materials than those born in a housing unit with earth flooring.

Table 5.3: Logistic regression estimates environmental variables on infant mortality, rural Ethiopia, 1990.

Variable	Beta coefficient	Exp (Beta)
Type of roof		
corrugated iron sheet	- 0.0858	0.9177
others	- 0.0020	0.9980
Type of walls		
bamboo & mud/reed & mud	0.0465	1.0476
others	0.0184	1.0186
Type of floor		
others	- 0.2863	0.7511
Source of water		
tap	0.4913**	1.6344
protected well / spring	- 0.3107**	0.7329
unprotected well/spring	- 0.0517	0.9496
Toilet		
available	0.0427	1.0436
Use soap		
yes	0.1198	1.1273

** significant at 1 %

Source of water shows different direction of association with different type of source of water. Tap and protected well/spring are found to be statistically significant. Use of tap water shows an increase in the risk of infant death while protected well/spring shows a decrease as compared to river or lake water. Here also, as in the univariate analysis, higher mortality is observed among households with tap water. This is contrary to one's expectations. The odds of infant mortality for users of protected well/spring is found to decrease by about 27 percent while the reduction is about 5 percent for the unprotected well/spring as compared to river, lake or ponds. Possible reasons have been forwarded in the preceding chapter.

Furthermore, as in the univariate analysis toilet shows higher infant death among families with a toilet facility as compared to those who have not. This is also contrary to one's expectations. This relation may need more elaborated studies.

Finally, in the fourth stage of the analysis all variables i.e. demographic variable along with all the socio-economic and environmental variables which have exhibited significant effect on infant mortality and those important variables, as to previous studies, such as sex of child, mother's education, toilet facility etc... are included in the model. The results are presented in table 5.4.

In the first model all the demographic variables are considered, so the results are the same as those presented in table 5.1. The second model contains all socio-economic and demographic variables simultaneously. As it can be observed the demographic variables have not lost their significance even when the effect of socio-economic variables is taken into consideration. But, the significance of survival of preceding child has diminished slightly. Infact, when the effect of socio-economic variables is controlled the magnitude of demographic variables especially of birth order and preceding birth interval, has increased.

The effect of father'education, father's occupation, altitude, mother's religion (Muslim) as well as household possession of goods have also remained significant. But, the significance of father's occupation has diminished slightly.

Table 5.4: Logistic regression estimates (Beta coefficients) of socio-economic demographic and environmental variables on infant mortality, rural Ethiopia, 1990.

Variable	Model 1	Model 2	Model 3
Birth order			
1	0.2075***	0.2945***	0.3046***
2	0.0895	0.1043	0.1142
3	- 0.0359	- 0.0393	- 0.0392
5+	- 0.1529***	- 0.1972***	- 0.2146***
Preceding birth interval			
< 2 years	0.5226***	0.5418***	0.5383***
2 to 3 years	- 0.0877*	- 0.0971**	- 0.0871*
Survival of preceding child			
alive	-.1046***	- 0.0795**	- 0.0721**
Sex of the child			
male		0.0348	0.0352
Ethnicity			
Amhara		0.0036	- 0.0177
Others		0.0839	0.0639
Religion			
Muslim		0.1256**	0.0890
Others		- 0.0508	- 0.0100
Area of residence			
lowland		0.2150***	0.1209**
Maternal education			
some		- 0.0645	- 0.0869
Father's education			
some		- 0.1564***	- 0.1626***
Husband's occupation			
prof./tech./admin.		- 0.8826*	- 0.8685*
others		0.3094	0.2978

Possession of goods (radio, watch, table) at least one of them		- 0.1015**	- 0.0931**
Source of water tap protected well / spring unprotected well/spring			0.4302*** - 0.2595** - 0.0461
Toilet available			0.0453
Use soap yes			- 0.0602
- 2 Log likelihood X^2	5142.283 126.60 P=0.000	5010.764 131.52 P=0.000	4985.662 25.10 P=0.000

*** significant at 1 % ** significant at 5 %
* significant at 10 %
Note: the initial -2 log likelihood with which the first model is compared is 5268.886.

When account is made of all other variables (model 3), the significant effect of demographic variables has persisted, Muslim religion has lost its significance and the significance and magnitude of altitude has diminished slightly.

In general the effect and direction of association of all variables with infant mortality are found to be mostly consistent with the results obtained in the previous regression models, except for the Amharas who have shown lower risk of infant mortality over Oromos and other ethnic groups.

When the significance of the three groups of variables (demographic, socio-economic, environmental) is assessed, the largest portion of the model is explained by socio-economic variables followed by demographic variables. In general, environmental variables have shown to have lower effect on infant death as compared to demographic or socio-economic variables.

Chapter 6: SUMMARY CONCLUSION AND RECOMMENDATIONS

This study has estimated the levels and trends of infant mortality and has examined the determinants of infant mortality in the rural population of Ethiopia. The analysis of determinants was carried out using univariate and bivariate comparison of infant death rates among categories of demographic, socio-economic and environmental variables.

Furthermore, the logistic regression was applied in order to define the individual effect of the different predictor variables. After a brief discussion on the background characteristics of the study, data quality was assessed. It has been shown that there may be some omissions of deaths and misreporting of ages in the data. However, the birth history data has shown evidence of better reporting, though some omission may have occurred for the most recent periods preceding the survey. These data are selected for the analysis of determinants. Eventhough the study of differentials is confined to the most recent five years period, the levels and trends of infant mortality are observed on 30 years period. Within in 30 years, infant mortality has fallen by 45 percent which is a 1.5 percentage point reduction per year. Although the estimates have shown a declining trend, the mortality level of 115 infant death per 1000 births, for the period 1985-89 is still very high.

The univariate analysis indicates the existence of variation in infant mortality among demographic, socio-economic and environmental factors categories of the population. Among demographic variables, preceding birth interval and survival of child followed by birth order have proved to have significant effect on infant mortality. Although the expected high mortality for higher order births did not emerge, first order births were found to be at a higher risk of dying at infancy compared to birth orders of 2, 3, and particularly 4. First order birth was 1.3 times at risk of mortality than those infants of birth order 4.

The finding reveals that short preceding birth intervals increase the risk of infant

mortality is also confirmed in this study. The risk of death is very high for those infants born within 2-years of a previous birth. This risk declines as the interval increases. For instance, children born after an interval of more than 3 years are about 2.21 times more likely to survive in infancy than those infants born after a gap of less than 2 years. Infants with a preceding sibling who is alive have shown lower mortality risk. Sex of the child is not found to have a significant effect on infant survival. However, as in most societies, boys are more likely to die than female infants.

With regard to socio-economic variables, region of residence, altitude, religion of mother, father's education as well as occupation, marital status and possession of modern household goods have proved to have significant effect on infant mortality. Accordingly, children of Christian women have less risk of dying than children of other religion and Muslim, in order of importance. Children of Gurage women have exhibited an advantage over Oromo, "others" and Amhara. However, the low infant mortality among Gurage women may be because of the low number of cases. Substantial regional disparity in infant mortality is also observed in the study. The highest rates are observed in Gambela, Metekel, Dire Dawa and Keffa, while the lowest rates are observed in West Godjam followed by Borena, Bale, Asosa and Sidamo respectively. Furthermore, living in the highland areas has a lower infant mortality risk over that of lowland areas.

Children whose mothers have some education show a lower risk of dying than children of women with no education or with non-formal education. Likewise, less chance of infant death is observed for those women with an educated husband. The risk is likely to decrease with the increase in the husband's education. Children of married women, children of working women and children of women who work at home have shown mortality advantage over children of unmarried women, children of non-working women and children whose mothers work away from home respectively.

Households which possess radio, table or a watch have shown lower risk of infant mortality than those which do not have such items. Also, infants of women who listen to radio are 1.23 times likely to survive at infancy as compared to those whose mothers do not listen to radio. Households which have access to electricity have shown less risk of infant deaths as compared to those which have no access to it.

Findings regarding environmental characteristics are in some cases unexpected. For example, less chance of infant death is observed for those households that use protected well/spring or river/lake/pond as compared to tap water. Furthermore, higher infant death is observed in households which possess toilet facilities than those which do not have. Lack of hygiene may be the cause of these inverse relationships. However, these findings require further studies.

Infants of women who use soap have shown a survival advantage over those infants of mothers who do not use soap. Regarding housing characteristics, the study has shown that the building material used for the walls, roof and flooring is not statistically significant. Nevertheless, children living in housing units of thatch roofing and earth flooring have higher risk of dying than those living in housing units with corrugated iron sheet or other type of roofing and other flooring than earth.

A two-factor analysis was also made among demographic variables and among some socio-economic variables controlling for maternal education which is known to be the most influential variable. The finding, with regard to this analytical step is mostly consistent with the result obtained in the univariate analysis. The strong effect of short preceding birth interval persists even when the effect of birth order survival of preceding child and maternal education is taken into account. Also the significance of survival of preceding child has remained. The effects of ethnicity, religion, and altitude have persisted even after controlling for the effect of maternal education.

Father's education has proved to have strong effect in situations where the mother has no education. When she has some education, father's education has shown significant effect on infant mortality when it is grade 7 and above.

The multivariate analysis has mostly confirmed the results obtained in uni/bivariate analysis. Regarding the relative importance of demographic factors, the analysis shows that preceding birth interval is the most important determinant of infant mortality followed by birth order and survival of preceding child.

Concerning the socio-economic characteristics, father's occupation, father's education, mother's religion followed by altitude are found to be the most important determinants of infant death. Among environmental variables, source of water has proved to be an important predictor variable.

When the effect of socio-economic/environmental variables is controlled, the magnitude of demographic variables, especially that of birth order and preceding birth interval, has increased and remained significant. With regard to socio-economic variables, when the effect of demographic variables is taken into consideration, the results confirm those obtained previously except for the Amhara women who have shown a lower risk of infant mortality as compared to Oromo and women of other ethnic groups. This result is in accordance with studies undertaken by Assefa (1991), Yohannes (1990), and Mulugeta (1995).

Father's education, altitude, father's occupation, mother's religion and source of water have shown significant independent effect on infant mortality. In general, socio-economic and demographic variables are found to have higher effect on infant death as compared to environmental variables, in rural Ethiopia. This is in accordance with the findings of Meegama (1980) in her study in Sri Lanka and Gubhaju et. al (1991) in their study in rural Nepal.

Reviewing the results of the study in terms of the hypothesis forwarded at the beginning, we have seen that hypothesis 1 is only partly true, hypothesis 2, 3, 4, 8 and 9 are verified.

1. First order and higher order (above 5) births have lower chance of surviving than intermediate order births.

2. The higher the length of preceding birth interval the higher is the chance of surviving.

3. Male infants are likely to experience higher mortality than their female counterparts.

4. The risk of dying of infants is lower among literate mothers.

8. Mortality level varies from one region to an other and is likely to be higher in the lowland areas than in the highland areas.

9. Socio-economic and demographic factors, in general, affect the chances of infant survival more than environmental factors.

Results concerning hypothesis 5, 6 and 7 are not supportive

5. Infants of working women are likely to experience higher mortality than those of non-working mothers.

6. The risk of dying during infancy of children born to families who have no access to toilets is higher than those who have access.

7. Access to safe drinking water reduces the risk of infant mortality.

RECOMMENDATIONS

Maternal demographic factors namely, birth order and birth interval are found to be strong determinants of infant death. Thus efforts should be made to discourage short birth interval and early child bearing. Some of this may be achieved through the introduction of health messages for young adults, in particular for females in order to create an awareness of the hazards of early childbearing and short birth spacing. Besides the use of contraception for birth spacing purpose should be encouraged and practical steps taken to make these available to the rural population. The introduction of family planning programmes together with MCH programmes and services will undoubtedly reduce not only infant mortality but also fertility. Use of antenatal care can reduce a significant proportion of infant deaths.

The other noteworthy result of the study is the high correlation between the survivorship of successive siblings. Therefore, special attention needs to be focussed on mothers whose earlier children have died encouraging them to monitor their pregnancies and to identify problems for early help if needed. Moreover, it may be useful if health education programmes (on child care, nutrition, hygiene, etc...) were designed for families that have suffered a child death so that the risk of another child death may be substantially reduced.

Among others, better maternal and paternal education, better quality of housing, improved environmental condition, access to toilet, safe water as well as electricity have proved to be important for lowering infant mortality. Thus, improvement of overall socio-economic situation of the regions, in general, and particularly increasing the educational opportunity for the rural population and betterment of access to services like water and electricity are suggested as having substantial impact in the reduction of infant mortality.

Besides efforts should be made to provide adequate pre and post-natal care, trained midwives, mass education on appropriate infant nutrition, child care and self care.

Diarrhoea, acute respiratory infections, malnutrition and malaria (in low land areas) are the main causes of infant mortality. Therefore, health services should be made available to treat and to teach the rural population against these diseases.

Immunization coverage should be expanded to reach most of the rural population, and safe delivery services should be provided in facilities accessible to them, with possiblities for referral to higher level care when the need aries.

However, sustained reduction in infant mortality can be achieved only through the improvement of the overall socio-economic conditions of the rural population.

Although this study suggested some of the important determinants of infant mortality in rural Ethiopia, there is still much room for investigating the mortality determinants more thoroughly. As any other research study the present study is not exhaustive and the 1990 NFFS which provides a wide range of variables can be used for further studies.

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ANNEX

Annex I: Infant mortality by region, rural Ethiopia, 1990.

Background variable	Infant death rate per 1000		significance
	Births	death rate	
Region of residence			P<.001
West Gojjam	274	76.6	
Borena	146	102.7	
Bale	128	109.4	
Asosa	88	113.6	
Sidamo	593	114.7	
Arsi	418	124.4	
West Shewa	428	135.5	
North Shewa	245	138.8	
East Shewa	161	155.3	
Addis Ababa	127	157.5	
South Shewa	444	168.9	
East Gojjam	171	175.4	
Wellega	495	175.8	
Illubabor	733	178.7	
South Omo	49	183.7	
North Omo	441	188.2	
West Harerge	273	197.8	
East Harerge	353	204.0	
Keffa	268	220.1	
Dire Dawa	45	222.2	
Mekele	239	284.5	
Gambella	86	290.7	

Source: Computed by the author based on the 1990 NFFS rural data.

Annex II: Log likelihood ratio test of significance of demographic variables on infant mortality, rural Ethiopia, 1990.

Step	Variable	Log likelihood	-2LL	X^2	df	P
1	none*	-2772.82	5545.63			
2	birth order	-2766.54	5533.08	12.55	4	0.0061
3	preceding interval	-2575.85	5151.69	381.4	2	<0.001
4	survival of preceding child	-2571.66	5143.32	8.36	1	0.0039
5	sex of the child	-2571.14	5142.28	1.04	1	0.3077

* a model with no variable thus birth order is compared with the initial log likelihood function.

Annex III:

Log likelihood ratio test of significance of socio economic and environmental variables on infant mortality, rural Ethiopia, 1990.

Step	Variable	Log likelihood	-2LL	X^2	df	P
1	none*	-2771.38	5542.75			
2	ethnicity	-2270.24	5540.47	2.28	2	0.4722
3	religion	-2763.87	5527.73	12.74	2	0.0266
4	altitude	-2757.97	5515.93	11.81	1	0.0687
5	mother's education	-2756.75	5513.49	2.44	1	0.8340
6	father's education	-2750.10	5500.19	13.30	1	0.0064
7	marital status	-2750.00	5499.99	0.20	1	0.4754
8	work status	-2749.89	5499.78	0.21	1	0.4957
9	place of work	-2745.92	5491.84	7.94	1	0.4321
10	occupation	-2714.51	5429.01	62.83	2	0.0695
11	HH possession	-2704.06	5408.12	20.90	1	0.1142
12	listening radio	-2703.36	5406.72	1.40	1	0.6921
13	electricity	-2701.63	5403.25	3.47	1	0.1277
14	wall	-2700.94	5401.87	1.38	2	0.7840
15	roof	-2699.49	5398.98	2.90	2	0.4009
16	floor	-2699.34	5398.67	0.30	1	0.6479
17	source of water	-2687.85	5375.70	22.97	3	0.0001
18	toilet	-2687.66	5375.32	0.38	1	1.0301
19	soap	-2686.04	5372.07	3.25	1	0.9746

Annex IV: Logistic regression estimates (Beta coefficients) of environmental variables on infant mortality, rural Ethiopia, 1990.

Variable	Model 1	Model 2	Model 3
Source of water			
tap	0.4654***		0.4913***
protected well/spring	- 0.3051***		- 0.3107***
unprotected well/spring	- 0.0392		- 0.0517
Toilet			
available	0.0399		0.0427
Use soap			
yes	- 0.0720**		0.1198
Type of walls			
bamboo & mud/reed & mud		0.0301	0.0465
others		0.0894	0.0184
Type of floor			
others		- 0.2807	0.0465
			0.0184
Type of roof			
corrugated iron sheet		0.0090	- 0.2863
others		- 0.0759	
-2 Log likelihood	5505.360	5532.258	5497.204
X^2	33.43	9.04	41.58
	P=0.000	P<0.1	P=0.000

*** significant at 1 % ** significant at 5 %