Original article

Determinants of infant and early childhood mortality in a small urban community of Ethiopia: a hazard model analysis

Assefa Hailemariam[1] and Makonnen Tesfaye [2]

Abstract: By applying Cox's proportional hazard model regression analysis to data collected using a retrospective survey conducted in Sebeta, a town 25 Km west of Addis Ababa, the capital city of Ethiopia, the paper examines the factors impinging on the survival of infants and children between 1 - 3 years of age. It is shown that for higher order births (more than 5), for births to young women (under 20 years of age), and for those to older women (more than 34 years of age), the risk of dying at infancy is higher. The risk of infant mortality is also high for births with short previous birth intervals. In fact, the length of the previous birth interval is found to be the single most important factor affecting the chances of survival during infancy. It is further shown that education of mother, occupation of father, household income, source of drinking water, availability of latrine, and survival status of older sibling have direct effect on infant mortality. Among these, source of water and availability of latrine are identified as having significant effects on infant mortality even after controlling for the effects of other variables. During early childhood, however, the effects of age at maternity, birth order and preceding birth interval becomes trivial. Following birth interval appears to have a strong effect on the chances of survival during early childhood. Household income, religion and survival status of the previous sibling are found to have significant effects on early childhood mortality. The findings provide solid ground to support strategies to broaden MCH/FP services, environmental health and income generating scheme to reduce the risk of death for infants and children. [*Ethiop. J. Health Dev.* 1997;11(3):189-200]

Introduction

Infant and child mortality have long been used as indicators of the level of socio-economic development of a nation. Most of the developed countries have registered low levels of infant and child mortality rates. In the developing countries, particularly, in sub-Saharan Africa, although significant achievements have been made, infant and child mortality still stand at high levels. In Ethiopia, in 1990, about 10% of the infants died before their first birthday and more than 15% of the children died before their fifth birthday (1).

Also various studies (2-9) show high levels of infant and childhood mortality in the country. This high level of mortality may be associated with demographic, socio-economic, and environmental factors such as ethnicity, housing condition, crowding, availability of latrine, and early termination of breast feeding (9). However, most of the studies conducted so far examined the effects of the socio-economic and environmental variables and did not consider the inpact of the demographic factors (age at maternity, birth interval, birth order, and survival status of preceding sibling mainly due to the general lack of data. Some studies (2, 3, 6) identified such variables as sex of child, mother’s place of residence, education, religion, ethnicity, marital status, income, and environmental sanitation as important determinants of infant and childhood mortality. Others (7, 9) identified additional factors such as care at delivery, duration of breast feeding, child nutrition, and paternal education.

[1] From Demographic Training and Research Center, Institute of Development Research, Addis Ababa University, P. O. Box 1176, Addis Ababa, Ethiopia, and [2]Population Studies and Analysis Center, Central Statistical authority, P.O. Box 1143, Addis Ababa

Other factors such as maternal age, birth order, and birth interval are also shown to have significant impact on the chances of infant and child survival (10, 11). Cultural values and norms, as well as community level or environmental variables among others, are also known to influence the chances of infant/child survival (12, 13). However, in Ethiopia, indepth studies dealing with demographic, socio-ecomonic and environmental correlates of infant/child mortality are lacking. Identifying the socio-economic, environmental and demographic determinants of infant and early childhood mortality is believed to assist in the design of programs for lowering the risk of high infant and child mortality that prevails in the country. In view of the strong association between infant and child mortality and fertility, lowering infant and child mortality may subsequently lead to fertility decline (15, 16).

This study, therefore, attempts to narrow the gap in our present understanding of the effect of demographic, socio-economic and environmental factors on infant and early childhood mortality by controlling for social and demographic characteristics of the mother and the child.

The objectives of this paper are : (i) to analyze the separate and combined effects of the demographic variables (age at maternity, birth order and length of the preceding and subsequent birth interval) on infant and early childhood mortality in the absence and presence of other socioeconomic and environmental factors and (ii) to determine the relative importance of each of the demographic variables.

Methods

Data: The study is based on data obtained from Sebeta Town, about 25 Km west of Addis Ababa, between June and July 1992. All females of reproductive age who were permanent residents of the town at the time of the survey were included in the study. Consequently, a total of 3,140 women living in 2,134 households were interviewed. Female interviewers conducted the interview using structured questionnaires. Two sets of questionnaires, namely, the household and individual questionnaires were used. The household questionnaire was used to develop and collect inforrmation on socioeconomic and environmental background characteristics of the households, such as source of drinking water, type of toilet facilities, and availability of radio in the household.

The individual questionnaire was used to obtain information on women's characteristics, such as age, marital status, education, work status, occupation, religion, ethnicity, husband's background characteristics, household income, the number of children ever born, the number of children dead, births in the last 12 months, birth history of each live birth, breastfeeding status, and duration of breast feeding.

Since age in months is an important requirement for studies which include birth intervals, children with missing month of birth were dropped from the analysis. The differential in reporting month of birth among sub-groups of the women was examined and found to be insignificant, implying that the exclusion of these from the analysis would not introduce serious bias in the study. Although children whose mothers have died have higher mortality risks, in this study, it is assumed that mortality among children whose mothers have died is similar to that of children whose mothers are alive (17).

Data reporting was considered to be poor for older women (those aged 40 years and older) compared to younger women. Reporting of children ever born and children dead was better for the most recent births (10-15 years prior to the survey). However, age data indicated the presence of age heaping, age shifting and age under-reportings especially for older women. In order to minimize the magnitude of error and bias in the results, data analysis is limited to births that occurred in the 15 years preceding the survey. Of 6405 live births to all women, only 5385 (3, 114 births for infant mortality and 2, 271 for early childhood mortality) were included in the analysis due to the exclusion of births with missing month of birth, and births which occurred before 15 years prior to the survey date.

Statistical methods: Several models are available for handling studies of this kind (linear regression, logistic regression, etc.). However, such models do not handle censored cases (cases with incomplete exposure). The proportional hazard model, first developed by Cox (17), is a well known model for handling censored cases. It is a special case of the more general survival model in that it combines aspects of the life table and regression analysis and allows the formulation of relations between a set of covariates and the survival function as in conventional multiple regression.

It is used in the analysis of survival data when mortality risks vary among individuals.

The model assumes that, at a given age (or duration since the start of life), the force of mortality is a constant (specific to that age) multiplied by a proportional factor which is determined by the characteristics of the individual. Specifically, at duration d for an individual i with a known set of explannatory variables $Z_i=(z_1,z_2,...z_z)$ the hazard (risk) function is given by $\lambda(t;Z)=\lambda(d)\exp ß'Z_i$ where $\lambda(d)$ is the baseline hazard; and $ß=(ß_1,ß_2,...ß_k)$ is a vector of parameters. The factor $\exp ß_j$ is the relative risk associated with the j^{th} explanatory variable. Parameters are estimated using maximum likelihood procedure. This is the model employed for examining the determinants of infant and child mortality in this study.

STATA, a standard statistical software, was used for data analysis. The data required for estimation has the form (t_i,δ_i,Z_i), where t_i represent time to death or censorship since entry into the study (in this case, number of months child stayed alive); δ_i indicates whether child was excluded from the study population due to death or censorship. For infant mortality analysis, δ_i=0 or 1, depending on whether the infant died before age one or survived to age one. For child mortality analysis also, δ_i=0 or one depending on whether the child died while aged 1-3 years or survived to age three. Z_i is a vector of explanatory variables.

The demographic variables included in the model are birth order, age at maternity, preceding birth interval, and following birth Interval. Birth order indicates the order of birth of the index child and it is treated as a categorical variable in the model with three categories representing births of order 2 to 3, 4, and 5 or above. Births of order 4, indicated the lowest death rate and are used as a reference catagory.

First order birth are known to be at a higher chance of mortality, mainly due to the detrimental biological influence of being the first birth. It appears that toxaemia of pregnancy is more frequently associated with first births (19). The increased risk of mortality among first born children may also be due to the young age of mother at their birth. However, in this study, since the multi-variate analysis includes preceding birth interval as one of the main explanatory variables, first births are excluded because they are preceded by no one.

Age at maternity refers to the age of the mother at the birth of the child and it is also grouped into three, namely, less than 20 years (early), 20-34 years (intermediate), and 35 years or more (old). Maternal age of 20-34 is used as the reference category. Preceding birth interval is the length of the interval between the birth of the index child and its older sibling. Three categories of preceding birth interval, (less than two years, 2-3 years, and 3 years and more) are included. The reference category is the 2-3 years birth interval. 'Following birth interval' refers to length of time between the birth of the index child and the one following it. This variable is used only in the early childhood mortality analysis and it is treated as a dummy variable (1 if<18 months, 0 therwise).

A number of demographic, socio-economic, cultural and environmental variables expected to have close relationship with infant/child mortality were used as control variables. These variables were included to see if they modify the effects of maternal factors on infant/child mortality. These include survival status of previous birth, parental education (i.e., educational levels of mother and father), occupation of father, work status of mother, place of work of mother, mother's ethnic back ground, religion of mother, source of water, availability of latrine, and household income. Place of birth of mother (urban or rural) and sex of the child were not used here because infant/child mortality differed very little by place of birth of mother or by sex of child.

All of the control variables were treated as categorical. Three categories of education were used for father's and mother's education: no schooling (illiterate and informal education), elementary (grades 1-6), and high (junior and above) . The educational category 'high' was used as a reference category. Three categories of father's occupation were employed: professional-secretarial, salesservice, and others (production workers, laborers and all others). The first group, i.e., the professional group was used as a reference category. Two groups of work status of mothers were considered: working and non- working. Household income was categorized into three: less than

Birr 100, Birr 100-299, and Birr 300 or more. The category 'Birr 300 or more' was used as a reference category.

Ethnicity and religion of mother are the two socio-cultural variables used as control variables. The two major ethnic groups in the study area, that is, Oromo and Amhara, and all other groups together, were compared. The Amhara had the lowest infant/child mortality and this group was used as a reference category. Religion of mother was grouped into Orthodox, Protestant/Catholic, and Muslim. Followers of Orthodox Christianity had the largest number of cases. This group was used as a reference category.

Environmental contamination was controlled using source of water and availability of latrine. Private pipe, shared pipe, public tap, and well/river were the four categories for source of water. Private pipe was used as a reference category. Latrine was categorized as private, shared and none. Those with private latrine were used as control category. Survival status of older sibling at the time of survey was included to control for child mortality pattern in the family. In the analysis, the effects of variables of main interest were first considered and then the effect of these variables was examined after adjusting for the effects of the control variables.

Results

Population Characteristics: At the time of the survey (June 1992), the Town had a total pupulation of 11624. This excludes those living in unconventional living quarters. Of these, 5436 were males and 6188 were females giving a sex ratio of 88 males per 100 females. More than half of the population (55.1%) belonged to the economically active age group. The dependent population (children under 15 and adults 60 yrs and above) constituted 44.9%. There were more females in the economically active age group compared to males (57.3% against 52.5%). However, most women were not economically active. At the time of the survey, nearly three quarters of the women had no work other than household chores. Women of reproductive age (15-49 years) constituted a little over one quarter of the total female population (Table 1).

Table 1: **Distribution of the population of Sebeta town by broad age groups and sex**

Age Group	Male		Female		Total	
	No.	%	No.	%	No.	%
0-14	2334	42.9	2364	38.2	4698	40.4
15-59	2852	52.5	3548	57.3	6400	55.1
60+	250	4.6	276	4.5	526	4.5
Total	5436	00	6188	100	1624	100

Table 2 presents some socio-economic background characteristics of the respondents.

Data on marital distribution show that less than 40% of women in their reproductive years were in marriage and 15.8% were either divorced or widowed while 46.5% were never married at the time of the survey. Although the majority of the women were literate, only 26.8% had attained secondary or higher education. The educational distribution of currently married husbands on the other hand shows that men had better education than women. While the percentage of literate among the female population was 78.5, the corresponding percentage for males was 90.6. In all the other educational categories also the proportion for males is much higher than that for women.

Table 2: **Percentage distribution of woman aged 15-49 years by selected socio-economic characteristics**

Variable Distribution	Percentage	N
Marital Status		
Single	46.5	1460
Married	37.8	1186

Widowed	5.4	169
Divorced/Separated	10.3	325
Education of Woman		
Illiterate	21.5	674
Read and Write	16.4	516
Elementary	19.4	608
Junior	15.5	488
Secondary	25.2	792
Above Secondary	1.6	51
Not Stated	0.4	11
Education of Husband		
Illiterate	9.3	110
Read and Write	18.3	217
Elementary	23.7	281
Junior	15.8	188
Secondary	22.5	268
Above Secondary	8.7	103
Not Stated	1.7	20
Work Status of Woman		
Working	27.0	847
Not Working	73.0	2292
Place of Birth		
Urban	59.2	1857
Rural	40.2	1263

A large majority of the respondents had no work other than household chores, only 27% reported as working at the time of the survey. Nearly 60% had urban origin while 40% were migrants to the town from rural areas.

Infant mortality: In this section, we first present the level of infant mortality in the town before applying the hazard model. Table 3 presents the levels of infant and child mortality estimated using the Trussell version of the orginal Brass technique of estimating infant and child mortality from information on children ever born and children surviving classified by age of mothers (20). It may be observed that infant mortality rate for the town at the time of the survey was about 86 per 1000 live birth. This indicates that the level of infant mortality was relatively lower in the town compared to other urban areas in the country at that time. For instance, the level of infant mortality estimated for urban Ethiopia using the 1990 National Family and Fertility survey was 93.6 per 1000 live births (1). The 1994 Census for Urban Oromyia resulted an adjusted infant mortality rate of 93 per 1000 live births and 78.5 for Addis Ababa (21,22).

Table 3: Average infant, child(1-4) and under-five mortality per 1000 live births, Trussell, north model; Sebeta, 1992

	Rates per 1000 live births
Infant mortality rate ($_1q_0$)	86
Child mortality rate ($_4q_1$)	57
Under five mortality rate ($_5q_0$)	138

Tables 4 through 8 show results of the proportional hazard model applied to the data. Table 4 presents seven hazard models of infant mortality. The first three models estimate the univariate effects of variables of main interest, namely, birth order, age at maternity, and preceding birth interval. Models 4-6 include two variables at a time, and model 7 includes all three variables simultaneously and is considered the full model. In this and subsequent tables the effects of the various covariates are expressed as relative risks.

The effects, or the relative risks, are calculated as exp$ß_{ij}$, where $ß_{ij}$ is the estimated coefficient for the i^{th}category of variable j. For a given variable, relative risks compare mortality risks for different categories with that of the reference category. For example, in the full model (model 7) of Table 4, the relative risk of 1.781 for age at maternity of less than 20 years means that mortality rate for infants born to mothers aged less than 20 years is 1.781 times higher than that for infants born to mothers in the reference category, that is,

Table 4: **Relative effect of variables of main interest (maternal factors) on infant mortality.**

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Birth order							
2-3	1.4189			1.216	1.415		1.254
4	1.000			1.000	1.000		1.000
5+	1.60*			1.603*	1.553*		1.544*
Age at maternity							
<20 years		1.844♣		2.016♣		1.697↑	1.781♣
20-34		1.000		1.000		1.000	1.000
35+		1.272		1.121		1.039	1.211
Preceding birth							
Interval							
<2 years			1.755↑		1.731↑	1.668↑	1.644↑
2-3 years			1.052		1.004	1.341	1.018
>3			1.000		1.000	1.000	1.000

Note 1 In this and the following tables, the symbols *, ♣, ↑ indicate level of significance (t test, two side) at 10, 5 and 1 percent level, respectively

Note 2 Model 1-3 estimate univariate effects; model 4-6 include two variables at a time while model 7 (full model) contain all variable simultaneousely.

women aged 20-34 years. The symbols indicating level of significance refer to the departure of the relative risk from unity, the value of the relative risk for the reference category.

The single-factor effect (models 1-3) indicates that, when the effect of other factors is not taken into account, births of order 2-3, and higher (5 and above) seem to have higher mortality risks compared to births of order 4. Births of order 2-3 had 42% higher risk of dying while those of order 5 or higher had 60% higher risk compared to births of order 4. However, the effect is not statistically significant.

Infants born to mothers under 20 years of age had a significantly higher risk of dying (84%) compared to those born to mothers in the reference category (aged 20 - 34 years). Infants born to older mothers (35 years or more) were also at a higher risk of dying (27%). A birth within two years of the birth of the index child had a significantly higher risk of dying at infancy (at 0.01 level) compared to preceding birth interval of more than three years. Whereas, a birth that occurred 2-3 years after the birth of the index child had no significant impact on infant mortality compared to that born after an interval of more than three years (Table 4).

The two-factor effect (models 4-6) indicates that the effect of births of order 2-3 compared to births of order four declined when age at maternity is controlled. However, controlling the effect of age at maternity or the length of preceding birth interval did not alter the risk of dying at infancy for higher order births (birth order 5 or higher). This suggests that the relatively higher risk of dying for infants of order 2-3 is mainly due to the young age at maternity. Controlling for the effect of the preceding birth interval appears to have reduced the effect of maternal age on infant mortality. Birth order and preceding birth interval affect the chance of infant survival independently of each other.

Results in the full model (model 7) show that the independent effect of the variables persisted even after making adjustment for the effects of any two of the other variables. Although the magnitude of the effects are reduced, they are still significant. After controlling for the effect of age at maternity and length of preceding birth interval, births of higher order have 54% higher risk of dying before the first birthday than births of order 4. When the effects of birth order and length of preceding birth interval are controlled, children born to mothers under 20 years of age have 78% higher risk of dying compared to those born to mothers aged between 20 and 34 years. Children born within two years of the preceding birth have 64% higher chance of dying at infancy, even after controlling for age and birth order, compared to those born after three or more years of the pervious child.

Log likelihood ratio tests are used in order to assess the significance of the contribution of variables as well as to determine their order of importance. Table 5 presents the change in -2 x log likelihood (-2LL) when a backward selection procedure is employd. In step 1 '-2LL' of a model containing all of the demographic (maternal) factors is presented. In step 2 a model containing maternal age and birth interval is compared to the 'Full model (a model containing all variables). The increment in the goodness of fit of the model (χ^2= difference in -2LL) indicates that birth order has a significant impact on infant mortality rate at 10 percent level. Similarly, in step 3 and 4 models which exclude, respectively, maternal age and birth interval are compared to the full model. The result shows that age at maternity and length of preceding birth intervals have significantly increased the goodness of fit of the model.

Table 5: **Log likelihood ratio test of significant of variables: infant mortality**

step	Model	-2* Log Likelihood	X^2	df	p
1	Full Model	2277.46			
2	$ß_2=0$	2280.41	2.95	1	$0.05<p<0.1$
3	$ß_2=0$	2282.47	5.01	1	$0.025<p<0.01$
4	$ß_3=0$	2285.76	8.3	1	$p<0.0005$

A Comparison of -2 x log likelihood of the models shows that the preceding birth interval is the most important variable, followed by age at maternity in affecting the chances of survival at infancy. Birth order has the least but statistically significant effect on chances of survival at infancy.

Table 6 presents nine hazard models after controlling for certain variables. Model 1 contains the effects of birth order, age at maternity and length of the preceding birth interval. Models 2-5 include the socio-economic variables (mother's education, work status and household income). Survival status of previous sibling is also included in addition to the variables of main interest. In models 6 and 7, the variables are entered in blocks, ethnicity and religion in model 6, and source of water and availability of latrine in model 7. Model 8 is the full model and model 9 considers only control variables. Education and occupation of father are not entered at this stage because the numbers of cases were not the same for the two variables and this made comparison rather difficult. These will be considered later in the paper. Place of work is also dropped from the model because of strong colinearity with work status of mother.

The results show that none of the control variables included in the analysis appear to explain the effect of higher birth order on increased infant mortality. Controlling maternal education, availability of latrine and household income, indicates marginal change on the effect of birth order. The other variables do not appear to affect the impact of birth order on the survival chances at infancy. The higher chance of dying during infancy for higher order births lost its statistical significance after controlling for the effect of maternal education.

Model 4 shows that some of the effect of young maternal age on infant survival is explained by household income. The effect of young maternal age is stronger in low income households. Infants born to mothers in households whose income is less than Birr 100 had higher risk of dying compared to those born to mothers living in households with higher income. Controlling effects of other variables did not change the effect of age at maternity on infant mortality.

Analogous to birth order, statistical control of variables considered here shows that the effect of the length of preceding birth interval is invariant under most conditions. Only survival status of previous sibling seem to explain a little of the effect of preceding birth interval on infant mortality. This and the bi-variate results show that the negative impact of short preceding birth interval appears to increase if previous child has died. The change in the effect of preceding birth interval is small when all other variables are controlled simultaneously.

Table 6: **Relative risks of maternal factors when control is made for some background variables, infant mortality: Hazard model.**

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Birth order									
2-3	1.254	1.300	1.244	1.267	1.269	1.254	1.208	1.215	
5+	1.537*	1.467	1.559	1.609*	1.498	1.519	1.614*	1.634	
Age at maternity									
<20 yrs	1.781♣	1.549	1.800♣	1.6432*	1.661♣	1.807♣	1.760♣	1.679♣	
35+ yrs	1.211	1.840	1.208	1.179	1.223	1.177	1.288	1.302	
Preceding birth									
interval									
<2 yrs	1.644↑	1.633↑	1.644♣	1.707♣	1.558♣	1.622↑	1.613♣	1.531♣	
2-3 yrs	1.018	1.027	1.107	1.041	1.018	1.001	0.903	1.012	
Education of mother									
No school		1.548*						1.020	1.043
Elementary		1.548						1.275	1.313
Work status of mother									
Working			1.312					1.231	1.237
Incom(Birr)									
<100				2.347↑				1.399	1.384
100-299				1.678				1.165	1.159
Preceding sibling's survival status									
Dead					2.106↑			1.648♣	1.901↑
Ethnicity									
Aroma						1.408*		1.057	1.004
Others						1.094		0.995	1.049
Religion									
Muslim						1.174		1.483	1.446
Prot/Catholic						1.672		0.935	0.914
Water source									
Pipe-com							1.407	1.361	1.301
Public tap							2.801↑	2.455↑	2.409↑
Well/river								0.707	0.761
Latrine									

Common							1.439	1.303	1.308
None							1.686♣	1.473	1.498*
-2LL	2274.5	2257.7	2275.0	2258.6	2266.3	2271.1	2225.0	2198.8	2214.0

Note 1. Reference Categories are not shown.

Note 2. Model 1 estimate effects of main variables; Model 2-4 in addition, include one background variables at time. Model 5 and 6 add background variables in block on top of main variables, while model 8 (ful model) contain main varables and background variables simultaneously. Model 9 considers the effect of bacground variabls in group.

When the control variables are considered, women's education, other than its effect through maternal factors, appears to have an independent effect on the chances of survival at infancy. However, when either source of water, latrine or household income is added into the model, education lost its role as an important variable in explaining the variability in infant mortality. Ethnicity, source of water, latrine, and household income influence the risk of infant survival by operating through mechanisms other than maternal factor. However, the importance of these variables in affecting the chances of survival at infancy declines with the introduction of maternal education into the model. For instance, the magnitude of the effect of ethnicity and income declined when maternal education was introduced and vanished when all other variables were simultaneously controlled.

Once the effects of maternal factors are taken into accont, work status of mother and religion are not found to be important determinants of the survival status of infants. The single factor effect, however, indicates that infants born to working mothers had higher mortality risks relative to nonworking mothers. This may be because working women have less time for infant feeding (including time for breastfeeding) and caring compared to non-working women.

Another variable which has direct and significant effect on infant survival is the survival status of the preceding sibling. When the preceding birth has died, the chance of dying of the index child is about two times that of a child whose older sibling has survived. However, when the effects of other variables are controlled, this high effect is reduced but still remained significant.

The effect of maternal and socio-economic factors on the risk of infant survival was also considered by restricting the analysis to currently married mothers. This was done so as to control for some of the fathers background characteristics. Table 7 presents the hazards of main variables along with education, and occupation of father.

Note that the significant effect of young age at maternity (under 20) is lost when the analysis is restricted to currently married mothers. When father's education is controlled, the effects of birth order and preceding birth interval on the chances of infant survival did not change, but that of age at maternity increased. Father's education appears not to have any significant impact on infant survival.

Table 7: Relative effects of maternal factors, when father's background is controlled, on infant mortality

Variables	Model 1	Model 2	Model 3	Model 4
Birth order				
2-3	1.833*	1.8507*	1.8765*	1.879*
5+	2.111♣	2.0883♣	2.0256♣	2.043♣
Previous birth				
interval				
<2 years	1.805↑	1.809↑	1.775♣	1.783♣
2-3 years	0.981	0.969	0.957	0.956
Age at ,atermotu				
<20 years	1.5902	1.6524	1.547	1.581
>34 years	1.097	1.318	1.976	1.061
Father's education				
No schooling		1.317		1.057
Elementary		0.961		0.791
Occupation of father				
Sales-service		2.254↑	2.341↑	
Prod-others		1.936♣	1.936♣	
-2LL		1663.3	1642.1	1640.6

Note 1. Reference categories are not shown

Note 2. Model 1 estimate effects of main variables; Model 2 and 3 in addition, include one background variables at a time, while model 4 full model contain main variables and background variables simultaneously.

Father's occupation appears to have very little impact in explaining the effects of high birth order on infant mortality. Only a slight change in the effects of preceding birth interval and age at maternity is observed when father's

occupation is controlled. Father's occupation has its own highly significant effect on infant mortality rate. Infants born to fathers working in the sales-service sector and production/laborersothers are, respectively, 2.3 and 1.9 times more likely to die compared to infants born to fathers engaged in professional-secretarial activities. Occupation of father remains important even after controlling for the effects of other socio- economic variables such as education of father and household income (see Table 7). When all other control variables are included in the model simultaneously, however, the effect of father's occupation is not only reduced in size but also lost its statistical significance.

Child mortality: As stated earlier, the length of following birth interval is used as a covariate in this analysis and this has reduced the number of cases to 1,250 only. Table 8 presents hazards of child mortality. Model 1 considers the effects of maternal factors alone. Model 2-4, in addition, include the effects of education of mother, household income and survival status of preceding child. Model 5 is the full model and model 6 considers the effects of control variables only.

Table 8 shows that the effect of age at maternity, which was strong in the case of infant mortality, has disappeared for child mortality. High order births and short preceding birth intervals have relatively high but non-significant effect on child mortality. Of the four variables of main interest, only length of following birth interval appears to have strong and highly significant effect on child mortality. The single factor effect of length of following birth interval is such that the chance of dying during childhood of an index child born within 18 months after the birth of his/her older sibling is 3.8 times higher than that of a child born after 18 months.

The effect of maternal factors on child mortality is not influenced when the control variables are entered into the model sequentially. In fact, the magnitude of the effect of short preceding birth interval is

Table 8: **Relative risks of maternal factors when control is made for some background variables, child mortality: Hazard model.**

Variable		Multi-variate effects					
	Uni-variate Effect	1	2	3	4	5	6
Birth order							
2-3	1.138	1.158	1.189	1.276	1.191	1.177	
5+	1.310	1.447	1.356	1.523	1.367	1.193	
Age at maternity							
<20 yrs	1.0953	1.118	1.190	1.041	1.115	1.385	
35+	0.3654	0.308	0.295	0.305	0.306	0.317	
Preceding birth interval							
<2yrs	1.519	1.362	1.386	1.414	1.292	1.082	
2-3 yrs	1.373	1.454	1.478	1.487	1.465	1.407	
Following birth interval							
<=18 Month	3.797↑	3.869↑	3.796↑	3.870↑	3.738↑	4.589↑	
Education of mother							
No school			1.776			1.061	0.968
Elementary			1.255			1.214	1.218
Education of father							
No school						1.203	1.157
Elementary						1.312	1.411
Occupation of father							
Sales-serv						0.739	0.809
Prod-other						1.292	1.358
Work status of woman							
Working						1.741	1.688
Income (Birr)							
<100				6.043		6.334↑	6.409↑
100-299				2.921		3.102↑	3.151*
Survival of older sibling							
Dead					2.766	2.666	2.42♣
Ethnicity							
Aroma						1.815	1.730
Others						1.767	1.564

Religion							
Muslim						2.552	2.555
Prot/Chatholic						2.234	2.284*
Water							
Pipe-com						0.952	0.936
Public tap						0.467	0.569
Well/river						1.293	1.031
Latrine							
Common						1.464	1.221
None						1.211	0.952
-2 x Long likelihood		467.2	465.4	452.8	562.1	20.0	438.9

Note 1. Reference Categories are not shown

Note 2 figures in Column 2 are the univariate effects of main variables; column 2-2-7 present the multivariate effects. Model 1 estimate the combined effects of main variables. Models 2-4 in addition, include one background variables at a time, while model 5 (full model) contain main variables and background variables simultaneously. Model 6 considers the effect of background variables in group.

Reduced when survival status of the preceding sibling is controlled. However, the reduction in the effect is negligible. The death of the preceding sibling is expected to raise the survival chance of the index child by removing the competition for food and maternal care. The net effect of the length of the following birth interval is almost the same as that obtained in the absence of the control variables.

The control variables, taken as a group, are important in explaining the variability in early childhood mortality. However, the variation is statistically singificant only for household income, religion and survival status of previous sibling. Other things being equal, children born in households with a monthly income of less than Birr 100 are about 6.3 times more likely to die during early childhood compared to those children born in households with a monthly income of more than Birr 300. The corresponding risk for children born in households with a monthly income of Birr 100-299 is about 3.10 times higher (Table 8).

When the effects of all other variables are taken into account, ethnicity loses its significance. Although it is difficult to explain why religion becomes important during early childhood period than at infancy, the finding suggests that net of other effects, children born to Muslim mothers are 2.6 times more likely to die compared to those born to Orthodox mothers and those born to Protestant/Catholic mothers are 2.3 time more likely to die compared to those born to Orthodox mothers.

Discussion

The analysis generally suggests that the hazards to infant and child survival arise from young and old age at maternity, short birth intervals and higher birth order. Births to young (under 20) and old (35 and older) mothers are at a greater risk of dying during infancy than those to mothers aged 2034 years. The gap is wider for young mothers and more pronounced during infancy. Births within two years after the birth of the preceding child had significantly higher risk of dying at infancy compared to births that occurred three or more years after the birth of the preceding birth. High order births (five and higher) were found to be at a higher risk of dying during infancy compared to births of order 4. Length of following birth interval was also found to have a considerable effect on childhood mortality. The likelihood of dying before age three of children born within 18 months of the birth of their older sibling is 3.8 times higher than those of children born after 18 months. This high negative effect of short subsequent birth interval persists even after the effects of other variables are taken into account.

When the relative importance of maternal factors is considered, the preceding birth interval is the most important determinant of infant mortality followed by age at maternity and birth order, respectively. For early childhood mortality, however, the situation is different. Following birth interval is the single most important maternal factor affecting the survival status during early childhood.

The control variables have differing impact during infancy and early childhood. While source of water and latrine are very important during infancy, household income and survival

status of preceding child appear to be influential during early childhood period. Education of woman has its own direct significant effect on infant mortality although this effect is reduced when source of water, latrine and household income are controlled. Source of water, availability of latrine, ethnicity, and occupation of father are shown to have independent effect on infant mortality.

Mortality during infancy and early childhood can be significantly reduced if births to very young mothers, to mothers aged 35 years or older, births that occur within two years after the birth of the previous child and births of order five and higher are prevented. The strong association between infant/child mortality and age at maternity, birth order and birth interval suggests that high risk births can be prevented by expanding family planning, and reproductive health services.

The study also shows that socio-economic variables, especially those relating to improved environment and higher household income play important roles in lowering infant and childhood mortality. Availability of latrine and access to safe water were found to be important factors affecting infant and child mortality. Greater attention should therefore be given towards increasing access to safe drinking water, female education and improving household income.

This study has attempted to provide some insight about the determinants of infant and early childhood mortality. A better understanding of the determinants of infant and early childhood mortality may be achieved in future studies if more health related information on child birth and on child care practices are collected. More specifically, it would be useful to collect detailed information on such variables as birth attendant, access to, and utilization of, maternal and child health services, treatment of umbilical cord, birth weight, nutrition status of mother, food preparation practices, personal hygiene, vaccination, and treatment during illnesses as well as duration and intensity of breastfeeding.

References

1. Central Statistical Authority, 1990 National Family and Fretility Survey Report. Addis Ababa, 1993
2. Assefa H. Infant and early childhood mortality in Shewa Region: An investigation into the Levels and Differentials. M.Sc. Thesis in Demography, Addis Ababa University, Addis Ababa. 1991.
3. Yohannes K. Correlates of Intant and Child mortality in Addis Ababa, M.A. Thesis in Population Studies, University of Ghana, Legon. 1990.
4. Abate M. Mortaltiy in rural Ethiopia: Levels, trends and differentials. PhD Thesis, University of Pennsylvania., Philadelphia. 1988.
5. Abdulahi H. Prenatal, Neonatal and Infant Mortality in Ethiopia. In procedings of the East Africa Workshop on Research and Intervention Issues Concerning Infant and Child Health. IDRC, Ottawa, 1988.
6. Kassahun D. Infant and Child Mortality Differentials in Rural Ethiopia, M.A. Thesis in Population Studies, University of Ghana, Legon. 1987.
7. Tesfayesus M. Mortality Levels and Differentials in Ethiopia: with reference to Metu, Alemaya and Addis Ababa. A Thesis submitted for the Degree of Doctor of Philosophy, University of Dares-Selam. 1985.
8. Nebiat T. Health, Nutrition and Problems of Maternal, Infant and Child Mortality in Ethiopia. In Proceedings of Conference on Population Issues in Ethiopa's National Development. ONCCP, Addis Ababa. 1989;II:505-546.
9. Shamebo D. Epidemiology for public health research and action in a developing society; the Butajirra Rural Health Project in Ethiopia. The Ethiopian Journal of Health Development 1994;8 Special Issue.

10. Bhakta G, Kim S and Abdul Kashem M. Socio-economic Demographic and environmental determinants of infant mortality in Nepal. Journal of Biosocial Science. 1991;23(4):425-435.

11. Pant PK. Effect of education and household characteristics on infant and child mortality in Urban Nepal. Journal of Biosocial Science. 1991;23(4):437-443.

12. United Nations. 1985. Socio Economic Differentials in Child Mortality in Developing Countries. New York (UN publication, Sales No. E. 85.XIII.7).

13. Holian J. Community level determinants of infant mortality in Mexico Journal of Biosocial Science, 1987;20(1):67-77.

14. Central Statistical Authority Population and Housing Census of Ethiopia 1984, Analytical Report at National Level, Addis Ababa 1991.

15. Assefa Hailemariam. An overview of the determinants of high fertility in Ethiopia. Ethiopian Journal of Dev. Research, 1992;14(2):1-30.
16. Assefa Hailemariam. Fertility Levels and Trends in Arsi and Shewa Regions of Central Ethiopia. Journal of Biosocial Science., 1991;23(4):387-400.
17. Brass W. Methods for Estimating Fertility and Mortality from Limited and Defective Data. Laboratories for Population Studies. The University of North Carolina Chapel Hill. 1975.
18. Cox D.R. Regression Models and life tables. Royal Statistical Journal. 1972;34B:187-220.
19. Federici N. and Terrenato L. ‘Biological Determinants of early life Mortality’ in Biological and Social Aspect of Mortality and the length of life. Proceedings of a Seminar at Fiuggi Italy. May 1980;13-16 Liege:IUSSP, 1980.
20. United Nations Manual X: Indirect Techniques for Demographic Estimation. Department of International Ecomomic and Social Affairs. Population Studies. 1983 No. 81.
21. Office of Population and Housing Census Commission. The 1994 Population and Housing Census of Ethiopia: Results for Oromiya Region 1994;vol. I part III.
22. Office of Population and Housing Census Commission and analytical report at national level. Central Statistical Authority. The 1994 Population and Housing Census of Ethiopia: Results for Addis Ababa. Volume I. Statistical Report 1994.