CHAPTER (1)

GENERAL INRODUCTION

1.1 INTRODUCTION:-

Infant mortality ; the probability of dying before age one expressed per 1000 live births, has been used as a measure of children's well-being for many years (Amouzou and Hill,2004). It is considered – crucially - as one of the most important indicators for the health status of a community and its description is very vital for planning public health strategies (Park, 2005).

Data indicate that about eleven million children under the age of five years die annually in the world as a whole, of whom over ten million are in the developing world (Amouzou and Hill,2004; Hosseinpoor,2005) That is why child mortality has received renewed attention as part of the United Nation's (UN)Millennium Development Goals(MDG) (Hosseinpoor et al.,2005; Schell,2007), targeting reduction of infant and child mortality by two-third between 1990-2015, as children are the precious assets of a nation (UNICEF,2006).

Globally, there is a large variation in infant mortality rate (IMR) from a high of 182 per 1,000 live births in Sierra Leone to as low as 3 per 1,000 live births in Sweden (Schell, 2007). The level varied from 5 per 1000 live births in developed countries to 59 per 1000 live births in the developing countries to about 98 per 1000 live births in the least developed world (UNICEF, 2006). This wide variation has been attributed to the varied level of medical and socioeconomic progress between these countries (Jatrana, 1999).

While the direct causes of child death are well known, our knowledge about the relative importance of underlying or distal socioeconomic determinants is less clear (Mosley and Chen, 1984; Schell, 2007). For example, the association between female literacy and child health is hardly controversial, but it is not known whether it is the reading skills per se or other immeasurable effects of increased gender equality that contribute most to child survival (Schell, 2007)

Furthermore, the association between infant mortality and socioeconomic and bio-demographic factors is well documented at both individual and community levels from as early as 1824 through the use of survey data (Mausy-Stroobant, 2001). This study attempts to arrive at better understanding of the association between socioeconomic and bio-demographic factors and infant mortality, in order to drive and prioritize intervention policies to decrease infant mortality and its burden.

1.2 BACKGROUND ON STUDY AREA AND POPULATION:

Egypt is located on the northeast corner of the African continent. It is bordered by Libya to the west, Sudan to the south, the Red Sea to the east, and the Mediterranean Sea to the north. It has the largest, most densely settled population among the Arab countries and the second largest among African countries (El-Zanaty and Way 2006).

The total area of the country covers approximately one million square kilometers. However, much of the land is desert, and only 6 percent of Egypt's area is inhabited. The majority of Egyptians live either in the Nile Delta located in the north of the country or in the narrow Nile Valley south of Cairo, the capital (El-Zanaty and Way 2006). The triangular Nile Delta is the only delta in Egypt and is 100 miles long and 155 miles wide, while highest lands are in the south and the land slopes gently toward the Mediterranean Sea (SIS, 2007).

Throughout Egypt, days are commonly warm or hot, and nights are cool. Egypt has only two seasons: a mild winter from November to April and a hot summer from May to October. It is generally very dry; there is almost no rainfall on a regular basis. The people depend on the annual summer floods of the Nile River for water. The floods begin in June and end in October. Without the Nile, there would likely be no Egypt (SIS, 2007)

Administratively, Egypt is divided into 26 governorates and Luxor City. The four Urban Governorates (Cairo, Alexandria, Port Said, and Suez) have no rural population. Each of the other 22 governorates is subdivided into urban and rural areas. Nine of these governorates are located in the Nile Delta (Lower Egypt), eight are located in the Nile Valley (Upper Egypt), and the remaining five Frontier Governorates are located on the eastern and western boundaries of Egypt (El-Zanaty and Way 2006). The country has a major ethnic group with few minorities. Arabic is the official language and almost the only one. Main religion is Islam (90%) in addition to 10%Christians (Wikipedia, 2007).

Approximately one-third of Egyptian labors are engaged directly in farming, and many others work in the processing of trading of agricultural products. However, the Egyptian economy relies on tourist revenues (Wikipedia, 2007).

Egypt's economy expanded steadily during the 1990s. Reflecting that growth, the gross domestic Product (GDP) per capita has achieved a level of US $1,380. The country's economic growth has been accompanied by improvements in number of human development indicators (El-Zanaty and Way 2006). According to the World Bank Country Classification, Egypt has been promoted from the low income category to lower middle income category.

Demographically, the latest population census in Egypt carried out in November 1996 showed that Egypt has a de facto population of 59.3 million. The total population reached 69.6 million by the year 2005, and 71.3 million in 2006 according to CAPMAS (Central Agency of Public Mobilization and Statistics 2005, 2006). The rate of natural increase has been declining in Egypt since 1991; most of the decline has been the result of changes in fertility behavior. The crude birth rate (CBR) dropped from a level of 30 per thousand population in 1991 to 28 per thousand by 1994 and remained fluctuating around a level of 27 births per thousand until the end of the decade (El-Zanaty and Way 2006).

There is a recent rapid increase of population that resulted from the rise of population growth rate was due to rapid decrease of mortality rates than that of birth rates. Birth rate dropped from 25.83 per thousand in 2004 to 25.49 per thousand by the end of 2005, while Mortality rate changed from 6.48 per thousand in 2003 to 6.38 per thousand by the end of 2005. Normal increase rate fell from 1.94 percent in 2004 to 1.91 percent by the end of 2005. (SIS, 2007)

Declines in mortality during the period 1960-2004 had a demonstrable effect on increasing the life expectancy of the Egyptian population. Life expectancy increased by 19.0 years for females and 16.8 years for males during the period. In 2006, life expectancy at birth rose to 69.2 years from 68.4 years in 2004 for males and to 73.6 years from 72.8 years in 2004 for females. However, 34%of the population are younger than 15 years while only 4.1 % are above 65 years old (El-Zanaty and Way 2006; SIS, 2007).

Early childhood mortality levels had declined steadily over the period from 1990 to 2005. Infant mortality decreased by around 45 percent, from a level of 60 deaths per 1,000 births during the period (1991-1995) to a level of 33 deaths per 1,000 in the five-year period (2001-2005), while under-five mortality declined from 81 deaths per 1,000 births 41 deaths in the five-year during the same periods respectively. The major two causes of childhood mortality in Egypt are diarrheal disease and acute respiratory tract infections (ARI). Diarrhea alone resulted in more than 50 percent childhood mortality before 1985 (Casterline, Cooksey and Ismail, 1989; Yassin, 2000), but following the introduction of the National Diarrheal Disease Control Program (NCDDP) in 1981 which aimed at improving case management of diarrhea, childhood mortality attributed to diarrhea decreased by at least 25%. However, diarrhea is still the number one childhood killer in Egypt followed by ARI (Yassin, 2000).

Many national health policies and programs were adopted by the country, one of which was "Health for All by Year 2000" adopted in 1990, It placed a priority on meeting child health needs. The country also addressed the demographic and population problems by implementing many national population policy programs aiming at slowing the growth rate of which family planning programs were the most important and efficient ones (El-Zanaty and Way 2006).

1.3 PROBLEM STATEMENT:

During the past half-century there have been remarkable decline in child mortality in the developing world, the greatest reductions were in the Middle, East and North Africa where child mortality rate fell from a high of 200 deaths per 1000 live births in 1960 to as low as 50 deaths per 1000 live births by 1990 (Mogford, 2004). Following the same pattern, Egypt has experienced rapid declines in infant, early childhood, and maternal mortality. However, compared to other countries in the region, and especially to developing nations, Egypt, with an infant mortality rate (IMR) of 43.5 in 2000 (El-Zanaty and Way 2001), remains among those countries in need of continued child and maternal health interventions (Lara and Pullum, 2005). In spite that early childhood mortality levels have declined steadily, infant mortality decreased by around 45 percent, from a level of 60 deaths per 1,000 births during the period (1991-1995) to a level of 33 deaths per 1,000 in the five-year period (2001-2005), still around 80 percent of early childhood deaths in Egypt are taking place before a child's first birthday (El-Zanaty and Way 2006).

An important question to answer is what are the factors-among the socioeconomic, demographic and biological selected- contribute to infant mortality differentials in Egypt? And among these factors which ones have the greatest impact? And are there any differences between these factors in early and late infancy?

1.4 JUSTIFICATION:-

In spite of the general agreement on the leading causes of childhood deaths, the differential contribution of each cause is still controversial. Furthermore, studies on childhood mortality differential and determinants are still too few to reflect a comprehensive taxonomy of inequalities by identifying high-risk groups, or to fine-tune the policy measures for reducing mortality (Yassin, 2000).

Traditionally, social science research on child mortality has focused on the association between socioeconomic status and patterns of mortality, while medical research was more concerned about biological factors associated with mortality. In spite that both contributed to our knowledge on child mortality in developing countries the different concerns and methodologies have compartmentalized such knowledge.

Only recently a joint frame work was used to evaluate all the associated factors, use of such frame work should facilitate specification of different causality order and possible interactions among the socioeconomic and biological determinants (Mosley and Chen, 1984). Furthermore, this will clarify our understanding of the determinants of child mortality in order to provide solid foundation for planning and implementing health policies and plans.

For Egypt in particular, studies with regard to determinants of infant mortality focused only on one or two factors and tend to focus on socioeconomic indicators such as household income (Casterline, Cooksey and Ismail 1989; Lara and Pullum 2005). It also rarely worked with the new approach of joint framework mentioned above or took into consideration the difference between the impacts of socioeconomic versus bio-demographic factors. Furthermore, even the few studies that worked on socioeconomic and biodemographic determinants in the whole country concentrated on childhood mortality and there was no particular focus on infancy period (The first year only).

Furthermore, Egypt offers an intriguing setting for an examination of the relationship between socioeconomic status and child mortality because of the prominence of income distribution and related equity issues in Egyptian political life (Casterline, Cooksey and Ismail, 1989).

This study intends to investigate the significance of the relationship between selected socioeconomic and bio-demographic factors and infant mortality. The quantification of the associations between these variables and infant mortality will be in a ranked–order so as to identify the most critical factors necessary for intervention priorities and heath policies in Egypt.

1.5 OBJECTIVES:-

1.5.1 GENERAL:

To examine the distribution and relationship between selected socioeconomic and bio-demographic factors and infant mortality in Egypt during the period 2000-2005.

1.5.2 SPECIFIC:

With regard to infant mortality in Egypt during the period 2000-2005:

1. To measure infant mortality rates and post neonatal mortality rate.
2. To identify socioeconomic and bio-demographic factors which are associated with infant mortality.
3. To quantify the impact of the selected socioeconomic and bio-demographic factors on infant mortality.

1.6 LITERATURE REVIEW:

The determinants of infant mortality have been frequently researched as evidenced by numerous published articles. Authors studied extensively socioeconomic, demographic/maternal, biological and environmental determinants. Some studies even tried to join more than one group of factors in order to compare their impact for example socioeconomic against demographic determinants. Most of the studies used survey (for example Demographic and Health Survey (DHS)) or census data.

There is large literature on the relationship between infant mortality and socioeconomic status, and many studies have shown a close association between them, but most of these studies gave conflicting results. Socioeconomic status indicators that were frequently used are income per capita, Gross National Product (GNP), urban/rural residence, work status and household assets.

In his study, Mogford (2004) investigated economic and social explanations of mortality change using national level World Bank data of forty two Sub-Saharan Africa countries predicting child mortality by woman's education, GNP and foreign debt to export ratio. He concluded that per capita GNP does not significantly predict child mortality after controlling for other influences, However foreign debit appears to slow mortality, and mother education is the most important factor among those studied. These findings were further supported by Sswayana and Younger (2004) who used Uganda DHS (1974-1999) and found that GNP has no significant association with infant mortality.

Another study by Wang (2003) that used Gross Domestic Product (GDP), share of health expenditure in GDP and some assets like electricity and sanitation, found that GDP is inversely related to infant mortality at national level, but GDP was ranked late. Interestingly he found that other variables like electricity were the most important determinant in rural and urban areas. So, he suggested that the income effect on health may have been overestimated in earlier studies due to model misspecification that omitted important indicators e.g. access to electricity.

On the other extreme, a study by Schell et al (2007) used Gross National Income per capita (GNI/capita), young female illiteracy, income inequality, public spending on health and poverty rate as socioeconomic indicators from national datasets comprising 208 countries and found that absolute wealth (GNI/capita) was the most important indicator among all distal determinants (World Development Indicator, 2003). The importance of per capita income was also supported by Amouzou and Hill (2004).

At the first glance Wang and Schell results might appear conflicting, but Schell argued that they are in fact consistent and the results in Wang analysis are due to “over adjustment” in other words inclusion of factors that are in the causal pathway in the analysis, which is known to weaken association between distal factors and out come.

On the other hand, few studies address the impact of socioeconomic status using individual level income due to its measurement difficulty, even those who studied such income effect used wealth index as a measure of household economic status. For example a study conducted in Iran used 2005 DHS, investigating socioeconomic inequality and infant mortality at both national and provincial level, Hosseinpoor found a reverse association between IMR and wealth index. Poerwanto and Stevenson (2003), through the analysis of 1997 DHS data, used Family Welfare Index (FWI) which is very similar to wealth index, in addition to other socioeconomic and demographic factors, concluded that FWI has the most important association with infant mortality in a reverse manner.

In the same context, It worth mentioning that there is a new trend in studying the association between infant mortality and socioeconomic status; speaking about a curvilinear rater than simple linear relationship. For example in a study by Finch (2003) conducted in the United States: he used income, occupational grade and income inequality among states to demonstrate the relationship after controlling for other socioeconomic factors (e.g. race, parity and age of the mother) as well as some behavioral factors. He found a clear curvilinear relation between income and IMR, but there was no relationship between income inequality among states and IMR. However, these results seems optimistic and unrealistic for developing countries where large number of the population lie below poverty line and governments are trying to reduce IMR of about 100's per 1000 live births in settings where even simple medical care is not easily obtainable.

With regard to mother education, following the pioneering work of Caldwell (1979) in Nigeria on the relationship between mother education and infant and child mortality; large number of studies focused on this relation and used mother education as an important proxy or indicator for socioeconomic status. Caldwell himself concluded that maternal education is the single most important determinant of difference in child mortality, even after controlling for other socioeconomic factors. He further concluded that maternal education should not be employed as a proxy for general social and economic change, but must be examined as an important force in its own right.

Caldwell's results were further supported by Hobcraft (1993) who used 25 DHS datasets in a multivariate analysis. Hobcraft added an explanation to the inverse relationship that educated females tend to marry late, utilize prenatal care and immunize their children. Mother education was also shown to be the single most important determinant of infant mortality in a study that used hospital records in Belgium (Devlieger, Martens and Bekaert 2005).

Furthermore, the inverse relationship between mother education and infant and child mortality was documented by many authors who supported Caldwell's findings for example: Bhuiyat and Streatfield (1991) in Bangladesh (Matlab), Rajna et al. (1998) in Uttar Pradesh (India) and Tulasidhar (1993) using India 1981 census. The latter further suggested a positive relationship between duration of education (years of education) and child mortality especially at the primary school level. In the African context, a study in Malawi by Kalipeni in 1993 found the same inverse relationship with mother education. Contradicting with these findings and conclusions Adetunji (1993) who worked on DHS data from Ondo state in Nigeria, found a pattern that is different from what expected and IMR was higher among secondary school level mothers infants compares to uneducated ones. So he concluded that other factors determine this relationship for example duration of breastfeeding.

In 1998, Desai and Alva in their work entitled “Maternal Education and Child Health: Is There a Strong Causal relationship” argued that the strong correlation between child mortality and mother education demonstrated by Caldwell and his colleagues does not necessarily establish causality and maternal education may be just a proxy of socioeconomic status. She further supported her argument analyzing data for 22 developing countries found that the effect of mother education was attenuated after controlling for father education and access to piped water and sanitation, and further reduced or even became insignificant after controlling for area of residence.

Research during the past decade has focused on a broad set of socioeconomic variables (place of residence, paternal occupation, parental education, dwelling characteristics) and readily measured bio-demographic determinants (birth order, maternal age, birth spacing, breast feeding, and nutrition). Fortunately, recently there has been considerable emphasis on bio-demographic determinants of child survival, in particular maternal demographic characteristics **(**Casterline et al, 1989); this is clearly reflected in the increasing and accumulating evidence on the importance of biodemographic factors from recent literature.

The importance of biodemographic factors was demonstrated in many studies, for example a study by Hobcraft (1985) who used data from 39 world fertility surveys (WFS) found that child spacing variables are the most important determinants of infant and early child mortality in a form of inverse relationship. He also concluded that in spite of the weaker association between infant mortality and birth order and mother age, their effect is to be considered serious. Mortality was generally higher for first born children and for teenage mothers.

In 1994, a study by Forste used 1989 DHS for Bolivia to demonstrate the effect of breast feeding practices and birth spacing on infant and child mortality. It concluded that delaying the next conception for more than two years doubles the likelihood of the index child surviving to his second birthday, while stopping breast feeding during the early months of life doubles the risk of dying. Same findings were obtained in studies by Adetunji (1993) in Nigeria, Rajna (1998) in India and Manda (1999).

Other three studies that supported the above findings were: Boback, Pikhart and Koupilová (2000) study in Czech Republic using national birth and death registries for the period 1989-1991 which found that low maternal education, unmarried status, maternal age out of 24-34 age range and birth order greater than three are all associated with increased risk of infant mortality. The second study highlighted the importance and significance of breast feeding, its duration and preceding birth interval in addition to some environmental factors like water supply and sanitation through analyzing data of 89 DHS in 56 countries in the 1990's (Rutestein,2000).The last one found that birth order and interval, infant's sex and mother age in addition to regional level of malaria endemicity had a strong impact on infant mortality in Mali using both 1996 DHS and malaria mapping data (Gemperli et al., 2004).

Other issues were raise by some authors like inequality among different ethnic groups (Gyimah, 2000; Suwal, 2001) and sex differences in mortality. With regard to the latter some studies tried to address the problem of excess female mortality especially in the Indian subcontinent, which is contradicting with national biologically plausible ability of the females to survive better than males, and is explained by sex preference in some areas in the world that might even reach very extreme levels of female infanticides. Two studies documented an inverse relationship between excess female mortality and mother education (Bhuiyat and Streatfield, 1991; Tulasidhar, 1993).

As mentioned earlier some authors even tried to join more than one set of determinants, in order to demonstrate the impact of each or even sometimes to compare the importance of each group in different levels of development.

Based on an old observation by Kim in 1988, a study in backward region in India (Mewat region of Haryana state) by Santoch Jatrana (1999) tried to explore the hypothesis that states: In a traditional society, demographic factors affect infant mortality more than socioeconomic factors "i.e. in early stages of development, demographic factors replace socioeconomic factors, and in later stages the effect of demographic factors becomes very small". Using field survey data (1996-1997) ; this study concluded that when infant mortality rates were high , demographic/maternal factors such as maternal age, previous birth interval, survival of preceding child and utilization of colostrums were the most important determinants. Surprisingly this study did not find any significant association between parent education and infant mortality when controlling for demographic factors.

In contrast to Jatrana results, Suwal (2002) concluded that in an under privileged, traditional and cultural diverse country infant mortality is determined by both socioeconomic factors and bio-demographic factors. He studied Nepalese children from 1991 Nepal Fertility, Family planning and Health Survey and DHS (25,384 individuals included). The same results were also obtained by Armstrong Schellenberg et al (2002) who studied combination of socioeconomic factors (e.g. .tin roof, bicycle or radio) and biodemographic factors (e.g. gender of child, mother age, ethnic group and birth order and interval) using Southern Tanzania DSS sample in a case-control study that enrolled 508 cases and found that all these factors are independently related to infant and child mortality. Even when comparing two different continents using India and Sub-Saharan Africa, the results were not different at all suggesting the importance of both factors, this was shown in the work of Madise, Matthews and Whitworth (2003) who used data from 1998/1999 national family health survey from 16 states in India and 18 DHS data from Sub-Saharan Africa countries in 1995 or later.

In between these two extremes is a population based case control study by Kabir (2003) using data from rural Ballabgrah of North India, The study found that biodemographic factors are important all through infancy but socioeconomic factors are only important in the post neonatal period (i.e. no role in early stages).

In Egypt, many studies tried to explore the relation between different socioeconomic, biodemographic and environmental factors and infant and child mortality. For example Casterline, Cooksey and Ismail (1989) analyzed data collected in the Egyptian Fertility Survey (EFS) which is part of WFS, aiming at estimation of the effect of income on infant and early child mortality at the household level in Egypt. They concluded: there is no evidence that household income affects survival through infancy but the effect is pronounced during early childhood, they also found that infant mortality does not vary with type of place of residence, no association with household toilet facility type and maternal demographics are the most important determinants of infant mortality in Egypt. Only region of residence among socioeconomic factors studied (including mother education) was found to have considerable association with infant mortality.

Other two studies by Yassin (2000) worked on child mortality in rural Upper Egypt using sentinel community survey (SCS). In the first study he aimed at studying the indices, causes and sociodemographic determinants of childhood mortality, he found no significant association of mortality with sex of the child, parity, birth interval and order. While mother age, mother education and father education were found to be significant determinants. Yassin also found that diarrheal disease is the number one cause of death in childhood. He further studied diarrheal disease in his second study using the same data and found significant inverse relationship between recurrent diarrhea and mortality and household meat consumption, mother's age at birth, child's age and father illiteracy.

Environmental determinants of infant and child mortality were the focus of an unpublished by Abu-Ali study using DHS dataset to assess the importance of water supply and sanitation on infant and child mortality and found that sanitation is more important than water source although the latter was also positively related to infant and child mortality. The study also found that living in urban area, mother education, sex of the child and mother ages are significantly related to mortality. Being a second order birth as opposed to fourth or higher order and living in urban area were fond to be significant determinant of infant mortality in Egypt in contrast to mother education and sex of the child which were not associated with mortality (Lara and Pullum, 2005).

As we see from the above literature, studies in Egypt did not concentrate on infant mortality only and usually joined infant to childhood stages although it is well documented that the determinants are different during the two stages of development. Even the studies which focused on infant mortality only either were lacking generalizability working in small areas and not the whole country, or studied one group of determinants (socioeconomic or biodemographic). Also, the studies rarely used DHS data, which is a popular source of data for studying determinants of infant mortality all over the world. So, in this study I will try to look at both socioeconomic and biodemographic determinants of infant mortality using DHS data.

CHAPTER (2)

METHODOLOGY

2.1 STUDY DESIGN:

Population-based cross-sectional secondary data analysis of the 2005 Egypt Demographic and Health Survey (EDHS) using children dataset.

2.1.1 WHY DHS DATA?

The DHS uses identical survey instruments across countries. DHS data are nationally representative, and a range of basic population indicators (in addition to mortality rates) can easily be constructed (Wang, 2003).

2.1.2 ABOUT THE 2005 EDHS:

The 2005 EDHS is the fifth survey implemented in Egypt as part of the DHS program, the earlier surveys were conducted in 1988, 1992, 1995, and 2000. It was conducted under the auspices of Egypt Ministry of Health and Population (MOHP) and National Population Council (NPC) and implemented by El-Zanaty & Associates (El-Zanaty and Way, 2006).

The purpose of the survey was to provide the Ministry of Health and Population (MOHP) of Egypt with information on fertility, reproductive practices of women, maternal care, child health and mortality, child nutrition practices, breastfeeding, and anemia. This information is important for understanding the factors that influence the reproductive health of women, also the health and survival of infants and young children. In addition, the survey was designed to provide information on the prevalence of female circumcision, domestic violence, and children's welfare. The survey results were intended to help policymakers and planners in assessing the current health and population programs and in designing new strategies for improving reproductive health and health services in Egypt (El-Zanaty and Way, 2006).

Funding for the survey was principally provided by the United States Agency for International Development (*USAID*); USAID/Cairo through its bilateral health and population projects with additional contributions from United Nations International Children's Emergency Fund (*UNICEF*) and *Ford foundation*. Technical support for the 2005 EDHS was provided by ORC Macro through the MEASURE DHS project (El-Zanaty and Way, 2006).

The following paragraphs summarize the survey methodology as described in the report of 2005EDHS (El-Zanaty and Way, 2006).

2.1.3 EDHS DESIGN:

The sample was a nationally representative (data weight level), three stage probability sample of 1,359 segments based on 1996 census which was updated to 2004 using CAPMAS (*Central Agency of public mobilization and statistics 2005*) information. Each segment consisted of 200 households at both rural and urban levels based on a quick count operation (El-Zanaty and Way, 2006).

The first stage included selection of the primary sampling units. The units of selection were shiakhas/towns in urban areas and villages in rural areas. A total of 682 primary sampling units (298 shiakhas/towns and 384 villages) were selected. The second stage of selection involved division of shiakhas/towns or villages into parts of roughly equal population size (about 5,000) of which a total of 1,019 parts were selected. Then a total of 1,359 segments were chosen from the parts in each shiakhas/town and village in the 2005 EDHS sample. The last step in this stage was household listing operation of the selected segments (El-Zanaty and Way, 2006). The third stage involved selecting the household sample. Using the household listing for each segment, a systematic random sample of households was selected for the 2005 EDHS sample (El-Zanaty and Way, 2006).

In the Urban Governorates, Lower Egypt, and Upper Egypt, the 2005 EDHS design allowed for governorate-level estimates of most of the key variables, but in the Frontier Governorates, the sample size was not sufficiently large to provide separate estimates for the individual governorates. To meet the survey objectives, the number of households selected in the 2005 EDHS sample from each governorate was not proportional to the size of the population in the governorate (El-Zanaty and Way, 2006). Due to this heterogeneity in the sample size, the analysis in this study will be based on the sample weights.

2.1.4 SAMPLE SIZE:

A sample of 22,807 households was chosen for the 2005 EDHS. Of which, 22,211 households were found, and 21,972 households were successfully interviewed which represents a response rate of 99 percent (El-Zanaty and Way, 2006).

The survey interviewed all ever-married women aged 15-49 years who were present in the sampled households on the night before the interview. A total of 19,565 women were identified as eligible to be interviewed. Out of these women, 19,474 were successfully interviewed, which represents a response rate of 99.5 percent (99.4 percent in urban areas and 99.7 percent in rural areas) (El-Zanaty and Way, 2006). The reported total number of births in the five years preceding the survey was 13,851, and they were all eligible for this study.

2.1.5 QUESTIONNAIRE DESIGN:

The 2005 EDHS involved two questionnaires: a household questionnaire and an individual questionnaire. The questionnaires were based on the model survey instruments developed by MEASURE DHS+ for countries with high contraceptive prevalence. Questions on a number of topics not covered in the DHS model questionnaires were also included in the 2005 EDHS questionnaires. Questionnaires were translated to Arabic language and then pretest was conducted during the preparation to assure validity and reliability. The questionnaires for the 2005 EDHS were finalized after the pretest (El-Zanaty and Way, 2006).

2.1.6 FIELD WORK:

Fieldwork for the 2005 EDHS began on April 21, 2005 and was completed in late June 2005. The field staff was divided into 14 teams; each team had 1 supervisor, 1 field editor, 3 to 4 interviewers, and 2 staff members assigned to height and weight measurement and anemia testing. All supervisors were males, while the field editors and interviewers were females. One male and one female staff member were involved in the anthropometric measurement and the anemia testing. During the fieldwork, the 14 field teams worked in separate governorates; the number of governorates assigned to an individual team varied from one to three, according to the sample size in the governorates (El-Zanaty and Way, 2006).

2.1.7 DATA PROCESSING:

As soon as interviewing in a cluster was completed, questionnaires were collected by staff from the central office. Machine entry and editing began while interviewing teams were still in the field. The data from the questionnaires were entered and edited on microcomputers using the Census and Survey Processing System (CSPro), a software package for entering, editing, tabulating, and disseminating data from censuses and surveys (El-Zanaty and Way, 2006).

Fifteen data entry personnel worked in processing the 2005 EDHS survey data. During the machine entry, all data was reenterd for verification. The data processing staff completed the entry and editing of data by the end of July 2005 (El-Zanaty and Way, 2006).

2.1.8 QUALITY CONTROL:

Many data validation and quality control measures were introduced at various stages of the survey including (El-Zanaty and Way, 2006):

- Refined selection and extensive training of the personnel involved in all stages (for example field workers and data managers)
- In sample design stage: repetition of the quick count (carried out to provide an estimate of the number of households in each part) in 10 percent of the parts. If the difference between the results of the first and second quick count was less than 2 percent, then the first count was accepted.
- In sample design stage: About 10 percent of the segments were relisted. Two criteria were used to select segments for relisting. First, segments were relisted when the number of households in the listing differed markedly from that expected according to the quick

count information. Second, a number of segments were randomly selected to be relisted as an additional quality control test

- Questionnaire: A pretest was conducted during the preparation for the 2005 EDHS.
- Field work: field editors regularly conducted reinterviews using a shortened version of the EDHS questionnaire. The results of the reinterviews were compared to the responses in the original questionnaire and any mistakes were discussed with the interviewer. The teams also were closely supervised throughout the fieldwork by a fieldwork coordinator, two assistant fieldwork coordinators, and other senior staff.
- Data Processing: 100 percent of each segment was reentered for verification.

2.2 STUDY POPULATION:

Egypt live born infants who were:

- Born one to five years preceding the 2005 EDHS.
- Their mothers were ever-married women* aged 15-49 year interviewed during 2005.
- Either survived the infancy period or not.

2.3 KEY WORDS:

- *Socioeconomic status* – Characteristics of economic, social and physical environments in which individuals live and work, as well as demographic and genetic characteristics.
- *Infant mortality:* The Probability of dying between birth and exactly one year of age expressed per 1,000 live births (UNICEF, 2006).
- *Post neonatal mortality*: The probability of dying between one month age and exactly one year of age expressed per 1000 live births.
- *Neonatal mortality*: The probability of dying before one month of age per 1000 live births

*DHS uses ever-married females in all Arabic and Islamic countries since it is totally unacceptable to have a baby born out of wedlock. So nobody will admit it and its generally of low prevalence in such countries.

2.4 EXPLANATORY VARIABLES:

This study uses variables available in EDHD 2005 data, including socioeconomic, demographic and biological or health predictor variables. Socioeconomic variables are maternal highest level of education, wealth index, type of place or residence (rural/urban) and mothers working status. While the demographic variables are age of the mother at birth, age at first birth, sex of the child and region of residence. And the biological or health outcome predictor variables are birth order, previous birth interval, birth size, and place or delivery. Table 2.1 shows explanatory variables definitions and dummies used in the analysis.

Table 2.1: Variables* of Interest and their definitions:

NO.	Variable	Definition
SOCIOECONOMIC VARIABLES		
1	Maternal highest education	None(0) Primary (1) Secondary(2)Higher(3)
2	**Wealth index(quintile)	Poorest(1) Poorer(2) middle(3) Richer(4) Richest(5)
3	Type of place of residence	Urban (1) Rural (2).
4	Mother's Working Status	Not working(0) Working (1)
5	Sex of the HH head	Male (1) Female (2)
DEMOGORAPHIC VARIABLES		
6	Age at birth	Age of the mother at time of child birth in years
7	Age at first birth	Age of the mother at her first birth in years
8	Sex of the child	Male (1) Female(2)
9	Region of residence	Urban governorates(1) Urban lower Egypt (2) Rural Upper Egypt (3) Urban lower Egypt (4) Rural upper Egypt (5) Frontier governorates (6)
HEALTH PREDICTOR VARIABLES		
10	Birth order	The birth order of the child of the mother.
11	Birth interval	Interval in month between the index child and the preceding One.
12	Birth size	Large(1) Average (2) Small(3)
13	Place of delivery	Home (0) Urban public health sector (1) Rural public health sector(2) Private health sector (3)

*There are other variables that have shown to affect infant but my choice was limited to those available in the dataset.
**Wealth index is a measure developed by the ORC Macro and the World Bank to measure socioeconomic level of the household in a ranked order; it is a proxy for long-term standard of living of the household. Information on household assets was used to create the wealth index of the households interviewed in the EDHS. It was based on data collected in the EDHS household questionnaire the household's ownership of consumer items such as a fan to a television and car; dwelling characteristics such as

flooring material; type of drinking water source; toilet facilities; and other characteristics that are related to wealth status. Each household asset for which information is collected is assigned a weight or factor score, which were all then summed in one score. The sample is then divided into population quintiles, i.e., five groups with the same number of individuals in each. At the national level, approximately 20 percent of the household population is in each wealth quintile from the poorest to the richest (DHS+, 2002; El-Zanaty and Way, 2006).

2.5 OUTCOME VARIABLE:

A dichotomous dependant variable child's survival status through two particular age ranges infancy(first year of life) or post neonatal period (from one month to one year), has been given a value of 1 if the child failed to survive (died) during the period and 0 if survived beyond the first birthday or was censored by the survey date. Children who died were compared to those who survived the age interval.

The outcome variable used in the neonatal models is the log odds of dying. Neonates who died within the age were compared to those who survived the period.

2.6: HYPOTHESIS:

1. Biodemographic predictors are as important as socioeconomic predictors of infant mortality.
2. There is no difference between predictors for neonatal and post neonatal mortality.

2.7 SCOPE AND LIMITATIONS:

- Information on the explanatory and the outcome variables were collected at the same time since it is a cross sectional study, so it is unlikely to get the exact temporal association and causal relationship.
- Selection bias: the survey collects data on children whose mothers are alive. Children whose mothers have died are likely to have higher mortality levels because of disease

being transmitted from mother to child or because the child received inadequate care when the mother was sick or after she died.

- Reporting and misdating bias especially on providing information on the size of the child at birth, age at death in months and respondent age. Furthermore, using size at birth as a proxy for birth weight is a subjective measure.
- Omission of a shortly lived child death may be a source if bias and it is usually difficult to estimate such deaths.
- The analysis will be restricted to the variables available in the dataset. .
- Confounders, like health service utilization in terms of antenatal care and vaccination are not included in the analysis because of the high proportion of the missing values.
- The reliability of the DHS data depends on the completeness with which births and deaths are reported, and problems with age heaping at 12 month especially for death reports.

2.8 PLANS FOR UTILIZATION AND DISSEMINATION OF RESULTS:

The study -after approval- will be presented for publishing in a specialized journal; also there are plans to advice the relevant bodies and health policy makers in Egypt about the results.

2.9 ETHICAL CONSIDERATIONS:

This is a secondary data analysis using anonymized data collected in EDHS 2005. Informed consent was obtained from the respondent by a trained interviewer before the interview. Authorization to use this dataset was obtained from Macro International Inc. The protocol was reviewed by the University of the Witwatersrand Ethical Committee and ethical clearance was obtained.

2.10 DATA MANAGEMENT:

The dataset (2005 EDHS) is in custody of Macro International Inc. after obtaining authorization; data was downloaded from their web site. Rectangular format of the children subset was selected for the study. A total of 23 variables were selected, some were used directly while others were used to generate or create variables of interest ending up with 13 explanatory variables in addition to the outcome variable with its corresponding time matrix.

13,851 observations were recorded in the dataset representing the total number of live birth for interviewed women in 2005 EDHS in the five year duration preceding the survey. All observations were used for the analysis without any exclusions keeping in mind to adjust for clustering effect on the mother and independency between some observations (for example in the case of twins) at analysis level. Fortunately the completeness of variables selected for analysis was satisfactory (100%).

2.11 DATA ANALYSIS:

STATA 9.0 software was used to analyze the data. Before going into the analysis some variables were recoded in order to ease the analysis or make meaningful interpretation of the results. For example, the continuous variables birth order and birth interval were categorized into groups. Furthermore, those who were first order (no preceding birth interval) were added to the second category (birth interval > two years) since it holds the same biological meaning.

The continuous variables age at birth and age at first birth were not categorized to allow for more precise measurement of the relationship that could be obscured by categorization and to allow testing for high polynomial order relationship or non linear one (quadratic or cubic), this sort of relationship was reported by some authors (Reichmann and Paganini,1997). Some already categorized variables were further edited by combining some of their strata either because of the small number of observations in some strata that will probably decrease the statiscal power or to give a meaningful interpretation for the variable. These variables were: Mother's occupation, place of residence in which all the public sector facilities (hospital, clinic, health center... etc) were joined in one category so as to give meaningful interpretation of the sector as a whole. The last variable which was recategorized is birth size.

I first present descriptive statistics of background characteristics of the respondents. This was achieved by conducting distribution tables calculating frequency and proportion of live births in each strata of categorical variables and mean and standard deviation of continuous variables.

The next step was modeling the effect of selected socioeconomic and biodemographic determinants selected on infant and post neonatal mortality using event-time technique (proportional hazard models), the unit of analysis was person-month lived by the infant and post neonate, and event was death during the first year of life (infancy) or the eleven months following the first month (post neonatal). Modeling process constituted the second and third levels of analysis of which the second level involved bivariate analysis while the third was multivariate analysis using Cox proportional hazard regression models (Cox 1972). Logistic regression models were used instead of Cox's proportional models for modeling the effect of selected socioeconomic and biodemographic factors on neonatal mortality. This is because during the first month of age there is no variation in duration and thus the dependent variable is binary with value zero if the neonate survived and one if died during neonatal period.

2.11.1 MODEL SPECIFICATION:

In the bivariate analysis, I examine the gross effect of each variable on infant, neonatal and post neonatal mortality. While the third level (multivariate analysis) intended to investigate the net effect of the explanatory variables after controlling for other variables, entry level was at 15% ($\alpha=0.15$) and retention level at 5% ($\alpha=0.05$), in other words variables which were found to be significant in bivariate analysis were included in the multivariate analysis and variables were then considered to be independent determinants of infant mortality if their p-value was less than 0.05. The results of proportional hazards and logistic regressions were expressed in terms of hazard ratios and odd ratios, respectively. This represents the risk of dying relative to a reference category for each variable, the relative risk of reference category is unity; values greater than one indicate an increase in the risk while values less than one indicate a decreased risk.

Three multivariate models were used to study effect according to the grouping of explanatory variables showed in table (2.1), the first model included only socioeconomic variables, the second added the demographic variables and the third added biological predictors to what already existed in the previous models. This in fact allow studying the effect of each group of determinants alone and on each other, this method of modeling was used by many authors for example Desi and Alva (1998).

Before going into modeling process we took into consideration the problem of clustering effect and violation of assumptions of independence of some observations. In order to avoid this we specified the option cluster in STATA which is capable of controlling cluster effect in each model used. This method in fact provides a robust estimation of standard errors because no assumptions were made. After modeling I checked for possible interaction terms, and then for assumption of proportional hazard models which is that the variable has the same proportional effect over time.

The advantage of using Cox regressions over logistic regression in spite that they both can estimate the effect of many explanatory variables as well as controlling for confounders at the same time is that Cox regression allows inclusion of right-censored and uncensored observations. In our case there was no need to exclude those who did not complete one year of age at interview. This model assumes that for an individual with a vector of variables in x, the hazard rate (death rate) at time t is given by:

$$\lambda(t;x)= \lambda o\ (t)\ \exp\ (\beta_1 x_1+\beta_2 x_2 \ldots\ldots.\beta_k x_k)$$

Where $\lambda o\ (t)$ is an unspecified baseline hazard (i.e. at x=0) , x is a vector that represents k variables and $(\beta_, \beta_2 \ldots\ldots.\beta_k)$ are k regression coefficients. In this analysis t is age in months at death during infancy (first year) or censoring beyond infancy or interview date.

While for neonatal logistic regression models the equation is:

$$\text{Log odds of outcome} = \beta_{0+}\beta_1 x_1+\beta_2 x_2 \ldots\ldots.\beta_k x_k$$

Where β_0 is the intercept term (constant), $X_1 \ldots\ldots X_k$ represent the given explanatory variables, while $\beta_, \beta_2 \ldots\ldots.\beta_k$ represent their related regression coefficient. (Kirkwood and Sterne, 2005).

CHAPTER (3)

RESULTS

3.1 BASELINE CHARACTERISTICS OF THE RESPONDENTS:

The study investigates factors associated with mortality of Egyptian infants born in the five year period preceding 2005 EDHS. Where out of 13,851 live births 463 deaths occurred before the first birthday, the total follow up time is 144,835 person-months. This gives an IMR of 32 per 10,000 person-months, which is slightly lower than the IMR reported by 2005 EDHS (33 per 1000 live birth). The difference between the readings can be explained by the more precise way of measuring rate using person-time contribution in the study rather than total number of birth as denominator, as some of live births did not complete one year of age and were right-censored by the date of interview.

The explanatory variables are divided into three groups socioeconomic, demographic and biological or health predictor determinants. Table (3.1) describes the baseline characteristics of the 13,851 live births in terms of the selected factors of these groups. The table shows that 33.4% (4633) of the mothers were not educated while 53.9% (7467) attained secondary or high level of education. Of these mothers only 17.77% (2461) were working.

Out of the 13,851 babies almost one quarter (24.7%) lies in the poorest wealth quintile, only 15.6% (2156) belonged to the highest wealth scale (richest), 63.6% (8809) were living in rural areas and 94.70% (13118) of the households were male-headed.

Table (3.1): Percentage distribution of live births by some of the selected variables				
No.	Variable	Category	Frequency	(%)
1.	**Mother's Education**	None	4632	(33.4)
		Primary	1752	(12.7)
		Secondary	6199	(44.7)
		Higher	1268	(9.2)
2.	**Wealth Index**	Poorest	3432	(24.7)
		Poorer	2964	(21.4)
		Middle	2728	(19.7)
		Richer	2571	(18.6)
		Richest	2156	(15.6)
3.	**Type of Place of Residence**	Urban	5042	(36.4)
		Rural	8809	(63.6)
4.	**Mother's Working Status**	Working	11,390	(82.2)
		Not Working	2461	(17.8)
5.	**Sex of Household Head**	Male	13,118	(94.7)
		Female	733	(5.3)
6.	**Sex of the Child**	Male	7068	(51.0)
		Female	6783	(49.0)
7.	**Region of Residence**	Urban Governorates	1979	(14.3)
		U/ Lower Egypt	925	(6.9)
		R/ Lower Egypt	2879	(20.8)
		U/ Upper Egypt	1718	(12.4)
		R/ Upper Egypt	5657	(40.9)
		Frontier Gov.	693	(5.0)
8.	**Birth Order**	First Order	4190	(30.2)
		2—4 Order	7492	(54.1)
		5 +	2169	(15.7)
9**.**	**Birth Interval**	<24 month	2052	(14.8)
		24 + and First Order	11799	(85.2)
10.	**Birth Size**	Large	616	(4.5)
		Average	11,127	(80.9)
		Small	2015	(14.6)
	TOTAL		**13.851**	**(100)**

Considering the distribution of demographic categories it was found that; mean mother's age of the at first birth was 21 years (ranging between 11-43 years old) and the mean age of the mother at birth of the study child was 26.5 years (ranging between 14 and 48 years). 51% (7068) of the live births were males, 27.7% (3804) were living in Lower Egypt, while 53.3% (7375) were living in Upper Egypt.

With regard to biological determinants it was found that 30.2% (4190) babies were first births, 54.1% (7492) were second to fourth order births, and the remainder higher order births. Only 14.8% (5052) of respondents reported preceding birth interval of less than 24 month (2 years), and 80.9% (11,127) reported giving birth to an average sized baby. While 37.3% (5169) of births occurred at home and almost the same percentage occurred at a private sector facility, only 26.1% (3651) of the babies were born in a public sector facility.

3.2 LEVELS AND DIFFERENTIALS:

Table (3.2) shows levels and differentials of infant and post neonatal mortality across different categories of socioeconomic and bio-demographic determinants selected in the study. From the table one can notice that mothers with no education had the highest level of IMR and PNMR. It was not surprising to the highest levels of infant and post neonatal mortality among the poorest category of wealth index and in rural residents compared to urban residents.

Consistently, infant mortality and post neonatal mortality show higher levels among those who lived in rural Upper Egypt, of fifth birth order or more, born within less than 24 months birth interval from the preceding sibling and born to a female-headed household.

Table (3.2): Levels and differentials of Infant and Post-neonatal Mortality by selected variables EDHS (2005)

Variable	No. of Infant Deaths	Time at Risk (Person-month)	IMR (/ 10,000 baby -month)	PNMR (/10,000 baby -month)
1.**Mother's Highest Education**				
None	205	48444	**42.3**	**17.5**
Primary	71	18409	38.6	13.6
Secondary	161	64943	24.7	6.5
Higher	26	13057	19.9	1.5
2. **Wealth Index**				
Poorest	158	35583	**44.4**	**18.3**
Poorer	92	31073	29.6	12.6
Middle	82	28456	28.8	9.5
Richer	84	26905	31.2	5.9
Richest	47	22836	20.5	3.1
3. **Type of Place of Residence**				
Urban	151	53631	28.5	6.0
Rural	312	91822	**34.0**	**13.3**
4. **Mother's Working Status**				
Working	377	118739	31.8	**11.0**
Not Working	86	26114	**32.9**	8.8
5. **Sex of Household Head**				
Male	437	137273	31.8	10.6
Female	26	7580	**34.3**	**11.9**
6. **Sex of the Child**				
Male	261	73255	**35.6**	9.4
Female	202	71598	28.2	**11.9**
7. **Region of Residence**				
Urban Governorates	45	21115	21.3	4.2
U/ Lower Egypt	33	9560	34.5	5.2
R/ Lower Egypt	75	30236	24.8	4.3
U/ Upper Egypt	60	17986	33.3	9.5
R/ Upper Egypt	227	58735	**38.6**	**18.0**
Frontier Gov.	23	7221	31.9	5.5
8. **Birth Order**				
First Order	139	43552	31.9	8.5
2—4 Order	220	78467	28.0	9.2
5 +	104	2283	**45.5**	**19.7**
9. **Birth Interval**				
<24 month	110	21425	**51.3**	**11.6**
24 + and First Order	353	123428	28.6	8.8
10. **Birth Size**				
Large	32	6666	48.0	**21.0**
Average	256	117889	21.7	7.9
Small	152	19529	**77.8**	2.1
11. **Place of Delivery**				
Home	179	54985	32.5	**15.5**
Urban Public Sector	84	22783	36.9	9.7
Rural Public Sector	64	14786	**43.3**	6.1
Private Sector and NGOs	130	52255	24.9	6.7
TOTAL	**463**	**144835**	**32.0**	**11.0**

Interestingly, the levels of mortality are different comparing infant to post neonatal across strata of some determinants; for example: while IMR is higher among male children, PNMR is higher among females. Also, the highest level of IMR is shown among small size babies and babies born in rural public sector, while PNMR highest levels were reported among large size babies and home delivery, respectively. Such inconsistent results need more investigation and statistical proof so as to see if these differences, across strata of same factor in the two periods, are real differences. This analysis approach will facilitate drawing conclusions about predictors of mortality and eventually plan appropriate health policies.

3.3 PREDICTORS OF INFANT MORTALITY:

3.3.1 BIVARIATE ANALYSIS:

The main aim of bivariate analysis is to study the gross effect of each socioeconomic or biodemographic determinant. Cox's proportional hazard models are fitted for each variable separately for the infancy period, after adjusting for clustering effect on the mother (for multiple pregnancy and siblings), so as to obtain robust standard errors.

Table (3.3) column (1) shows the results of bivariate analysis for infancy period. There is a statistically significant association between infant mortality and mother level of education, wealth index, sex of the child, birth order, birth interval and region of residence. That is infants born to mothers with secondary or higher level of education or born to households belonging high wealth quintiles are at lower risk of death during infancy period. Likewise, females, those who were second to fourth birth order and those born after a preceding birth interval of 24 month or more shared a significantly lower risk of death during infancy period.

On the other hand, the variables: mother's working status, type of place of residence (rural\urban), sex of the head of the household, age of the mother at birth and age of the mother at first birth show no significant association with infant mortality. It is worth mentioning that age of the mother at first birth or current birth and their squared values are not significantly related to mortality contradicting with large body of literature that pointed to such a strong relation as discussed in chapter (1).

Table (3.3): Results of Bivariate Regressions (Adjusted Odd and Hazard Ratios) Showing the Association between Infant Mortality and Selected Socioeconomic and Biodemographic Variables EDHS (2005).

Variable	**Infant Mortality** HR (95% CI)	**Neonatal Mortality** OR (95%CI)	**Post-neonatal Mortality** HR (95% CI)
1.**Mother's Education**			
None	1.00	1.00	1.00
Primary	0.91(0.69—1.21)	1.01(0.70—1.46)	0.77(0.49—1.22)
Secondary	0.59(0.47—0.73)***	0.74(0.55—0.98)*	0.37(0.25—0.54)***
Higher	0.47(0.29—0.75)**	0.73(0.43—0.82)*	0.09(0.02—0.35) **
2. **Wealth Index**			
Poorest	1.00	1.00	1.00
Poorer	0.67(0.52—0.87)*	0.65(0.45—0.93)*	0.69(0.46—1.02)
Middle	0.65(0.49—0.87)*	0.74(0.51—1.07)	0.52(0.33—0.82)*
Richer	0.71(0.53—0.95)*	0.98(0.58—1.40)	0.33(0.19—0.56)***
Richest	0.47(0.33—0.68)***	0.68(0.44—1.03)	0.17(0.08—0.37)***
3. **Type of Place of Residence**			
Urban	1.00	1.00	1.00
Rural	1.19(0.96—1.47)	0.91(0.70—1.15)	2.20(1.49—3.24)***
4. **Mother's Working Status**			
Working	1.00	1.00	1.00
Not Working	1.65(0.82—1.34)	1.19(0.88—1.61)	0.80(0.51—1.26)
5. **Sex of Household Head**			
Male	1.00	1.00	1.00
Female	1.07(0.70—1.63)	1.04(0.62—1.74)	1.12(0.54—2.35)
6. **Age at child Birth**	1.01(0.99—1.03)	1.02(0.90-1.04)	1.00(0.97—1.03)
7. **Age at First Birth**	1.00(0.97—1.02)	1.02(1.00—1.05)	0.93(0.89—1.99)
8. **Sex of the Child**			
Male	1.00	1.00	1.00
Female	0.80(0.66-0.97)*	0.63(0.49—0.80)***	1.26(0.91—1.74)
9. **Region of Residence**			
U/ Governorates	1.00	1.00	1.00
U/ Lower Egypt	1.57(0.95—2.65)	1.68(0.93—3.04)	1.23(0.41—3.64)
R/ Lower Egypt	1.15(0.76—1.73)	1.19(0.74—1.90)	1.01(0.43—2.35)
U/ Upper Egypt	1.54(1.60—2.37)	1.39(0.82—2.34)	2.21(0.99—4.95)
R/ Upper Egypt	1.78(1.25—2.52)**	1.18(0.77—1.70)	4.22(2.14—8.34)***

Frontier Gov.	1.47(0.84—2.57)	1.52(0.82—2.84)	1.30(0.33—5.09)
10. **Birth Order**			
First Order	1.00	1.00	1.00
2—4 Order	0.88(0.71—1.10)	0.81(0.62—1.05)	1.08(0.72—1.62)
5 +	1.44(1.10—1.88)*	1.12(0.80—1.54)	2.33(1.48—3.65)***
11. **Birth Interval**			
<24 month	1.00	1.00	1.00
24 + and First Order	0.56(0.45—0.70)***	0.66(0.50—0.88)**	0.41(0.29—0.57)***
12. **Birth Size**			
Large	1.00	1.00	1.00
Average	0.45(0.31—0.65)**	0.49(0.30—0.81)**	0.37(0.21—0.65)*
Small	1.51(1.02—2.24)*	1.94(1.15—3.25)*	0.99(0.54—1.82)
13. **Place of Delivery**			
Home	1.00	1.00	1.00
Rural Public Sector	1.11(0.85—1.44)	1.55(1.11—2.17)*	0.39(0.20—0.90)*
Urban Public Sector	1.31(0.95—1.80)	2.16(1.47—3.17)***	0.62(0.38—1.01)
Private Sector and NGOs	0.75(0.59—0.95)*	1.04(0.76—1.14)	0.43(0.30—0.65)***

* P-value <0.05 ** P-value < 0.01 *** P-value <0.0001, based on robust standard errors
U: Urban, R: Rural

3.3.2 MULTIVARIATE ANALYSIS:

In addition to identifying socioeconomic and biodemographic factors associated with infant mortality in Egypt, a specific objective is to quantify the impact of these factors on infant mortality. Multivariate analysis is a helpful tool to achieve this objective, since the results obtained measure the net effect of each determinant in the presence of all other contributing factors or after controlling for the effect of other factors and confounders. By this we can nominate independent predictors of infant mortality in Egypt that could be the focus of effective health policies in Egypt.

Table (3.4) shows the results of three fitted Cox's proportional hazard models for infancy periods. The results show hazard ratio with their corresponding 95% confidence interval and p-value. Analysis included variables which were significant at 15% (p-value: 0.15) (starting cut point) as recommended by some biostatisticians (e.g. Kirkwood (2005)) in bivariate analysis. Then the variables are considered to be independent (i.e. after controlling for other predictors) significant predictors of mortality in the fitted multivariate models if their p-value was < 0.05 (Final cut point) and 95% confidence interval does not include one.

The first model (model 1) only includes socioeconomic predictors, in the second model (model 2) demographic factors were added to indicate to what extend they operate through demographics. In the final full model (model 3) proximate determinants and biological predictors were added to demonstrate any importance of socioeconomic effects in the presence of biodemographics. Before modeling the effect of clustering was adjusted and robust standard errors were obtained.

Regarding infant mortality determinants, in the first model both mother education of secondary and higher level imply significantly lower risk of infant death (37% (19-52%) and 47%(16–70%) less, respectively) compared to no education. There is no statistically significant difference between no education and primary level of education among mothers, after adjusting for wealth. After controlling for mother's education, the poorer wealth category has 27% (CI (4-44%)) less risk of mortality compared to the poorest quintile.

After controlling for demographic covariates added in the second model, mother education and wealth index remained as significant predictors of infant mortality. But, upon adding biological determinants to the model; the effect of wealth index on infant mortality disappeared and the relationship lost statistical significance. In contrast to mother's education which show a statistically significant inverse relationship with infant mortality even after controlling for wealth index, sex of the child, place of residence, birth order, birth interval, birth size and place of delivery. That is infant deaths are less likely among infants of mothers of higher education (AHR:

0.49 CI (0.27—0.88)) and secondary education (AHR: 0.64 CI (0.48—0.86) compared to no education

Table (3.4): Results of Multivariate Regressions (Adjusted Hazard Ratios) Showing the Association between Infant Mortality and Selected Socioeconomic and Biodemographic Variables EDHS (2005).

Variable	**Model (1)** HR (95% CI)	**Model (2)** HR (95% CI)	**Model (3)** HR (95% CI)
1.**Mother's Education**			
None	1.00	1.00	1.00
Primary	0.95(0.71—1.27)	0.96(0.72—1.29)	0.91(0.67—1.23)
Secondary	0.63(0.48—0.82)**	0.64(0.49—0.84)**	0.64(0.48—0.86)**
Higher	0.53(0.30—0.94)*	0.53(0.30—0.93) *	0.49(0.27—0.88) *
2. **Wealth Index**			
Poorest	1.00	1.00	1.00
Poorer	0.73(0.56—0.96)*	0.75(0.58—0.99)*	0.78(0.59—1.02)
Middle	0.78(0.57—1.67)	0.83(0.60—1.15)	0.80(0.60—1.15)
Richer	0.92(0.65—1.30)	1.01(0.71—1.44)	1.05(0.74—1.51)
Richest	0.67(0.41—1.08)	0.75(0.46—1.22)	0.92(0.56—1.50)
3. **Type of Place of Residence**			
Urban	1.00	1.00	1.00
Rural	0.94(0.73—1.21)	1.02(0.41—2.56)	1.28(0.51—3.25)
4. **Sex of the Child**			
Male		1.00	1.00
Female		0.80(0.67—0.97)*	0.80(0.66—0.96)*
5. **Region of Residence**			
Urban Governorates		1.00	1.00
U/ Lower Egypt		1.59(0.96—2.65)	1.94(1.17—3.24)
R/ Lower Egypt		1.03(0.38—2.81)	1.06(0.48—2.97)
U/ Upper Egypt		1.50(0.97—2.32)	1.64(1.00—2.57)
R/ Upper Egypt		1.36(0.51—3.59)	1.22(0.45—3.31)
Frontier Gov.		1.27(0.63—2.54)	1.40(0.67—2.90)
6. **Birth Order**			
First Order			1.00
2—4 Order			0.74(0.57—0.94)*
5 +			1.05(0.77—1.42)
7. **Birth Interval**			
<24 month			1.00
24 + and First Order			0.50(0.39—0.63)***
8. **Birth Size**			
Large			1.00
Average			0.49(0.34—0.70)***
Small			1.61(1.09—2.37)*
9. **Place of Delivery**			
Home			1.00
Urban Public Sector			1.29(0.98—1.70)
Rural Public Sector			1.64(1.18—2.28)*
Private Sector			0.96(0.73—1.25)
Log likelihood	-4373.2312	-4365.6472	-4058.6995
Wald's P-value	<0.0001	<0.0001	<0.0001

* p-value <0.05 ** p-value < 0.001 *** p-value <0.0001, Based on robust standard errors.

The demographic determinants: sex of the child and region of residence are found to be independent predictors of infant mortality after controlling for mother education and wealth index. The risk of infant death is 20% (4-34%) less among female compared to male infants.

The third model reveals statistically significant association between fertility factors and infant mortality. That is the risk of infant death is 50% (CI(37-61%)) less among infants born after a preceding birth interval of 24 months or more compared to an interval less than 24 month. Likelihood of infant death is highest among small size babies (AHR: 1.61 CI(1.09 -2.37) compared to large size babies, and 26% (CI(6-43%)) less among second to fourth order of birth compared to first order.

Looking at the third model which added biological predictors we can conclude that birth order, birth interval, birth size and place of delivery are all independent predictors of infant mortality after controlling for other predictors and each other. In addition to mother education and sex of the child, which are still independent predictors.

3.3.3 ASSUMPTIONS:

Assumption of Cox's proportional hazard models should be holding before drawing conclusions about them. The assumption is that the variable should have a period specific constant, which can vary across periods but have the same proportional effects in each period. In other words the effect of the variable should not vary over that time period. Two methods are used to check for these assumptions: log-log survival curves (graphical) and scaled Schoenfeld (covariate-specific) test, testing for null hypothesis that the proportional hazard assumption has not been violated.

The power of the Schoenfeld test is that it determines which variables violated the proportionality assumptions.

For the final infant mortality model the assumptions are violated (p-value: <0.001) and the variables which violated the assumptions are mother education, sex of the child and place of delivery (see appendix one). In other words, we can say that the effects of these variables vary over time and they are time-dependent covariates. In order to find out if these variables are really time-dependant covariates we run the same final model, but specified them as time varying covariates and check for the assumptions again using Schoenfeld test, It show that the assumptions are not violated (p-value: 0.377) this time. The new model including time-dependent covariates is shown in appendix two.

These results in fact might be reflecting difference between determinants of mortality within the infancy period i.e. the effect of some variables vary across this period so some of them might be related to mortality in early stages but not late stages of infancy and vice versa.

In order to further prove the presence of such differences even within the infancy period, I splitted the period into two smaller periods: neonatal (first month of life) and post neonatal (1 month-12 month) periods. This time matrix is based on an old trend in biomedical research to study the predictors of each period separately. For example: Rajna, Mishrand and Krishnamoorth (1998) in India, Woldemicael (1998) in Eritrea, Kabir (2003) in India. This could be attributed to different conditions during the first month compared to older age, for example exclusive breastfeeding, protective effect of maternal immunoglobulin’s transferred to the neonate and almost the equality between different socioeconomic classes level of care during the neonatal period. Separate models for each period were run, so as to identify any differences between the predictors of mortality in these two periods.

3.4 PREDICTORS OF NEONATAL MORTALITY:

3.4.1 BIVARIATE ANALYSIS:

Because children's age is recorded in months, the use of a Cox model for analyzing neonatal mortality is not possible. Instead I rely on a logistic regression model of child survival before the first month of life. Bivariate logistic regression models were fitted to have an idea about the individual effects of different variables on neonatal mortality.

Unadjusted odd ratios were obtained and the results are shown in table (3.3) column (2). The results reveals that only males, small birth size, fifth or more birth order, less than 24 months birth interval and rural place of delivery are significantly associated with higher risk of neonatal mortality.

3.4.2 MULTIVARIATE ANALYSIS:

Table (3.5) shows the results of fitted multivariate logistic regression models in the neonatal period. The results are displayed in the form of adjusted odd ratios with their corresponding 95% confidence interval and p-value. Variables included in multivariate analysis are those which were significant at 15% level ($p < 0.15$) in the bivariate analysis. Then the variables are considered to be independent (i.e. after controlling for other predictors) significant predictors of mortality in the fitted multivariate models if their p-value is < 0.05 and 95% confidence interval does not include one. Three models are used to study the net effect of each statistically significant variable in bivariate analysis. The first model includes socioeconomic variables, demographic variables were added to the second model and biological variables were added to the final third model.

Table (3.5): Results of Multivariate Regressions (Adjusted Hazard Ratios) Showing the Association between Neonatal Mortality and Selected Socioeconomic and Biodemographic Variables EDHS (2005).

Variable	**Model (1) Adj-OR(95%CI)**	**Model(2) Adj-OR(95%CI)**	**Model(3) Adj-OR(95%CI)**
1.**Mother's Highest Education**			
None	1.00	1.00	1.00
Primary	1.01(0.69—1.48)	1.00(0.68—1.47)	0.87(0.58—1.31)
Secondary	0.70(0.49—0.99)*	0.69(0.47—1.00)	0.65(0.44—1.00)*
Higher	0.68(0.55—1.31)	0.61(0.31—1.21)	0.53(0.26—1.08)
2. **Wealth Index**			
Poorest	1.00	1.00	1.00
Poorer	0.70(0.49—1.01)	0.69(0.48—1.00)	0.71(0.49—1.03)
Middle	0.86(0.56—1.31)	0.82(0.54—1.26)	0.78(0.50—1.22)
Richer	1.21(0.80—1.83)	1.12(0.74—1.71)	1.07(0.69—1.66)
Richest	0.90(0.51—1.57)	0.82(0.47—1.43)	0.89(0.51—1.59)
3. **Age at child Birth**		1.01(0.98—1.03)	1.03(0.98—1.06)
4. **Age at First Birth**		1.03(0.99—1.07)	1.00(0.94—1.05)
5. **Sex of the Child**			
Male		1.00	1.00
Female		0.63(0.49—0.80)***	0.62(0.49—0.79)***
6. **Birth Order**			
First Order			1.00
2—4 Order			0.63(0.42—0.95)*
5 +			0.67(0.30—1.47)
7. **Birth Interval**			
<24 month			1.00
24 + and First Order			0.51(0.37—0.70)***
8. **Birth Size**			
Large			1.00
Average			0.54(0.33—0.88)*
Small			2.09(1.24—3.52)*
9. **Place of Delivery**			
Home			1.00
Urban Public Sector			1.60(1.12—2.29)*
Rural Public Sector			2.23(1.47—3.38)***
Private Sector			1.14(0.80—1.64)

* p-value< 0.05, ** p-value<0.001, *** p-value<0.0001, Based on robust standard errors. The results indicate that none of the socioeconomic factors is related to neonatal mortality, and the effect of mother's education disappears (N.B: The CI includes one) after controlling for biodemographic determinants.

Age of the mother at first birth and at child birth is significant at 15% in the bivariate analysis; the effect of these factors disappears after controlling for other covariates. After introducing biological determinants in the third model, one can say that the independent predictors of neonatal mortality are sex of the child, birth size, birth order, place of delivery and birth interval. Neonatal deaths are less likely among females (AOR: 0.62 CI(0.49-0.79)) relative to males, among babies of second to fourth birth order (AOR: 0.63 CI(0.42—0.95) compared to first order and among babies born after a preceding birth interval of 24 month or more (AOR: 0.51 CI(0.37—0.70)) relative to an interval less than that. The likelihood of neonatal deaths is highest among small size babies (AOR: 2.09 CI(1.24—3.52)) compared to large size babies and among those born in a rural public sector facility (AOR: 2.23(1.47—3.38)) compared to home delivery.

3.5 PREDICTORS OF POST NEONATAL MORTALITY:

3.5.1 BIVARIATE ANALYSIS:

After exclusion of neonatal deaths, Cox's proportional hazard models were fitted for each variable separately for post neonatal period, after adjusting for clustering effect of multiple births for the same mother, so as to obtain robust standard errors.

The last column of table (3.3) shows the results of bivariate analysis for post neonatal period. There is a statistically significant association between infant mortality and level of education (secondary and higher levels were protective compared to no education, while primary level did not differ statically from no education), wealth index, birth order, birth interval and region of residence. It worth mentioning that mother's working status, sex of the head of the household; age of the mother at birth and age of the mother at first birth are all not related to post neonatal mortality.

On the other hand, some predictors indicate significant relation with neonatal but not with post neonatal mortality, and vice versa. For example, sex of the child was significantly related to neonatal mortality only. Also, while type of place of residence (rural/urban) was found to be a significant predictor for post neonatal mortality, it is not related to infant mortality. The same is valid for birth size which show significantly higher hazard among small size babies compared to large ones during neonatal period, while this relation is not significant during the post neonatal period.

Although these results show gross effect of each predictor on neonatal and post neonatal mortality, they are interesting and worth further investigation. The more interesting results are those which show different levels of significance across the neonatal and post neonatal period. Such results deserves cautious investigation and might be reflecting and proving different effect of some predictors over time even within the infancy period as demonstrated in the infancy period models.

3.5.2 MULTIVARIATE ANALYSIS:

Table (3.6) displays the results of three Cox's proportional hazard models for post-neonatal period. The results display hazard ratios with their corresponding 95% confidence interval and p-value. The analysis included variables which were significant at 15% (p-value: 0.15) in bivariate analysis. Then the variables are considered to be independent (i.e. after controlling for other predictors) significant predictors of mortality in the fitted multivariate models if their p-value was < 0.05 and 95% confidence interval does not include one. Using the same three models described in the previous sections.

Table (3.6): Results of Multivariate Regressions (Adjusted Hazard Ratios) Showing the Association between Post neonatal Mortality and Selected Socioeconomic and Biodemographic Variables EDHS (2005)

Variable	**Model (1)** HR (95% CI)	**Model (2)** HR (95% CI)	**Model (3)** HR (95% CI)
1.**Mother's Highest Education**			
None	1.00	1.00	1.00
Primary	0.88(0.55—1.40)	0.94(0.59—1.50)	0.99(0.61—1.59)
Secondary	0.50(0.33—0.77)**	0.55(0.36—0.83)*	0.67(0.40—0.99)*
Higher	0.17(0.04—0.65)*	0.18(0.05—0.70) *	0.23(0.06—0.88)*
2. **Wealth Index**			
Poorest	1.00	1.00	1.00
Poorer	0.80(0.53—1.20)	0.86(0.57—1.30)	0.88(0.58—1.32)
Middle	0.74(0.45—1.20)	0.88(0.53—1.44)	0.82(0.49—1.37)
Richer	0.59(0.32—1.08)	0.79(0.43—1.43)	0.83(0.46—1.52)
Richest	0.43(0.19—0.95)*	0.57(0.25—1.29)	0.62(0.27—1.43)
3. **Type of Place of Residence**			
Urban	1.00	1.00	1.00
Rural	1.26(0.82—1.92)	3.1(0.29—34.99)	3.49(0.31—38.73)
4. **Sex of the Child**			
Male		1.00	1.00
Female		1.28(0.93—1.77)	1.28(0.92—1.79)
5. **Region of Residence**			
Urban Governorates		1.00	1.00
U/ Lower Egypt		1.26(0.42—3.70)	1.32(0.44—3.95)
R/ Lower Egypt		1.23(0.02—3.18)	0.21(0.02—2.96)
U/ Upper Egypt		1.90(0.85—4.22)	1.75(0.78—3.91)
R/ Upper Egypt		0.76(0.09—9.81)	0.58(0.04—1.59)
Frontier Gov.		0.45(0.06—3.63)	0.42(0.05—3.41)
6. **Birth Order**			
First Order			1.00
2—4 Order			0.75(0.48—1.18)
5 +			1.22(0.73—2.03)
7. **Birth Interval**			
<24 month			1.00
24 + and First Order			0.43(0.30—0.63)***
8. **Birth Size**			
Large			1.00
Average			0.44(0.25—0.77)**
Small			1.10(0.60—2.00)
9. **Place of Delivery**			
Home			1.00
Urban Public Sector			0.89(0.55—1.45)*
Rural Public Sector			0.70(0.34—1.43)
Private Sector and NGOs			0.82(0.52—1.29)
Log likelihood	-1420.8852	-1407.652	-1330.2353
Wald's P-value	<0.0001	<0.0001	<0.0001

* P-value <0.05 ** P-value < 0.001 *** P-value <0.0001, Based on robust standard errors.

Post neonatal mortality models (table (3.6)) shared the same results and pattern as in neonatal mortality with regard to the significance of birth interval, and even with more magnitude (AHR:

0.43 CI(0.30—0.63)). But the results are different considering mother education, birth size, birth order, sex of the child and place of delivery. Unlike in models for neonatal mortality, coefficients for birth order and place of delivery are not statistically related in models of post neonatal mortality. Also, while small size of birth carried a higher risk of neonatal death relative to large size, this relationship disappears in post neonatal period and there is no difference between large or small size of birth.

The most interesting difference between predictors of neonatal mortality and post neonatal mortality is in the factor (child's) sex, which is a significantly independent predictor of infant but not post neonatal mortality. This in fact contradicts the biological knowledge of lower death risk among females and raises the question of sex preference and discrimination.

Unlike neonatal models, post neonatal models give the first appearance of a socioeconomic factor as a determinant of mortality. Mother education shows a significant inverse relationship with post neonatal mortality. That is the risk post neonatal death is 77% (CI(22-99%)) less among babies of mothers with higher level of education compared to no education, and 33% (CI(1-60%)) less among babies of mothers with secondary level of education compared to no education.

In conclusion one can say that the independent predictors of neonatal mortality in Egypt are sex of the child, birth size, birth order, birth interval and place of delivery. Mother education, birth interval and birth size are the predictors of post neonatal mortality. And all these mentioned factors are predictors of the whole infancy period with some variation in some predictor's effects within the infancy period in the form of time varying covariates.

CHAPTER (4)

DISCUSSION

The main aim of the study is to examine the socioeconomic and biodemographic predictors of infant mortality in Egypt. Particularly, to identify the determining factors of infant mortality and their impact, in order to direct health policy plans. Cox's proportional hazard models were used to identify these factors. Then, the analysis has been further expanded by conducting two other sets of models: Cox's proportional hazard models for the post neonatal period and logistic regressions for the neonatal period. These models were used in order to find the factors that determine mortality in these two small periods within infancy and to pick any differences between them.

4.1 LEVELS AND DIFFERENTIALS:

Looking at the levels of both IMR and PNMR among different selected socioeconomic determinants, we notice that the results are consistent across the two periods and the highest levels of mortality are reported among mothers with no education, poorest category of wealth index and rural residents. These results might not be interesting to the reader since it is well known and documented in literature discussing these determinants, but the difference of mortality level across same variable strata worth a second look.

For example when considering mother education; while the level of infant death among mothers with no education is double that of mothers with higher level of education, the level of mortality in babies of mothers with no education is almost 17 times that of babies of mothers with higher level of education in the post neonatal period. Also when considering wealth index we find that post neonatal deaths among the poorest was 6 times that of the richest, while it is only double in the infancy period as a whole. A simple explanation of these results might support the theory and hypothesis of this study that socioeconomic factors are more important in older ages than young age, as during early age the same level of care and the importance of breastfeeding bridge the gap of unequal socioeconomic status. The gap widens with increasing age and socioeconomic factors start to play a stronger role.

The results also reveal vague differential by mother's working status, as while there is almost no difference between level of death among infants of working and non working mother, the risk of post neonatal mortality is higher among non working mothers' babies. This contradicts maternal leave theory (out going of women for work after the expiry of their maternal leave, and thus decreasing time space offered to their babies). The effect can perhaps be explained by socioeconomic status differences, since working women are more likely to be wealthier so they can afford other baby needs like regular hospital visits, vaccination and better food or even treatment for their children.

With regard to demographic determinants, a very wide variation exists in the level of IMR and PNMR between different regions in Egypt, both IMR and PNMR are very high in rural Upper Egypt. This can be attributed to socioeconomic inequality between different regions in the country. This is supported by former studies in Egypt (Casterline, Cooksey and Ismail, 1989; Yassin, 2000) and other countries like Iran (Hosseinpoor et al, 2005). The results indicate decreased female sex advantage with increase in age; as IMR is higher among males while PNMR is higher among females. This observation might raise the question of gender discrimination and sex inequality in such a developing country. This is consistent with the findings of Bhuiyat and Streatfield (2003) in Matlab DSS site in Bangladesh.

While the results of the biological determinants: birth order and birth interval are not unexpected or different from other studies, the results of birth size are really interesting. The level of infant death among small size babies was almost triple that for average babies, but the mortality of small size babies is even less in the post neonatal period. At the first glance this result might appear strange and unrealistic, but we can still argue that since small size babies are at a higher risk usually born very sick, most of the deaths occur during their early life days and neonatal period, so by post neonatal period small number of them are left reflected in that smaller level of death in that period. Or in other words because most of them die early and only few left in the post neonatal period.

4.2 PREDICTORS OF MORTALITY:

Studying the predictors of infant mortality revealed interesting results, the variation found between the predictors of the neonatal and post neonatal periods within the infancy stage is not only interesting for policy planning of that short period of life, but as a prove for the ongoing debate of the importance of socioeconomic determinants versus biodemographic factors in all stages of childhood. It will be more interesting to discuss these predictors in a chronological order starting from neonatal period to post neonatal period then finally to discuss the predictors of infant mortality all together in order to highlight differences between neonatal and post neonatal periods, then draw occlusions on them and eventually to drive health policies and priorities.

4.2.1 PREDICTORS OF NEONATAL MORTALITY:

The results of both bivariate and multivariate analyses demonstrate no association between neonatal mortality and socioeconomic predictors included in the analysis (mother education, wealth index, mother's working status and type of place of residence).

The lack of association between the five socioeconomic predictors and neonatal mortality supports what was demonstrated by other authors stating that the determinants of death during the first month of life seems to be explained mainly by other biodemographic factors rather than socioeconomic ones, even if the latter has some impact, it is very minor and indirect. This lack of association, even for mother education has been demonstrated in a study conducted in Tanzania by Mturi and Curtid (2005). In his study, socioeconomic factors like: maternal education, paternal education, rural/urban residence and presence of radio (proxy of wealth) indicates no association with neonatal mortality.

In this study, the overwhelming statistical significance of the biodemographic predictors sex of the child, birth interval, place of delivery followed by birth size and birth order, supports the findings and conclusions of the above study mentioned. The lack of significance of socioeconomic variables including mother education could be explained by the effect of breastfeeding which covers neonates with immunoglobulin to protect against diseases and all the nutritional requirement, this may create some sort of equality between different socioeconomic classes using the same standard food and almost the same standard of care before the progression to an older age where immunization should be provided and supplementary food is to be introduced.

On the other hand, this study further strengthens the importance of biodemographic determinants and their impact on neonatal mortality. For example sex of the neonate show highly significant relationship with mortality, and females are found to have 38% less risk of death compared to males. This is purely due to the biological advantage of females and their better survival chances over males discussed in other studies (Boback, 2000 and Gemperli, 2004).

The other factor that shows strong relationship with neonatal mortality is preceding birth interval, a preceding birth interval of 24 month or more carries almost 50% less risk of death compared to an interval less than 24 months. This is consistent with all the literature that looked at the importance of preceding birth interval. The significance of this factor could be attributed to the mother and not directly to the baby, since a mother with two or more years of rest between deliveries is more capable and prepared physiologically and psychologically to bear a baby. Also the disadvantage of pregnancy while already breastfeeding a previous sibling that is very exhaustive to both mother and baby health. These two explanations are known as maternal depletion syndrome (consecutive short spaced pregnancies tend to exhaust mother's biological resources and potentials) (Gyimah, 2002).

It would be appropriate to discuss the importance of birth order within the context of birth interval because the factors seems to be highly interrelated and even some authors linked them as one variable, but the relationship can not be completely explained by birth interval and its theories. There are other contributing factors; for example the advantage of second to fourth birth order over first and fifth or more order could be also attributed to age of the mother. In other words giving birth to the first child by a teenager mother who is not well prepared physiologically and psychologically to bear a child is a great disadvantage and contributes directly to higher infant mortality rate among first born babies. While also high order is probably confounded by old mother age and maternal depletion syndrome. Another theory is that as the order increases the family size increases and the presence of more children in the household creates a greater opportunity for the spread of infectious diseases.

This study also reveals significant relationship between neonatal mortality and place of delivery, where the riskiest place of delivery is rural public sector facilities, it is even worse than home deliveries and two times the mortality in urban public sector facilities. The advantage of home delivery over public sector in rural areas can be explained by the old tradition in rural areas where only complicated labours or deliveries are taken to the health facilities so this relation is definitely biased by this self-selection phenomenon. The other relation between size of the baby and neonatal mortality can be easily explained, since it is biologically plausible that small sized babies are at higher risk of death especially during their early days of life (Stoll and Kliegman, 2004).

It is also important to note that models of neonatal mortality demonstrate lack of differentiation by socioeconomic factors while biodemographic factors are the main predictors of mortality. This is a very important observation that could drive the health policies directed to the benefit of this young age. On the other hand, it is consistent with vast set of literature that questioned the importance of socioeconomic factors in that young age.

4.2.2 PREDICTORS OF POST NEONATAL MORTALITY:

After exclusion of neonatal deaths, models are fitted to identify determinants of post neonatal mortality. In this period the socioeconomic predictors: mother education and wealth index appear to have significant association with mortality giving the first appearance of socioeconomic factors. For mothers education both bivariate and multivariate models brought out no difference between primary education and no education, while a clear inverse relationship was demonstrated with secondary and higher level of education even after controlling for other demographic predictors. Controlling for biodemographic factors render wealth index non significant predictor of post neonatal mortality (i.e. the effect of wealth index disappears after controlling for biodemographic factors).

So among selected socioeconomic predictors, only mother education is found to be a significant independent predictor of post neonatal mortality. The appearance of mother education in this group is plausible with Cleland and Van Ginneken's theory; that the strength of such association is higher in late infancy compared to younger infants where mortality is determined more likely by biological factors (Tulasidhar, 1993). The inverse relationship demonstrated here was also discussed by Caldwell (1979) who explained it by the triad of better child care and feeding, improved health seeking behavior and the evolution in familial relationships.

Unlike neonatal models, child's sex is not related to post neonatal mortality. Such a result introduces another urgent question: Is there any sort of gender discrimination and male sex preference in Egypt that has obscured the biological disadvantage of boys?. Yount (2003), for example, demonstrated a health provider bias in treating diarrheal disease in Minia in Egypt, favoring better male treatment and supplementation with Oral Rehydration Solution (ORS). This might reflect a deep rooted sex discrimination problem undermining the immunological advantage of females by cultural practices characterized by discrimination against girls in nutrition, paternal and health care. The same findings were reported in the Far East (Bhuiyat and Streatfield, 1991; Tulasidhar, 1993). On the other hand, there is no evidence of any region inequality in the models.

As in neonatal period, preceding birth interval of 24 month or more carries lower risk of post neonatal mortality (57% less). This relation is again explained by the theory of mother depletion syndrome mentioned earlier, in addition to another theory that might also explain this in the post neonatal period called sibling competition theory. But, unlike neonatal period post neonatal models show lack of differentiation by birth order, in conformity with the results obtained by Yassin in Egypt (2000). The above can be justified by a pure biological concept relating the importance of birth order in terms of mother capabilities; this might also support what I said earlier about the importance of other confounders like age and not the factor itself.

4.2.3 PREDICTORS OF INFANT MORTALITY:

As mentioned earlier, the main aim of the study is to identify predictors of infant mortality in Egypt, but modeling predictors of infant mortality reveals more interesting findings namely the presence of time dependent covariates within that short period of life. To prove the suggested findings, I further split that short period into further smaller periods: neonatal and post neonatal as mentioned earlier. The findings of these two periods' models further supports the findings of the original infancy models as will be discussed in due course.

Concerning socioeconomic predictors, only mother education is found to be a significant determinant of infant mortality after controlling for other predictors. But it has been proved that it is a time-dependent covariate and its effect varies within this year. This finding is further supported by the splitted models as mother's education is not related to neonatal mortality, but it is a significant predictor of post neonatal mortality. So, we can say that the only significant socioeconomic factor (mother education) starts to play a role when the baby gets older especially after completing the period of exclusive breastfeeding. This contradicts with a huge body of research starting with Caldwell (1979), but it brings to mind the findings of other authors contradicted with Caldwell's work e.g. Gubhaju et al. (1991) using data from Nepal, they argued that at early stages of development, less developed areas tend to show higher importance of demographic rather than socioeconomic factors in determining infant mortality.

Infant, neonatal and post neonatal models show lack of association with type of place of residence (rural/urban). This finding that might be strange and contradicting with vast set of literature for example Wang (2003), but the consistency of the findings across the three groups of models made it more reliable to believe. In addition to the findings of Casterline, Cooksey and Ismail in Egypt (1989) that also showed no difference between rural and urban residency. This could be the outcome of successful government policies and plans on developing rural areas, or may be due to underreporting of deaths in rural areas. Child's sex, nominated as the second time-dependent covariate in the infancy model was found to be a significant predictor of neonatal mortality but not post neonatal mortality. This is one of the major findings of this study as discussed earlier.

However, the models fitted for infant mortality indicate significant association with birth size. Average sized babies are at 50% less risk of death compared to large size babies, while risk of mortality for those who were born small is 1.6 times that of the large sized babies. Although the factor is not found to be a time dependant covariate, and unlike neonatal post neonatal mortality models show no difference between small or large size babies in terms of their risk of death. This could be justified by figures and numbers rather than a time varying relationship. As death tendency among small size babies is more during their early days of life(as demonstrated in the neonatal model), Then at post neonatal stage only small numbers of small babies left leading to a death tendency comparable to that among large size babies. Keeping in mind that large size of the new born is not an advantage and carries a higher risk of death as it might be a consequence of some diseases like maternal diabetes.

The third and last time-dependent covariate in the infancy models is place of delivery. Supporting that it is found to be a predictor of neonatal mortality and not post neonatal mortality. This is very realistic because place of delivery is related to the immediate care and has nothing to do with life later on.

Predictors of infant mortality are in fact those of neonatal and post neonatal mortality joined together, and the variation between the models reflects the presence of time varying covariates. The presence of the time varying covariate mother education, which is the only significant socioeconomic predictor of infant mortality, supports the hypothesis of the study that the role of socioeconomic predictors ,if present, tends to appear later during infancy period (post neonatal period), and the biodemographic factors tend to play the major role in determining infant mortality.

CHAPTER (5)

CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS:

This study has examined the socioeconomic and biodemographic determinants of infant, post neonatal and neonatal mortality, in Egypt. Results from Cox's proportional hazard models and logistic regression models showed that: when infant mortality rate is high, biodemographic factors are the most important determinants, while socioeconomic factors are less important.

It has been found that birth interval, birth size and birth order are the main predictors of infant mortality in Egypt. The results suggest that those who were born after a preceding birth interval of 24 month or more, of average size and were second to fourth birth order shared lower possibility of expected infant death. Other factors that affect infant mortality are level of mother education, sex of the child and place of delivery. But the effect of these three factors varies within the first year of life, for example while mother education is a predictor of post neonatal mortality; it is not a predictor of neonatal mortality. Unlike other developing countries, type of place of residence (rural/urban) and age of the mother at birth or first birth are not associated with infant mortality.

The findings also reveal that mother level of education, preceding birth interval and birth size were significant predictors of post neonatal mortality in Egypt in the period 2000-2005, while preceding birth interval, birth size, birth order, sex of the child and place of delivery were significantly related to neonatal mortality in Egypt during the same period.

Unlike other studies, mother education did not predict neonatal mortality, but exclusion of neonatal deaths in post neonatal models gave the first appearance of mother education and a socioeconomic factor as a predictor. The above supports the non importance of any socioeconomic factor early in that period. With regard to education simply enrolling more girls in school has no effect, but ensuring that all girls gained at least some secondary education will reduce mortality.

Our results confirm previous theories on gender discrimination in Egypt favoring male gender, since the models show lack of association between mortality and sex of the child in the post neonatal period, contradicting with the biological knowledge (That death rates among males are always higher than females). The protective effect of female sex appearing in neonatal models is not contradicting with this observation, but it is further proving it. As during the early days of life breastfeeding offered to both sexes equally is the most important protective factor, but with progression to the ages of supplementary food and medical care provision discrimination attitudes start to appear and the biological advantage of females disappears.

This study concludes that among investigated factors biodemographic characteristics indicate the most substantial impacts on infant mortality rejecting this study's null hypothesis. The only significant socioeconomic predictor maternal education has a modest impact, at best, on infant mortality which appears at a latter stage of infancy period (namely post neonatal period). It is important to note that the latter was found to be a time varying covariate.

5.2 RECOMMENDATIONS:

The importance of fertility and family factors demonstrated in the study should be the focus of health polices directed toward decreasing infant mortality in Egypt. These policies can act through introduction of organized national family welfare programs, which may include efforts to limit family size, increase birth interval and improve maternal health as implemented by FMOH. On the other hand, improving public sector facilities especially in rural areas will definitely play a major role in decreasing infant and particularly neonatal mortality and this should be the focus of a new program to be implemented.

Policies should not only focus on socioeconomic and health related factors, but also on sociocultural and demographic characteristics of the community. This can be achieved through the introduction of new social policies attempting to promote health seeking behavior equally for both sexes and discouraging gender discrimination attitudes, taboos and beliefs, using health education programs via mass media or school programs or even simple home visits.

The importance of mother education cannot be ignored, and girls and women education has to be facilitated and encouraged in order to have secondary level of education obtainable. Keeping in mind that mother education can act indirectly on mortality through biodemographic and sociocultural factors, for that an educated mother will be more capable of understanding family welfare and planning programs and is more likely to use health facilities and bypass the old gender discrimination taboos and believes.

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APPENDIX 1.

Test of Proportional Hazard Model Assumptions for Final Infant Mortality Model:

Variable	Chi 2	p-value
1.**Mother's Education**		
None	1.00	_
Primary	0.06	0.811
Secondary	1.52	0.218
Higher	9.10	0.002
2. **Sex of the Child**		
Male	1.00	_
Female	11.07	<0.0001
3. **Birth Order**		
First Order	1.00	_
2—4 Order	0.17	0.678
5 +	1.02	0.312
4. **Birth Interval**		
<24 month	1.00	_
24 + and First Order	1.50	0.221
5. **Birth Size**		
Large	1.00	_
Average	0.07	0.788
Small	2.61	0.106
6. **Place of Delivery**		
Home	1.00	_
R/ Public Sector	9.97	0.002
U/Public Sector	22.23	<0.0001
Private Sector	5.41	0.020
Global Test	60.66	< 0.0001

p-value < 0.05 indicates violation of Cox's proportional hazard model assumptions.
H_0: Cox's proportional hazard assumptions not violated.
Global test: tests the assumptions for the whole model, Individual p-values indicates if the variable specifically violated the assumptions or not.

APPENDIX 2.

Test of Proportional Hazard Model Assumptions for Final Infant Mortality Model after Inclusion of the Variables that violated that Violated the Assumptions as TVC:

Variable	Chi 2	p-value
1. **Birth Interval**		
<24 month	1.00	_
24 + and First Order	1.22	0.270
2. **Birth Order**		
First Order	1.00	_
2—4 Order	0.42	0.518
5 +	1.98	0.156
3. **Birth Size**		
Large	1.00	_
Average	0.00	0.952
Small	0.91	0.342
TVC		
4. **Place of Delivery**	0.48	0.487
5.**Mother's Education**	1.16	0.282
6. **Sex of the Child**	0.00	0.973
Global Test	6.28	0.3773

p-value < 0.05 indicates violation of Cox's proportional hazard model assumptions.
H_0: Cox's proportional hazard assumptions were not violated.
Global test: tests the assumptions for the whole model, Individual p-values indicates if variable specifically violated the assumptions or not.
TVC: Time Varying Covariates