Infant Mortality in Egypt: Exploring the Role of Prenatal Care, and Implications for Public Policy

by

George J. Lara
University of Texas at Austin

and

Thomas W. Pullum
University of Texas at Austin

Abstract

This study examines the importance of prenatal care and maternal education with regard to infant death in Egypt. Birth history data from Egypt Demographic and Health Survey (EDHS) 2000 are used to model the log odds of a child dying in the first year of life during the five-year period prior to survey. The analysis is three-fold. First, log probability models are used to arrive at accurate estimates of ${}_1q_0$ and ${}_4q_1$. Second, generalized linear models are used to examine the bivariate relationships between infant mortality and various determinants, viz., prenatal care, maternal education, birth order, sex of child, and type of place of residence. Lastly, the effects of these variables are analyzed in a multivariate context. We find that while maternal education reduces the odds of infant death, it is prenatal care that maintains magnitude and significance in the multivariate analysis. Timely and important policy implications are offered.

[word count: 149]

Introduction

Infant Mortality in Egypt and Goals of the Present Study

In recent years, Egypt has experienced rapid declines in infant, early childhood, and maternal mortality. However, compared to countries in the region, and especially to other 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. Slowing the long-term downward trend in infant death rates are relatively high fertility and consistently low levels of educational attainment among females (Ashford, Haub, Kent, and Yinger 2004), two demographic qualities whose relationship has received much attention in the literature. Furthermore, increased proportions of the population living in poverty (Roudi-Fahimi 2004) exacerbate current population dynamics in Egypt.

For all these reasons, interest in infant mortality in Egypt has maintained an historical allure. Estimates of neonatal, infant, and childhood mortality derived from Egyptian survey data exist dating back to 1965 (El-Zanaty, Hussein, Shawky, Way, and Kishor 1996; El-Zanaty and Way 2001). By the early 1980s, studies appeared offering specific health interventions with regard to prevention and treatment of diarrhea among Egyptian infants born in rural areas. Interestingly, one of these studies written more than twenty years ago (Tekce 1982) called for improved education among Egyptian mothers and better training of health care providers.

As Casterline, Cooksey, and Ismail (1989) discuss in some detail, previous research on infant mortality in Egypt has tended to focus on socioeconomic indicators such as household income, and the direct and indirect effects of related measures on infant mortality in rural Egypt. Casterline and colleagues (1989; 1992) give three primary reasons for this direction in the literature, one of which is directly related to the goals of the present study. Ultimately, they find that while there exist more proximate determinants of infant and early childhood mortality, household income has both a direct negative effect on infant death and important indirect effects,

via household and behavioral variables, which become increasingly important with regard to the risk of death in later childhood.

The methodological approach of the present study is three-fold. First, in contrast to previous studies on infant and early childhood mortality in Egypt, the present study aims to demonstrate the efficiency with which birth history data and log probability models can be used to estimate ${}_1q_0$ and ${}_4q_1$ (in Egypt) for the period 1995-2000. Furthermore, with the above-mentioned previous research in mind, and due primarily to the nature of the data, we focus on illustrating the effects of prenatal care, maternal education, birth order, sex of child, and type of place of residence, on infant mortality in Egypt, both in bivariate and multivariate contexts. By, "nature of the data," we mean to say that insofar as roughly 11,500 births are contained in the dataset, we can expect a vastly smaller number of child deaths to have occurred in the five years prior to the survey. In addition, since the great majority of early childhood deaths occur in the first year of life, we focus on those deaths observed from ages zero to one.

Prenatal Care

Caldwell (1986) reminds us that some past research on infant and child mortality in developing countries has downplayed the importance of what he refers to as health inputs. Because of the lack of studies that analyze the effects of prenatal care on infant mortality in Egypt, we rely on the seminal prenatal care literature in the United States (US). Recent work by Alexander and Kotelchuck (2001) indicates that prenatal care, though characterized by debates concerning measurement, desired effects, selectivity issues, and the specific impacts on infant mortality, has played an important role in the unprecedented reductions in infant mortality in the US over the past few decades (Gortmaker and Wise 1997). The trajectory of studies on the various aspects of prenatal care, from Gortmaker (1979) to Wise (2003), underscores both the benefits of adequate care, and the potential dangers of differential access to care.

Maternal Education

Findings regarding the effects of maternal education on infant mortality generally indicate a negative relationship between the educational attainment of the mother and her risk of experiencing an infant death. However, in the rural Egyptian context of the early 1970s, Casterline et al. (1992) observed only weak effects of maternal education on infant and early childhood mortality, and instead, as mentioned above, focused on the rising importance of household income regarding the risk of death between ages one and four. According to Casterline and colleagues, this was because maternal education and other variables are expected to have a greater impact on infant mortality, and household income, as it works through other variables, becomes more important as the child ages. The authors also argue that the statistically significant effect of household income remained relatively under-estimated.

However, in contrast to the findings of Casterline et al., Caldwell (1979, 1986) argues that increasing the educational attainment of women is one important way to improve health outcomes in developing countries. To be clear, the present study does not address the major hypotheses of Caldwell for two major reasons. First, his brief anecdotal mention of Egypt relies on the restricted status of women in Muslim countries, and though this variable is included in the Demographic and Health Survey (DHS) questionnaire, it does not appear in the subset of the data used in the present analysis. Secondly, the approach undertaken by Caldwell was a national-level one. In the present study we utilize a dataset in which the live birth (sometimes followed by an infant death) is the unit of analysis.

Research Questions and Hypotheses

Aside from demonstrating that separate log probability models are capable of yielding estimates of ${}_1q_0$ and ${}_4q_1$, this study aims to answer three fundamental questions. Question 1: What are the more important predictors of infant mortality in Egypt today? Question 2: What are the effects of maternal education and access to prenatal care on infant mortality, and do these effects persist in the presence of controls for important covariates such as birth order, sex of

child, and type of place of residence? Question 3: What policy implications can we draw from the current statistical analysis of survey data, and what do the present findings mean for public policy in Egypt?

Statistical models will be used to test hypotheses pertaining to questions 1 and 2. With regard the first question, and based on prior research in Egypt and in the US, we hypothesize that the strongest effects in the present analysis will be associated with maternal education, followed closely by a strong statistically significant negative effect of prenatal care. Concerning Question 2, we construct a hypothesis based on aspects of the work of both Caldwell and Casterline and colleagues. First, we hypothesize, as alluded to above, that maternal education will reveal itself as the most powerful predictor of infant mortality in Egypt, but in later models the effect of the educational attainment of the mother will be explained away by prenatal care and other covariates.

Methods

Egypt Demographic and Health Survey, 2000

We use the Child Recode File from the Egypt Demographic and Health Survey 2000, hereafter (in the text and tables) referred to as EDHS 2000. This file contains observations of all 11,454 live births (after deletion of minimal cases due to missing data) to a nationally representative sample of Egyptian women of reproductive age (15-49 years) in the five years prior to survey. This file is appropriate for the present study because the unit of analysis is the child, and each observation in the dataset is a record of a pregnancy that ended in a live birth, which, in turn may or may not have resulted in an infant or child death. The present analysis emphasizes the value of recent birth history data as they can be utilized in studies of infant and child mortality.

Dependent Variable

As mentioned above, we employ two varieties of generalized linear model (GLM) in this analysis. Nevertheless, the dependent variable in all models is the same. We refer to a binary variable, 0=alive, 1=died, as *died0* which represents mortality or survival in the first year. For the GLM that estimates ${}_4q_1$ we call the dependent variable *died14*, which is coded the same as *died0*. Thus, *died0* is used in the estimation of ${}_1q_0$, and as the dependent variable in the bivariate and multivariate models that follow. On the other hand, *died14* is used only in the estimation of ${}_4q_1$.

Independent Variables

The first predictor variable in the bivariate and multivariate sections of the analysis is maternal education. Originally, the EDHS maternal education variable was coded none, primary, secondary, higher than secondary. Preliminary analyses prompted us to group maternal education as high and low (binary). Secondly, prenatal care is another binary measure signifying some care, or no care. Clearly, this does not lend itself to solving the measurement problems regarding prenatal care (Gortmaker 1979; Alexander and Kotelchuck 2001), but in the context of Egypt it serves as a point of departure. Birth order follows as a series of dummy variables representing

first birth, second birth, third birth, and fourth and higher birth orders. The original EDHS birth order variable was basically continuous up to 16th birth, but the present analysis will only focus on first, second, third, and fourth+ births. Sex of child is coded in the conventional way. Lastly, type of place of residence is coded urban and rural.

Estimates of ${}_1q_0$ and ${}_4q_1$

We use a GLM with dependent variable *died0* and a log link (log probability model) to estimate the probability of dying in the first year. Although not mentioned above, the equation includes a binomial error term (*time0*), which is calculated to take into account the differential exposure contributed by each live birth, during the five years prior to survey, to what essentially acts as the denominator of an empirical rate. In the event that a live birth occurred during the five-year interval, *time0* is equal to the fraction of one year in the five-year interval contributed by that particular birth. In terms of running the model *died0* is the dependent variable and the model is run without covariates. When the intercept is exponentiated and that value multiplied by 1,000, the result is an estimate of ${}_1q_0$. The same concepts and steps apply to estimating ${}_4q_1$. [Note: This process was refined by and is described in more detail by Balk, Pullum, Storeygard, Greenwell, and Neuman (2003).]

Bivariate and Multivariate Analyses

The bivariate portion of the analysis reveals the effects of maternal education, prenatal care, birth order, sex of child, and type of place of residence, each in turn. This approach yields five models that depict the direct effects of each predictor on infant mortality in the absence of controls. This also fulfills the requirements for testing the hypothesis associated with Question 1.

The series of five multivariate models begins by underscoring the effect of maternal education in the bivariate relationship. Secondly, prenatal care is added to the model. Then, Model 3 takes into account the birth order of the child. Model 4 includes maternal education, prenatal care, birth order and sex of child. Finally, the full model involves both maternal characteristics, both characteristics of the child, and urban. This series of multivariate models is meant to test the hypothesis for Question 2.

[Note: The only things about the GLM that changes from the estimation section to the bivariate/multivariate section is that covariates are added, and the log link is changed to logit.]

Findings

Estimates of ${}_1q_0$ and ${}_4q_1$, both by log probability model and DHS methods, are shown in Table 1. Interestingly, the estimates derived by GLM are higher in both cases by exactly one death per 1,000 live births. Although it was not mentioned above, the log probability models as they appear here do take into account the sample weight.

Characteristics of the Child Recode File, including the number of births and infant deaths used in the analysis, and percentage distributions of important covariates are found in Table 2. Of note in the birth order section is the high proportion (.33) of fourth+ births. Also interesting, given the high proportion of the Egyptian population which resides in the metropolises, is the 62% of the sample that is rural. These descriptive statistics are weighted by the sample weight.

Odds ratios depicting the bivariate relationships between select determinants and infant death are presented in Table 3. Concerning maternal characteristics, Model 1 indicates that those in the high maternal education category are 36% less likely to experience a child death. This

bivariate effect is highly statistically significant. In the bivariate Model 2, the effect of some prenatal care is the same as that of high education. This is to say that those children whose mothers received some care (this says nothing for quantity or quality) were 36% less likely to die in the first year, compared to those whose mothers received no prenatal care.

Moving to the characteristics of the child, birth order, in Model 3, is interesting in that being the second child has the most protective effect as compared to being the highest order birth. This finding coincides with the literature which argues that both first births and higher order births are exposed to the highest risk of death. In this bivariate model, the second born is 37% less likely to die as compared to the fourth+ birth. This relationship is also statistically significant. With regard to sex of child, the odds ratio associated with female is less than one, but is not statistically significant. This issue receives some elaboration in the Discussion section.

Lastly, in the bivariate model with urban we see that children born in an urban setting are 25% less likely to die as compared to their rural counterparts. However, this model also does not control for any covariates.

In Table 4 we present the results of our multivariate analysis. In order to emphasize the total change in the effect of maternal education, we begin in Model 1 by re-stating the bivariate relationship. With the addition of prenatal care in Model 2, those children with mothers in the high education group go from 36% less likely, to 28% less likely to die as compared to the low education group, and the effect of education in Model 2 is slightly less statistically significant. In Model 3, the introduction of birth order further reduces the protective effect (and statistical significance) of maternal education. However, the effect of prenatal care changes only negligibly from Model 2 to 3, and the effect of being the second born is more protective than having a mother in the high education group.

It is important to mention two things about the changes that occur from Model 3 to Model 5. First, is the complete lack of explanatory power in sex of child and type of place of residence. When female is added in Model 4, nothing changes about what was found in Model 3.

Furthermore, adding urban to Model 5 changes nothing about the previous model except that in the full model, the odds ratio associated with high education inches closer to unity and is no longer significant. Thus, from Model 3 to Model 5, the effects of prenatal care and second birth remain negative and statistically significant in the presence of controls for female and urban.

Discussion

Check of Hypotheses

In this case, the findings do not support our contention that maternal education is far and away the most important predictor of infant mortality in Egypt. In Table 3 it is clear that the bivariate effect of maternal education is the same, in magnitude and significance as that of prenatal care. In fact, part of the effect of maternal education is explained away by prenatal care, and more still when second order birth is in the model. Ultimately, while female sex of child has no effect on infant mortality, adding controls for female and urban renders maternal education non-significant.

Maternal Characteristics: Education and Prenatal Care

While Caldwell would encourage policymaking with the intentions of facilitating access and improving educational attainment among women, it may be argued that prenatal care or, (as he referred to them) health inputs are more important in the present analysis. Despite this finding, older (Tekce 1982) and more recent (Roudi-Fahimi and Moghadam 2003; Roudi-Fahimi 2004) research is calling for improved information, education, and training for women and health care providers. Tekce very importantly suggests that we realize that cultural beliefs about what should and should not be done to a child after he/she is born may prove to be a great hindrance in terms of the diffusion of knowledge and training.

At least in the US, work by Gortmaker (1979), Alexander and Kotelchuck (2001), and Wise (2003) has laid the groundwork for and maintained a sharp focus on improving prenatal care systems and increasing access to such systems. Since similar work in Egypt is lacking perhaps some of the same observations, concepts, and demands can be made of the Egyptian

health program. It may prove useful, in Egypt, to begin with the kind of study that Gortmaker undertook in 1979. Then, perhaps sometime in the future researchers can take full advantage of the prenatal care measures in DHS. Finally, the present findings create some impetus to explore the DHS measure(s) of prenatal care along with improved statistical techniques.

Child Characteristics: Birth Order and Sex

The present findings indicate that there is a statistically significant protective effect of being a second order birth as opposed to a fourth order birth or higher. It is widely accepted that first births to very young women are at somewhat higher risk of complications, as are births to women nearing the end of the reproductive span. Insofar as birth order, or parity, as it referred to when the woman is the subject, is correlated with age, we might expect interaction effects on the risk of experiencing a child death.

Another, less predictive characteristic of the child is sex. Whereas we anticipated an increased relative risk of infant death among males, no effect of sex, even in the bivariate model, was found. This relationship could be confounded by the existence of sex/male preference. EDHS could be used in a number of ways to test for any norms concerning a preference for a male child.

Urban

Urban type of place of residence, though not significant in the full model, is protective and significant in the bivariate relationship with infant mortality. Perhaps the lack of significance in the full model is a function of urban being so closely linked to variables such as maternal education, prenatal care, etc. Furthermore, it is probably the case that rural fertility is much higher than urban, thus confounding the relationship between urban and birth order.

Directions for the Immediate Future

Of course, immediate improvements to the present study can be made by searching out other important covariates (i.e., age of mother at birth, religion/Muslim, paternal characteristics, etc.). One might expect that the relationships observed in the present analysis would change upon

inclusion of other powerful determinants of infant mortality in Egypt. Finally, since select variables in some models have very similar odds ratios, immediate improvements might also include exploring the interactions between, say, female (sex of child) and urban, or maternal education and prenatal care. Such exploration would be warranted, invaluable, and a contribution to a literature that needs re-visiting.

A Final Note on Improving Data and Methods:

In terms of data, we are awaiting the release of Morocco DHS 2003 survey data and final report. In fact, more recent data for Egypt do exist, but the sample size of the survey and the geographic location of Morocco may provide what is needed for an excellent comparative study. Obviously, this would require a thorough discussion of infant mortality in Morocco and some explication of the various determinants of infant mortality in both countries.

Finally, a paper published in the *Journal of the American Statistical Association* by Guo and Rodríguez (1992) argues the importance of including some estimation of cluster-specific random effects. The idea is that multiple children born to the same mother may share certain unobserved characteristics and thus introduce some bias that can at times affect the results of any statistical model very noticeably. As Guo and Rodríguez recommend to those using birth history data to study infant mortality, the next version of this paper will include some measure of what they refer to as *frailty*.

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Table 1. Two Derivations of Infant and Child Mortality in Egypt

Source/Technique	1q0	4q1
Log Probability Models	44.5	12.3
DHS Egypt 2000 Final Report	43.5	11.3

Note: Exponentiated coefficient from each log probability model yields q for each age interval (X 1000).

Table 2. Frequencies of Births and Infant Deaths and Percent Distributions of Primary Predictors

Number of Births		11454
Number of Infant Deaths		506
Maternal Education		
	High	0.44
	Low	0.56
Prenatal Care		
	Some	0.53
	None	0.47
Birth Order		
	First birth	0.27
	Second birth	0.23
	Third birth	0.17
	≥ Fourth birth	0.33
Sex of Child		
	Female	0.49
	Male	0.51
Type of Place of Residence		
	Urban	0.38
	Rural	0.62

Source: EDHS 2000 Child Recode File
Note: Frequencies are not weighted, and percent distributions employ the sample weight.

Table 3. Bivariate Relationships between Primary Indicators and Infant Mortality

	Model 1	Model 2	Model 3	Model 4	Model 5
Maternal Education [ref cat: Low]					
High	.64***				
	(.11)				
Prenatal Care [ref cat: None]					
Some		.64***			
		(.10)			
Birth Order [ref cat: Fourth+ birth]					
First birth			.69**		
			(.13)		
Second birth			.63**		
			(.14)		
Third birth			.69*		
			(.16)		
Sex of Child [ref cat: Male]					
Female				.90	
				(.10)	
Type of Place of Res. [ref cat: Rural]					
Urban					.75**
					(.11)
Constant	-2.90***	-2.86***	-2.81***	-3.02***	-2.96***
N	11454	11454	11454	11454	11454

Source: EDHS 2000 Child Recode File
Note: Figures indicate odds ratios
Note: ( ) indicate robust standard errors
Note: *** p < .001, ** p < .01, * p < .05

Table 4. Effects of Primary Indicators on Infant Mortality in Egypt

	Model 1	Model 2	Model 3	Model 4	Model 5
Maternal Education [ref cat: Low]					
High	.64***	.72**	.78*	.78*	.80
	(.11)	(.12)	(.12)	(.12)	(.12)
Prenatal Care [ref cat: None]					
Some		.71**	.72**	.72**	.74**
		(.11)	(.11)	(.11)	(.11)
Birth Order [ref cat: Fourth+ birth]					
First birth			.84	.84	.84
			(.14)	(.14)	(.14)
Second birth			.73*	.73*	.73*
			(.15)	(.15)	(.15)
Third birth			.77	.77	.77
			(.16)	(.16)	(.16)
Sex of Child [ref cat: Male]					
Female				.91	.91
				(.10)	(.10)
Type of Place of Res. [ref cat: Rural]					
Urban					.91
					(.12)
Constant	-2.90***	-2.78***	-2.67***	-2.62***	-2.61***
N	11454	11454	11454	11454	11454

Source: EDHS 2000 Child Recode File
Note: Figures indicate odds ratios
Note: ( ) indicate robust standard errors
Note: *** p < .001, ** p < .01, * p < .05