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Child Mortality and Reproductive Patterns in Bolivia, 1993-1998

Guido Pinto Aguirre¹

Abstract

The objective of the present study is to examine the effects of several reproductive and demographic factors on child survival in Bolivia, one of the most impoverished nations in all of Latin America. We model the joint effects of maternal age, parity, pace of childbearing, duration of breastfeeding, and use of modern contraception on child mortality. Data for this research come from "Demographic and Health Survey" (DHS) carried out during 1998. The results obtained in this paper support the evidence found in other studies: breastfeeding and the pace of childbearing are the most important reproductive patterns affecting child mortality risks, and their strong, consistent effects tend to persist even after the introduction of various socioeconomic variables as controls: short preceding birth intervals and short durations of breastfeeding increase the risk of death during the first two years of life.

Resumen

El objetivo del presente estudio es examinar el efecto de factores reproductivos y demográficos sobre la sobrevivencia infantil en Bolivia, uno de los países más pobres de América Latina. Modelamos los efectos conjuntos que tienen la edad de la madre, paridad, intervalos entre nacimientos, duración de la lactancia y uso de contracepción moderna en la mortalidad de la niñez. Los datos utilizados provienen de la Encuesta de Demografía y Salud (ENDES), llevada a cabo en Bolivia durante 1998. Los resultados obtenidos apoyan la evidencia encontrada en otros estudios similares: la lactancia y el intervalo entre nacimientos son los patrones reproductivos más importantes que afectan a los riesgos de mortalidad en la niñez, y sus efectos son fuertes y consistentes aún después de considerar variables socioeconómicas en los modelos: intervalos anteriores entre nacimientos cortos y duraciones de lactancia cortas aumentan los riesgos de muerte en los primeros dos años de vida.

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Introduction

Despite of improvements in health and well-being in Latin America over the last few decades, factors such as infectious and parasitic diseases, malnutrition, and adverse reproductive characteristics (adolescent childbearing, short inter-birth intervals, high parity, etc.) persist as major obstacles to improvements in child mortality in many developing countries.

In an effort to clarify relationships among the various causes of infant and child mortality and to provide a comprehensive framework for research and policymaking, Mosley and Chen (1984) proposed a two level analytical model. The model organizes factors associated with infant and child mortality into either proximate or distal determinant categories. The proximate level includes biomedical and biodemographic factors that are directly associated with infant and child deaths. Proximate determinants typically involve the interaction of malnutrition and infectious diseases and adverse reproductive characteristics of mothers (maternal factors). The distal level includes social, cultural, and economic conditions, such as the association between infant mortality and maternal education and family occupation, which have been found to affect child survival in many developing countries. The Mosley-Chen model has served as a useful starting point for theory, research, and policy making over the last decade. One of the strengths of this framework lies in its focus on women's disproportionate poverty, lack of education, lack of economic opportunity, low social status, and women's unique reproductive role as major factors affecting child health and survival.

The Mosley-Chen model situates reproductive patterns under the proximate category of maternal factors that include maternal age, parity, breastfeeding, and duration of inter-birth interval components. It is important to bear in mind, however, that reproductive patterns as such should not be considered as the immediate mechanism and/or cause of death, in the sense that a specific disease or a combination of diseases are thought of and often recorded as such on a death certificate. Instead they are proximate determinants in the sense that they are associated directly with particular conditions that may lead to child morbidity, impaired intrauterine growth, poor postnatal growth, and subsequently to child death. A large number studies from around the world have consistently demonstrated that children are exposed to much higher levels of mortality when births are spaced too close to one another, when families are large, when children are born to very young or to older mothers, and when children are weaned early in the postpartum period (Cantrelle and Leridon, 1971; Wolfers and Scrimshaw, 1975; Clark, 1981; Rutstein, 1983; Da Vanzo et al., 1984; Hobcraft et al., 1985; Palloni and Millman, 1986; Hobcraft, 1987; Pebley and Stupp, 1987; Palloni et al., 1994; United Nations, 1994). While not meant to diminish in any way the importance of the non-maternal proximate category determinants in the Mosley-Chen hierarchy, it does appear from the weight of accumulated evidence that a combination maternal category factors has a particularly strong and universally negative impact on child health and survival.

In this paper, we focus our attention on the maternal proximate determinant categories. A focus on a single proximate determinate category seems justified for several reasons. First, it appears that a combination of adverse demographic or reproductive factors (that is to say, a combination of high parity, early supplementation and weaning

and short inter-birth intervals) has a particularly strong and negative impact on child survival net of all other proximate determinant factors. Reproductive pattern variables along with knowledge about the use of modern contraception would be expected to account for much of the overall variability in child mortality.

Secondly, the maternal proximate determinant category would appear to encompass a number of important mechanisms, both direct and indirect, which account for much of the observed variability in child survival. Although we might not have measures of some of these mechanisms, maternal category variables would be expected to closely proxy their effects. For instance, every time a woman becomes pregnant she is put at some risk of experiencing pregnancy complications. Often, these complications are more severe in developing country settings where women living in conditions of poverty have limited access to appropriate preventive and curative medical care, especially modern prenatal, delivery, and antenatal care services. Birth-related complications can include, among others, obstructed labor, hemorrhage, and obstetric fistulae associated with the delivery process, uterine prolapse, anemia, diabetes, cardiovascular diseases, hypertension, and cervical cancer.

A third reason is that maternal category variables are closely related to breastfeeding and weaning effects on child mortality. In developing countries, the availability of adequate breastfeeding alternatives is often limited. If appropriate supplements are available they are frequently too expensive for families to purchase on a regular basis. Thus children who are either never breastfed or weaned early in infancy are at a much higher risk of becoming ill and being malnourished. Because of the synergism between illness/disease and malnutrition as underlying causes of infant and child mortality, children experiencing both are at a much higher risk of dying. With the onset of supplementation, even after a prolonged period of full breastfeeding, children become increasingly more dependent on traditional foods eaten by the entire family. Often, foods which make up the regular diet are contaminated during the storage and/or cooking process. They may also be inadequate to meet the nutritional needs of small children. Thus, in developing countries like Bolivia, one would expect to see that the age pattern of malnutrition and mortality depends to a certain extent on the prevailing patterns of breastfeeding, supplementation, and weaning.

Finally, a large number of demographic studies have consistently demonstrated significant negative effects of reproductive and demographic factors on child survival. Although demographic variables may only proxy some of the specific underlying causes there is nonetheless a strong link between these levels of determinants.

With these considerations in mind, the overall objective of the present study is to examine the effects of several reproductive and demographic factors on child survival in Bolivia, one of the most impoverished nations in all of Latin America. We will model the joint effects of maternal age, parity, pace of childbearing, duration of breastfeeding, and use of modern contraception on child mortality. Mother's educational status, a socioeconomic and distal determinant of child survival in the Mosley-Chen hierarchy, will also be introduced as an efficient control variable for confounding factors. In this study we apply conventional multivariate statistical techniques for event history analysis (i.e., proportional hazard models) to estimate the simultaneous effects of reproductive pattern variables as well as other controls on child survival.

The article is divided into four sections, this introduction being the first. The second section presents a brief description of the data and methods used in the study. The final two sections contain the analysis of child mortality in Bolivia, and the conclusions and the policy recommendations that can be derived from the study.

Data and Methods

Data and variables

The data for this research come from “Demographic and Health Survey” (DHS) carried out during 1998 by the National Institute of Statistics (INE), with financial and technical assistance from USAID, UNFPA, UNICEF, PNUD, PMA and various international institutions.

The survey covers all nine departments in the country. A two-stage sample design was used to select 12,109 households. A total of 11,187 women aged 15-49 were interviewed, regardless of their marital status. The survey in all places was carried out on a house-by-house interview and the average rate of response was about 95 percent.

The main objective of the survey was to obtain reliable information on fertility, mortality, use of contraception, nuptiality, HIV/AIDS, anthropometric measures, etc., among Bolivian women. Demographic and socioeconomic factors were also included in the core questionnaire.

Births which occurred during the period 1993 -1998 are considered in this study; that is, the analysis covers 5 complete years preceding the survey. This restriction allows us to include both breastfeeding and contraception covariates in the analysis.

The dependent variable is defined as follows: First, the time elapsed between the birth of the child and the death of the child, if the child died on or before his/her second birthday. Thus, child mortality is measured by the interval between the date of birth and the date of death (i.e., age at death). These observations are usually known as failure cases. Second, the time elapsed between the birth of the child and the time of the survey, if the child was still alive when the survey ended. Third, the time elapsed between the birth of the child and date of his/her death, if the child died after his/her second birthday and before the time of the survey. The second and third cases are also known as censored observations.

The reproductive pattern covariates taken into consideration in the analysis are the age of the mother at the time of each birth, the order of the birth, the length of the previous birth interval, the duration of breastfeeding, and contraception. All of these are considered fixed covariates in the analysis. Maternal age at birth is defined by three dummy variables, which captures the U-shaped effect of maternal age on child mortality, **age1** is equal to 1 if the woman was aged 15 to 19 when the child was born, **age2** is one if she was 20 to 29 (reference category), and **age3** is 1 if the age was 30 to 49. The order of the birth is defined by three dummy variables; **par1** is 1 if the child is of order one, **par2** is 1 if the child is of order two or three. The reference category includes all those children born order four or more.

The timing between births only refers to the time since the preceding birth. Thus, the previous interval is also defined by three dummy variables: **pbint1** is 1 if births occurred between 0 and 18 months apart from each other, **pbint2** is 1 if births occurred between 19 and 23 months apart from each other, and **pbint3** is 1 if births occurred beyond 24 months. Firstborn children are placed in the same group as those with the longest interval (reference category).

Breastfeeding is defined through three dummy variables: **br1** is 1 if the child breastfed less than 12 months, **br2** is 1 if the child breastfed between 12 and 18 months, and **br3** is 1 if the child breastfed more than 18 months (reference category). The variable 'use of contraceptive methods' captures whether the woman did or did not use any contraceptive method before the birth of the child, and it is represented by a dummy variable: 1 if the mother did not use any contraceptive method, and 0 otherwise.

Mother's education is a proxy for socio-economic factors. Four dummy variables are included: **educ1** is 1 if the mother has no education, **educ2** is 1 if the mother only has elementary education, **educ3** is 1 if the mother was educated through high school education, and **educ4** is 1 if the mother has education beyond high school (reference category). The place of residence is captured by a single dummy variable (**rur**) that takes the value of 1 if the mother lives in a rural area. Similarly, if the household does not have piped drinking water, the dummy variable (**pipew**) takes the value of 1 and 0 otherwise.

The statistical technique

Empirical work about child mortality is based on logit models, in which the probability of dying in a certain time interval, conditional on being alive at beginning of the interval, is specified as a function of a set of explanatory variables. However, this approach has two shortcomings. First, the selection of the intervals and their lengths is arbitrary. Second, the information on the timing of the death is not used within the intervals being considered.

The so-called Cox proportional hazard model (Lawless, 1982; Palloni and Sorensen, 1990) is a statistical procedure not subject to these sorts of problems. The attention of this device is posed on the survival time, that is, the time between birth and death of the child. The hazard in the Cox-proportional specification has the following functional form:

$$h(t, z) = h_0(t) e^{\beta'z}$$

Where $h(t)$ is an unspecified time-dependent function, z is a vector of covariates, and β is a vector of unknown coefficients. Thus, the risk of dying is allowed to vary with time and a set of exogenous variables. The interpretation of the coefficients is rather simple, a positive β implies that when z increases, the probability of dying at each duration (time) also increases, and vice versa. Since all explanatory variables are specified as binary variables, a positive β implies that when z takes the value 1, the likelihood of dying increases.

The parameters of the proportional Cox models were fitted using their joint partial likelihood. The fitting of the models was carried out utilizing the statistical software package STATA on data files derived for this purpose. The implicit numerical procedure calculates the risk of dying at each point of time for every risk set defined by the fixed covariates.

The results

To examine the independent effects of reproductive factors, three different hazard models are fitted. These bio-demographic models are concerned with the interplay among pace of childbearing, breastfeeding, birth order, the age of the mother at birth, contraceptive use, mother's education, place of residence, and availability of drinking water.

In Table 1, we can observe that Model 1 only estimates the net effects of the reproductive-pattern covariates. While Model 2—the full model—includes all the reproductive-pattern covariates and control variables. Model 3 removes the effects of contraception in order to explore the existence of a possible correlation with mother's education and other control variables.

This table presents the estimated effects of the reproductive patterns as relative risks of dying during the first two years of life. A value of 1.00 indicates no greater or lesser risk than the average, while a value greater than 1.00 represents a higher risk in relation to the reference category, and a value less than 1.00 represents a lower risk. For example, Model 1 shows a relative risk of 1.70 for those children born into short birth intervals (less than 18 months), meaning that the risk of dying at any given month, controlling for all other covariates in the model, is 85 percent greater than the risk for those born in longer intervals (reference category). In other words, the risk of dying for children born into short intervals is about 1.70 times higher than the risk for children born into longer intervals. All the findings described in the following paragraphs refer solely to the risks presented in Table 1.

Some salient facts can be noted in this table. First, the effects of the reproductive patterns are statistically significant (small p values) and in the expected direction. Second, breastfeeding and the pace of childbearing emerge as the most important factors affecting child mortality. The effects of these covariates are consistently strong and significant across models, after controlling for other covariates. Third, the effects of maternal education also remain strong, significant, and in the expected direction, even when it is controlled for other covariates.

In Model 1, the effects of the reproductive factors on child mortality are statistically significant and in the expected direction. This model shows that once other factors are controlled, birth intervals emerge as one of the most important factors affecting child mortality. In fact, the risk of dying for children born into short birth intervals (less than 18 months after the previous birth) is 1.70 times higher than the risk for children born in long birth intervals (more than two years after the previous birth). That is, being born into poorly-spaced births increases the risk of dying during childhood in about 70 percent when compared with the well-spaced births. However, the effects of the previous birth interval could be somewhat underestimated, because fetal losses are ignored and birth-to-

birth not birth-to-conception intervals are considered. When the pace of childbearing increases (birth intervals are now between 19 and 23 months), the risk reduces to 52 percent, compared to those born into long birth intervals (more than 24 months) after controlling for other covariates.

The length of breastfeeding is also one of the most important factors affecting child mortality. Longer durations of lactation reduce the risk of dying. Children and infants who did not breastfeed or breastfed for short periods of time (less than 18 months) are about 12 times more likely to die before their second birthday than infants who breastfed for more than 24 months; infants who breastfed between 12 and 18 months are also less likely to die before their second birthday than infants who did not breastfeed or breastfed less than 12 months, after controlling for other covariates in the model. Therefore, stopping breastfeeding early in life considerably increases the likelihood of dying.

Since age and parity are strongly correlated, they need to be controlled for simultaneously in order to study their independent effects on the risk of dying. Consistent with other studies, maternal age has a U-shaped relationship with child mortality. In effect, the relative risks effects for age are statistically significant and have the expected direction. That is, the risk of child mortality for children under age two is higher when women are either too young (1.42) or too old (1.14), once parity and other reproductive factors are controlled for. The variables for parity also follow the expected pattern: high parities (four children or more) increase mortality when compared to low parities (one child). In fact, the risk of dying during childhood is increased by 91 percent for higher-order births (four or more), and by 30 percent for second- and third-order births, when compared with first-order births, once maternal age and all other factors are controlled for.

Use of contraception improves children's chances of surviving during their first two years of life. Infants whose mothers did not use any contraception are 1.82 times more likely to die than infants whose mothers did use contraception. However, contraception reduces its effect on child mortality once education and other variables have been introduced as controls.

Finally, mother's education is one of the most important factors affecting child mortality. There is a strong association between the instantaneous risk of dying and education in the face of other controls. Net of the other factors considered in the model, infants whose mothers had no education (0 years of schooling) are 3 times more likely to die before their second birthday than those whose mothers had received more than 12 years of schooling (reference group). This relative risk decreases to 2.8 when mothers have elementary education and to 2.1 when they have high school education, if all of the maternal education differentials were a direct result of schooling.

From Model 1 we can conclude that the effects of reproductive patterns are consistent with other findings. **First**, the pace of childbearing and breastfeeding independently affect child mortality: long interbirth intervals and long durations of breastfeeding reduce significantly mortality. **Second**, maternal age increases child mortality when the mother is very young or very old; and high parity (more than four children per woman) tends to increase mortality, once maternal age and other covariates

are controlled for. **Third**, contraception has an important effect on child survival once education is introduced as a control. And **fourth**, mother's education is an important social covariate that affects the risk of mortality during childhood. However, the effects of mother's education are independent of the effects of breastfeeding, preceding birth interval, maternal age, and birth order. Thus, this effect may be related to other non-maternal determinants of child mortality, such as attendance at birth, access to health services, birth weight, children's nutritional status, toilet facilities, vaccination, and medical care, not accounted for in the model.

In Model 3, contraception has been removed. However, the effect and the direction of the estimates remained in the same direction. This fact is reflected in the small reduction of the log likelihood, from -12500,62 in Model 2 to -12518,54 in Model 3. The most noticeable change in the relative risks belongs to maternal education, and within this variable, the risk for those children born to mothers with no education. In the latter case, the relative risk changed from 3.00 to 3.58. The conclusions that can be obtained from Model 3 about the effects of the reproductive-pattern covariates on the child mortality are similar to those presented for Model 2.

Conclusions and policy implications

The main purpose of this paper has been to analyze the effects of the reproductive patterns on child survival. The analysis was carried out using a set of bio-demographic hazard models.

The body of evidence accumulated during the last ten years shows the existence of a relationship between reproductive patterns and child mortality across societies. The results obtained in this paper support the evidence found in other studies: in Bolivia, the reproductive-pattern covariates (pace of childbearing, breastfeeding, maternal age, birth order, and contraception) are important correlates of child mortality, even after controlling for maternal education, place of residence and source of drinking water.

The results indicate that breastfeeding and the pace of childbearing are the most important reproductive patterns affecting child mortality risks, and their strong, consistent effects tend to persist even after the introduction of various socioeconomic variables, such as education, as controls. In this study, short preceding birth intervals and short durations of breastfeeding increase the risk of death during the first two years of life.

Some authors have suggested that the adverse effects of short birth spacing are causally related to three underlying mechanisms: maternal depletion, sibling competition and risk of cross-infection (Boerma and Bicego, 1992; Miller et al., 1992; Palloni and Millman, 1986). However, short birth intervals should be considered as a risk factor with some qualifications. For instance, the detrimental effect of short birth intervals on child mortality may be reduced by favorable socioeconomic conditions (Boerma and van Vianen, 1984).

Early weaning may also expose the child to higher risks of morbidity and mortality from contaminated food, especially in developing countries like Bolivia.

Breastfeeding protects children from early exposure to diseases and ill-health in different ways. Breastmilk provides the infant a balanced diet during the first six months of his life, immunological protection against diseases, and hygienic and sterile food free of outside contamination (Palloni and Millman, 1986; Wray, 1978; Puffer and Serrano, 1975).

Net of other factors, child mortality also increases to an important extent with increasing birth order, and with births to very young women or to very old mothers. Once all other factors in the model are controlled for, contraception does emerge as a strong correlate of child mortality; the effect of this covariate is in the expected direction.

The association of child mortality with maternal education also remains strong in the presence of the reproductive patterns in the models. That is, it is likely that mother's education in Bolivia is related to child mortality not only through the reproductive patterns but also through other proximate determinants such as nutrition, illness, medical care, environmental contamination, etc.

Since each pregnancy and childbirth carries a risk of child and maternal mortality, avoidance of many poorly spaced births at young or old ages constitutes an important rationale for health and family planning programs. On the one hand, health policies should encourage breastfeeding to improve children's nutritional status and their survival. At the same time, breastfeeding delays the next pregnancy and thus increases the length of the intervals between births (Jones and Palloni, 1994; Pinto, 1994). On the other hand, family planning programs should provide not only supplies of contraceptives, which are relevant to pace of childbearing, but also information and education about the effects of reproductive patterns on women's and children's health.

In a country like Bolivia where poverty and malnutrition are widespread, future reductions in child mortality are more likely to depend on mother's behavior in regards to lactation, and the pace of childbearing. Therefore, major health policies need to introduce effective contraceptive methods and encourage breastfeeding on the one hand; and promote education among women, on the other.

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Table 1. Hazard model estimates of the relative risks of the effects of reproductive patterns on child mortality, Bolivia, 1998

Covariates	Model 1	p	Model 2	p	Model 3	p
Maternal age						
15-19	1.4322	0.000	1.3681	0.000	1.3459	0.000
20-29	1.0000	-	1.0000	-	1.0000	-
30-49	1.1384	0.057	1.1147	0.117	1.1401	0.058
Parity						
1 child	1.0000	-	1.0000	-	1.0000	-
2 - 3 children	1.3044	0.002	1.2206	0.021	1.1980	0.037
4 + children	1.9121	0.000	1.6121	0.000	1.5749	0.000
Previous birth interval						
0 - 18 months	1.6960	0.000	1.6945	0.000	1.6711	0.000
19 - 23 months	1.5218	0.000	1.5064	0.000	1.5059	0.000
24 + months	1.0000	-	1.0000	-	1.0000	-
Breastfeeding						
0 - 11 months	11.5882	0.000	11.6065	0.000	11.5266	0.000
12 - 23 months	1.2634	0.081	1.2214	0.137	1.2524	0.094
24 + months	1.0000	-	1.0000	-	1.0000	-
Contraception						
Yes	1.0000	-	1.0000	-		
No	1.8196	0.000	1.4757	0.000		
Mother's education						
No education			3.0124	0.000	3.5809	0.000
Elementary			2.7831	0.000	3.1121	0.000
High School			2.1860	0.000	2.2372	0.000
Higher			1.0000	-	1.0000	-
Residence						
Urban			1.0000	-	1.0000	-
Rural			1.1559	0.028	1.2200	0.002
Drinking water						
Piped			1.0000	-	1.0000	-
No piped			1.1462	0.033	1.1728	0.013
Log Likelihood						
	-12545.26		-12500.06		-12518.54	
Chi- Square						
	948.22	0.000	1038.62	0.000	1001.65	0.000
df						
	9		14		13	