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MATERNAL EDUCATION, HOUSING CHARACTERISTICS, AND INFANT SURVIVAL IN GUATEMALA

By

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ABSTRACT

MATERNAL EDUCATION, HOUSING CHARACTERISTICS, AND INFANT SURVIVAL IN GUATEMALA

By

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Following the work of Mosley and Chen, Palloni, and Caldwell, I hypothesize that infants are more likely to survive infancy if their mother has more (rather than fewer) years of schooling; the housing structure is electrified; the housing structure has a type of floor material other than dirt/sand; and the household draws its drinking water supply from a source other than a surface source. I test these hypotheses with the 1999 Demographic and Health Survey in Guatemala. I construct a separate multinomial logistic regression for each of the three housing characteristics and control additional covariates.

Contrary to Caldwell, I do not find that maternal education affects infant survival. Infants in households with electricity (the only housing characteristic that matters) are more likely to survive to their first birthday. I explore the implications for public health policies in Guatemala, which has the highest infant mortality rate in Central America.

This thesis is dedicated to my mother, Jolene Rummel, my first teacher, and to my husband, Noah Van Oosterhout.

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TABLE OF CONTENTS

LIST OF TABLES

Introduction

The incidence of child and infant mortality is a serious concern for the entire developing world. As one of its eight Millennium Development Goals, the United Nations has called for the reduction of under-five mortality by two-thirds worldwide by 2015 (see www.un.org/millenniumgoals/). Towards this end, scholars seek causes of young child mortality that can be manipulated through public health policies. The purpose of my study will be to examine four such policy-manipulable variables—maternal education, electricity, source of household drinking water, and type of flooring material—with the most recent available data on infant mortality in Guatemala.

According to the Demographic and Health Survey (DHS) of Guatemala for 1999, the infant mortality rate, or IMR, the number of deaths below age one year per 1,000 live births, was 45 (1998-99 Guatemala Final Report, p. xxv), representing a decline from 51 in 1995 (1998-99 Guatemala Final Report, p. xxv). In 1999, the IMR in Guatemala was the highest of all nations in Central America and was still the highest in 2004, despite an estimated decline to 39 (Population Reference Bureau, 2004). This displays the precariousness of infant life in Guatemala, as compared with its neighbors and with the United States. By comparison, the United States' current year infant mortality rate is 6.5 (see www.census.gov/ipc/www/idbprint.html).

Mosley and Chen's Framework

The socioeconomic status of families is inversely related to the death rate of their infants (Preston, 1985). But, Mosley and Chen (1984) criticize social scientists for not identifying the relational mechanisms. To fill this gap, Mosley and Chen propose five categories of proximate determinants: maternal factors, environmental contamination,

nutrient deficiency, injury, and personal illness control. Each category contains more specific factors that relate to child morbidity and mortality. My study shall draw from this analytic framework.

John C. Caldwell illustrates the importance of Mosley and Chen's analytic framework in his 1986 paper, "Routes to Low Mortality in Poor Countries." Caldwell examines the contexts of Costa Rica, Sri Lanka, and the Indian state of Kerala in determining the key components to low mortality in these societies. (Caldwell also briefly mentions China in his analysis.) Caldwell demonstrates that gross national product is not a strong determinant, or indicator, of life expectancy or mortality trends. He argues that the areas he reviews have achieved low mortality through various means, but that provision of health services has perhaps the most significant effect on mortality. Other important factors in the decline of mortality include levels of female autonomy, the implementation of a nutritional "floor," a demand for education in the society, high rates of immunization, and the availability of health care to the general population.

The factors that Caldwell describes are generally related to internal development. The nutritional floor that he discusses consists of food support systems, such as food stamp programs, food distribution centers, or free school lunches, which keep the population from dropping below a certain level of necessary caloric consumption. Free immunization is likewise a development effort that can drastically lower mortality, and morbidity, especially among infants and children. Female autonomy could be described as the effects of a mother's level of education, along with her influence in household decisions. Women who have a voice in decisions concerning household economics, including those regarding food and healthcare, are likely to favor their children in such

decisions and thereby improve the children's chance of survival. Such women are also likely to give their daughters and sons equal treatment, rather than favor sons as is the case in some cultures. The more educated woman is likely to seek medical assistance, ensure its quality, and understand and follow directions on how to care for sick children. The level of female autonomy varies greatly by culture, and "female autonomy is greatest where both society and women themselves have little doubt about a woman's right to make decisions and to battle for her and her children's rights in the public arena" (202). The education of women plays a great role in bringing about such a situation (see also Rosero-Bixby's work on Costa Rica, 1986; Sastry, 1996; and Haines and Avery, 1983, on the importance of maternal education for infant survival).

. All of Caldwell's important factors eventually affect health care, and this is his ultimate determinant in mortality decline. None of the other factors (female autonomy, the nutritional floor, immunizations, etc.) alone will result in low death rates; rather, they act as a support system for the implementation of a universal health care program. The greater the prevalence of these "background" factors, the greater the likelihood that an overarching health care infrastructure will be in place, or enacted. Therefore, Caldwell recognizes the importance of development in reducing child mortality, through strengthening infrastructure.

Caldwell and Caldwell's subsequent (1993) article on women's position and child morbidity and mortality reinforces the importance of female autonomy and education, but also integrates several more factors into the definition of women's status in a society, including kinship, social status, work, income, ethnicity, culture, and radicalism. "It seems beyond doubt that improved education of mothers does quite dramatically reduce

infant and child mortality" (133), but the question of how it does so is in dispute. The Caldwells argue that education affects a myriad of aspects in women's lives, and not solely their propensity to take sick children to a clinic:

> Education attainment may be associated with such preventive health measures as isolating ill from healthy children, preventing accidents in the household, securing inoculations and antenatal care, separating animals' quarters from those of the family, maintaining appropriate food storage, and cleaning food utensils. The educated mother is more likely to seek health information and treatment from scientific, rather than from indigenous or folk sources (134).

The Caldwells discuss the problems in defining women's autonomy, as they do not want to equate it entirely with education—a point that Caldwell did not dwell on as much in his previous article. Education can contribute to autonomy, but it is not the same thing, in that education does not necessarily lead to (or cause) autonomy. Caldwell refers to some Muslim countries in explaining: "Where women must depend on men or on their husbands' relatives for decisions, and where they cannot take decisions about treatment and proceed to health facilities with their sick children, child mortality rates are unusually high" (136).

Alberto Palloni (1981) takes a more medical-based approach of internal factors in reviewing the subject of development and child mortality. He reviews trends in mortality decline in developed countries, such as in nineteenth century England, and asks why similar patterns have not taken place in the current developing world, specifically in Latin America. Palloni suggests that certain assumptions have been derived from mortality declines in the Western experience. These assumptions are the irreversibility, continuity,

and similarity of mortality patterns. Irreversibility is the idea that once a mortality decline begins, it does not turn back. Continuity means that mortality declines slow as they approach certain recognized plateaus as dictated by biological factors. Similarity of mortality patterns means that life expectancy breakthroughs occur at young ages, thereby affecting adult life expectancy as well. These are the patterns that predominated in the mortality transition of developed, Western countries, and have become the expected patterns for mortality decline in developing countries.

Palloni argues that the Latin American (and much of the current developing world's) context is different from that which created mortality declines in developed countries. He says that socioeconomic development coincided with the advent of new medical technologies to usher in Western mortality declines in the nineteenth and early twentieth centuries. He indicates that England's mortality declines were directly related to improvements in sanitation, standards of living, and food intake quality and quantity. Palloni believes that such advancements are necessary in order to facilitate the application and saturation of medical and technological advancements that can further reduce mortality.

> A drastic reduction in the deleterious effects of diarrhea, for example, is inconceivable without some transformation of hygienic conditions, development of institutions to provide treatment for dehydration and other secondary effects, and most important, adequate levels of nutrition and diffusion of information among the population to stimulate the introduction of healthy habits and practices (627).

Palloni argues that it is this combination of socioeconomic advances in concert with the spread of medical technology that will bring about greater mortality declines, as was the case in the United States and many European nations. Palloni further states that children, having underdeveloped immunities, are at a greater risk of dying from disease in contexts where, although medical interventions have taken place, they have not been followed up by improved hygienic, sanitation, and living standards. "Thus, the joint occurrence of a low standard of living and contact with new medical technology could have ambiguous consequences for the youngest members of the population who have not yet fully developed natural immunities, and are dependent on others to satisfy basic needs" (628).

Palloni computes the actual and expected probabilities of mortality for under-1 (infant) mortality and for under-5 (child) mortality for twenty-one Latin American countries. Palloni sees Latin American mortality declines as dependent on the rapid spread of medical technologies. Without the support of socioeconomic improvements, he expects the findings to uphold his hypothesis that child mortality would be higher than expected. He compares the two actual mortality rates (infant and child) to the Western rate, and their expected rates for each Latin American country as based on the Western model. For infant mortality, all of the actual rates were higher than the expected, except for Trinidad and Tobago. For child mortality, three countries had rates lower than expected, but the remaining eighteen countries had higher than expected levels of child mortality. Palloni says that such findings "...must be linked systematically to existing levels of living, geographic and climatic conditions, and viability of medical technology" (632).

In his analysis of causes of death (based on death records and a corrective statistical technique he developed due to a lack of reliable records), Palloni finds that infant and child mortality often result from water, food, and airborne diseases. The incidence of excess deaths due to water-food-airborne diseases in children is directly linked to unsanitary conditions that are not ameliorated by socioeconomic development:

> Not only do Latin American countries show an excess of infant and child mortality, but more importantly, the levels of such excess appear to be related to a disproportionate contribution of the complex of food-water-airborne disease. This complex is less responsive to the introduction of isolated medical interventions and depends heavily on standards of living, sustained public health interventions, and levels of information and health care practices of the population (640).

As such, these findings illustrate the importance of environmental contamination as a threat to child survival in poor countries (Mosley and Chen, 1984).

Palloni recognizes Caldwell's argument for level of education (Palloni uses illiteracy rates as a proxy for the same) of mothers as key in child survival due to a mother's greater capacity to care for and actively defend her child's rights. However, Palloni takes this argument a bit further in saying that education is really a proxy for the capacity of the entire society to do the same for itself and its children:

> ...The proportion illiterate in a population is less an indication of the fraction of mothers with inadequate knowledge to treat and feed a sick child or to challenge the authority of elders than a reflection of the degree of social and political maturity of the system above and beyond the amounts of wealth at its disposal and the degree of equality of its distribution (642-643).

The author finds that mother's education is an important factor in child survival, but due to great differences in the increase of child survival as education levels rise, he argues that the effectiveness of mother's education as an agent of child survival is dependent on social conditions. Therefore, Palloni argues, even though Latin America has imported medical technologies, the weakness of social and economic infrastructures minimizes the reduction in infant and child mortality levels. Although more medical breakthroughs may encourage a downward trend in Latin American mortality in the future, Palloni does not see these as having a great effect unless social and economic development raise the standards of living for the common person.

The variables selected for testing in this paper (source of drinking water, presence of electricity, and type of floor material) reflect Palloni's argument for the importance of higher living standards, including unpolluted environments, in relation to infant survival. Black (1984) discusses the detrimental effects of the E. coli bacterium on infants and children in developing countries. According to his report, E. coli is "particularly common" in developing countries, and E. coli is a major cause of sporadic cases of infantile diarrhea. "Because of the association of contaminated water and food with occurrence of this disease, it can be presumed that avoidance of fecally contaminated water and attention to hygienic food handling techniques would help prevent illness" (146).

Haines and Avery's (1983) study of child survival in Guatemala found that sanitation was significant in promoting survival to age two years. "Sanitation" is an index in Hanes and Avery's study that is defined as the number of households with modern sewage disposal systems plus one-half of the households with latrine sewage

disposal as a proportion of total households. Sanitation is also tied to the likelihood of contact with human waste, and therefore the spread of E. coli and other pathogenic bacteria.

Guzman (1989) speaks of the importance of potable water in Guatemala for the prevention of infant mortality. The source of a household's drinking water can also be a vehicle for the entrance of pathogens in the home. Surface water is thought to be more likely to be contaminated with human and animal wastes, household cooking and cleaning waste, and contaminated runoff. Therefore, surface water would be more likely to contain bacteria and organisms than would ground water, or water that has been treated and piped into a household. Jain (1985) cites an Indian government document to show that infant mortality is typically lower in households that have tap or pumped water as compared to those with other sources of drinking water. Out of seventeen rural Indian states surveyed, all but two showed lower infant mortality rates for households with tap or pumped water. One of the two had no count available for households with tap or pumped water, while the other had the same infant mortality rate for households with tap or pumped water as households with other drinking water sources. For the entire country of India, in 1978, households with tap or hand-pumped drinking water had an infant mortality rate of 119, while those with other sources of drinking water had an infant mortality rate of 140.

Electricity could also affect infant survival by pumping water for drinking and providing for the refrigeration of weaning foods (Jain, 1985; Sastry, 1996). Black (1984) indicates that E. coli bacteria multiply when foods are stored at household temperatures and that E. coli is "commonly transmitted via weaning foods to young children" (156).

Electricity may also act as a proxy for other household resources, in that households that have electricity may have more income than households that do not have electricity. Jain (1985) shows that the infant mortality rates of households that use electricity for lighting are lower than for households with other forms of lighting in 16 out of the 17 Indian states surveyed. For one of the states, no infant mortality rate is available for households with electric lighting. For the entire country of India, in 1978, the infant mortality rate among households with electricity for lighting was 90, compared to 139 for households with other lighting sources.

Johnson and Nelson (1984) found that flooring material, as part of housing construction quality, had a positive effect on child survival. Their study of Iloilo Province, Philippines, employed a housing quality index, which included floor material. The index also included type of construction material of walls, windows, doors, and toilet facilities. Households were then ranked according to the quality of material used in the above components, with a lower score corresponding with lower quality, and higher scores corresponding with higher quality. Their findings indicate that "The quality of housing construction was related to child survival ($t=-1.883$, $P<0.05$, one-tailed test)...Living in a poorly constructed dwelling reduced the odds of a child's survival to age 5" (p. 538).

A dirt floor can expose infants to parasites that bore through the ground. Bradley and Keymer (1984) explain that several parasitic worms, most importantly *Ascaris* and *Trichuris*, "are spread from the excreta to the mouth by way of a period of development in the soil" (170). These two parasites, along with many others, "have a wide distribution in developing countries and compete with their human hosts for food in the intestine"

(170). Exposure to such pathogens may then jeopardize the infant's health, and possibly lead to mortality. Infants by nature put things in their mouths, and if they are in contact with a dirt floor, they may be more likely to ingest such parasites. Bradley and Keymer go on to suggest that multiple parasitic infections, specifically in Guatemalan children, contribute to infant and child mortality.

Hypotheses

The present study will address Palloni's (1981) and Mosley and Chen's (1984) call for further attention to the factor of environmental contamination in affecting infant mortality. Such contamination could be a contributing factor to the high infant mortality rate in Guatemala.

The four hypotheses of this study are that the probability of infant survival will be higher if: (1) the mother has more, rather than fewer, years of schooling; (2) the housing structure is electrified; (3) the housing structure has a type of flooring other than dirt/sand floors; or (4) the housing structure draws or carries its water supply from a source other than a surface source.

Methods

Data

In order to investigate the relationship between the variables of interest and infant mortality, I used the Demographic and Health Survey, most recently conducted in Guatemala in 1998 to 1999. It contains information from 6,021 women between the ages of 15 and 49 (1998-99 Guatemala Final Report, Introduction, p. 2). The survey is split into three separate surveys, one focusing on women's (primarily reproductive) health, one on children's health, and finally one known as the Household Survey, which collects

information regarding household living conditions, occupations, and income. The children's health survey, which contains data on 4,545 children under age 5 (1998-99 Guatemala Final Report, Introduction, p. 2), along with some maternal and household data, was selected for our purposes.

Only a subset of the entire sample of children born to each female DHS respondent was utilized: those children who were born one to five years prior to the mother's interview date. The vital status of each live birth to the woman was obtained, and if the child had died, the mother was asked for the age at death. Limiting the study to children born at least twelve months before the survey meant that they had completely faced death (or not) in infancy. This eliminated the censorship of living children under age one year who might die after the survey but before age one. Those who live throughout infancy are positively selected by favorable personal, maternal, and household characteristics.

Table 1 shows the subset sample to be 3,948 births between one and five years ago. The dependent variable was age at death in months. I coded it as: 0=death at 0 to 11 months; and 1=survival to ages one to five years. There were too few cases of death at ages one to five years to analyze young child mortality after infancy (which stops on the first birthday).

Table 1: Description of Study Variables

	Category Labels and (Code)	N	Marginal Percentage
Infant Survival	Death at less than 1 year(0)	185	4.7%
	Survival OR death at 1-5 yrs. (1)	3763	95.3%
Has Electricity	No (0)	1936	49.0%
	Yes (1)	2012	51.0%
Source of Drinking Water	Other(0)	3417	86.6%
	Surface Water(1)	531	13.4%
Floor Material	Other(0)	1508	38.2%
	Earth/sand floor(1)	2440	61.8%
Education in single years			Mean: 2.56
Number of Older Siblings			Mean:2.99
Number of Younger Siblings			Mean: .58
Marital Status	Other marital status	313	7.9%
	Married/coupled	3635	92.1%
Sex of Child	Male	2000	50.7%
	Female	1948	49.3%
Valid		3948	100.0%
Missing		0	
Total		3948	

The births in this study took place between 1993 and early 1998. The infant mortality rate observed for them was 47 infant deaths per 1,000 live births reported in the survey for this time period (Table 1). This rate is bracketed by the infant mortality rate of 51 in 1995 and 45 in 1998-99 (DHS Guatemala Final Report) and thus appears consistent with other data on infant mortality in Guatemala. The sex ratio of births in this analysis is 103 males born per 100 females born, which is within the biologically normal range of 90 to 105 males per 100 females (Shryock and Siegel, 1971: 191). Therefore, the female births do not appear to be underreported, nor do the total number of infant deaths. In addition, information on the physical structure of the dwelling and the mother's education makes this survey appropriate for testing the hypotheses.

Measures: Four Independent (Test) Variables

The four independent (test) variables are years of maternal education (education in single years), source of household drinking water (1=surface water; 0=other), an

indicator of the presence of electricity in the housing structure (0=no; 1=yes), and the type of flooring material (1=earth/sand; 0=other). A lower score on the test variables of maternal education and whether a household has electricity should be strongly associated with the odds of infant mortality. A lower score on the variables of source of drinking water and type of floor material, however, should be strongly associated with infant survival.

Measures: Four Additional Covariates

Two variables have been introduced to the data set: the number of older and younger siblings of the index child. Preston (1985) has reviewed data from the World Fertility Survey, and found that sibling rivalry is significant in affecting infant and child mortality. The effects of older and younger siblings, however, are distinct:

> Mortality is also higher when the mother had two or more births in the period 2-6 years before the birth of the index child, although the effect has largely disappeared by the time the child reaches age 1...mortality at age 1 and 2-5 is increased very greatly by the occurrence of a closely spaced *subsequent* birth...Such a result supports a hypothesis of competition among siblings...(267, italics in original).

It is expected that index children with two or more older siblings would have a greater likelihood of experiencing infant mortality. However, infants that die prior to their first birthday may also be affected by the close spacing of a younger sibling. In addition, mothers who experience the death of an infant may wish to have more children in order to replace the child that died. Therefore, it is thought that greater numbers of

both older and younger siblings would be more likely to be associated with the death of the index child.

The child's sex (0 = male; 1 = female) is also included as a control variable, since females have a lower rate of infant mortality in most nations of the world (see Chen et al., 1981). In their study in Jordan, Tekce and Shorter point out, "Sex of child is not itself a socioeconomic variable, but a physiological attribute. The study found evidence, however, that family behavior in rearing of children varied depending on their sex...Therefore, sex of the child is included to identify this behavioral response to the child's needs" (263).

The marital status of the child's mother (1 = married/coupled; 0 = otherwise) has also been an indicator of child survival in past studies. According to the National Center for Health Statistics, the infant mortality rate for infants born to unmarried mothers in the United States was 1.8 times higher than for those born to mothers who were married in 1996. In their NCHS article, MacDorman and Atkinson state, "Marital status interacts with a wide variety of other factors, such as the degree of economic and social support for the mother and child; whether or not the pregnancy was wanted; as well as maternal age, educational level, and prenatal care attendance...Infant mortality rates were higher for infants of unmarried than of married women for all of the race and ethnic groups studied" (6-7). Maternal marital status is therefore considered in this study in order to determine whether marital status influences infant mortality in Guatemala. Because of the importance of informal unions in the Guatemalan culture, I lump women who are coupled and women who are currently married into the sample category.

Earlier studies have shown that children born to women ages 30-plus or at high birth orders are more likely to die in infancy. I have not controlled maternal age at the child's birth or its birth order because both are highly correlated with the number of younger siblings (each r=.79, data not in tables).

Statistical Approach

I used a multinomial logistic regression to test the associations of the independent variables with the categorical dependent variable (0=child died before 12 months old; 1=child lived to the first birthday). Since a dirt/sand floor was highly correlated at 0.516 with the absence of electricity in the housing structure, the presence of both variables in the same regression equation would violate the assumption of independent predictor variables (see Table 2). Thus, I ran three separate multinomial logistic regressions, one for each source of environmental contamination, and used maternal education as a predictor in two of the models, but excluded it from the model involving type of floor material. The correlation between maternal education and type of floor material was -.459, indicating strong dependence of the two variables. In addition, the omission of maternal education in this regression is further defended in that it is not statistically important when the indicator of development is the presence of electricity or the source of household drinking water. The regressions were performed with the multinomial regression function in the SPSS version 11.0 software package.

Table 2: Correlations of Study Variables

Correlations

		Infant Survival	Has Electricity	Drinking Water	Floor Material	Number of Older Siblings	Number of Younger Siblings	Education in single years	Sex of Child	Marital Status
Infant Survival	Pearson Correlation	1	-.011	.003	-.009	-.019	-.105	.022	.003	.006
	Sig. (2-tailed)	.	.477	.846	.570	.226	.000	.176	.847	.710
	N	3948	3948	3948	3948	3948	3948	3948	3948	3948
Has Electricity	Pearson Correlation	-.011	1	-.342	-.516	-.138	-.095	.380	-.002	-.061
	Sig. (2-tailed)	.477	.	.000	.000	.000	.000	.000	.911	.000
	N	3948	3948	3948	3948	3948	3948	3948	3948	3948
Drinking Water	Pearson Correlation	.003	-.342	1	.255	.076	.061	-.205	-.012	.061
	Sig. (2-tailed)	.846	.000	.	.000	.000	.000	.000	.455	.000
	N	3948	3948	3948	3948	3948	3948	3948	3948	3948
Floor Material	Pearson Correlation	-.009	-.516	.255	1	.168	.126	-.459	.000	.070
	Sig. (2-tailed)	.570	.000	.000	.	.000	.000	.000	.996	.000
	N	3948	3948	3948	3948	3948	3948	3948	3948	3948
Number of Older Siblings	Pearson Correlation	-.019	-.138	.076	.168	1	-.094	-.342	-.009	.111
	Sig. (2-tailed)	.226	.000	.000	.000	.	.000	.000	.562	.000
	N	3948	3948	3948	3948	3948	3948	3948	3948	3948
Number of Younger Siblings	Pearson Correlation	-.105	-.095	.061	.126	-.094	1	-.116	-.010	.102
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.	.000	.550	.000
	N	3948	3948	3948	3948	3948	3948	3948	3948	3948
Education in single years	Pearson Correlation	.022	.380	-.205	-.459	-.342	-.116	1	.007	-.077
	Sig. (2-tailed)	.176	.000	.000	.000	.000	.000	.	.679	.000
	N	3948	3948	3948	3948	3948	3948	3948	3948	3948
Sex of Child	Pearson Correlation	.003	-.002	-.012	.000	-.009	-.010	.007	1	.014
	Sig. (2-tailed)	.847	.911	.455	.996	.562	.550	.679	.	.381
	N	3948	3948	3948	3948	3948	3948	3948	3948	3948
Marital Status	Pearson Correlation	.006	-.061	.061	.070	.111	.102	-.077	.014	1
	Sig. (2-tailed)	.710	.000	.000	.000	.000	.000	.000	.381	.
	N	3948	3948	3948	3948	3948	3948	3948	3948	3948

** Correlation is significant at the 0.01 level (2-tailed).

Discussion of Results

Maternal Education

Maternal education does not reach statistical significance in predicting the odds of a child's survival to the first birthday (Odds Ratio = 0.981, $p > .10$; Table 3). It rejects Hypothesis 1. These findings are surprising in light of studies by Caldwell, and Mosley and Chen's proximate determinants of infant mortality. In this instance, it may be that the mother's education in child rearing is not necessarily reflected in her years of schooling. Women may learn how to care for infants from their mothers, female family members, and friends, thereby nullifying the relationship between years of schooling and infant survival. Mothers may learn the importance of hygiene, especially in relation to food consumption, and other preventative measures from others, not necessarily through formal education. In addition, these social resources, while they could be enhanced through formal education, are not necessarily absent for the mother with little schooling. While there may be benefits to the child if his or her mother has an increasing amount of formal schooling, these may work indirectly on child survival by improving the mother's housing characteristics or reducing her fertility (see correlations between maternal education and these variables in Table 2). The findings suggest that Caldwell's, along with Mosley and Chen's interpretation of the direct relationship between maternal education and infant survival may need revision in light of declining infant mortality rates as the majority of the lesser developed countries complete their fertility transitions.

Table 3: Logistic Regression of Infant Survival (0=No; 1=Yes) on Electrification of Housing Structure and Other Predictors

		Std. Error	Wald	df	Sig.	Exp(B) Odds Ratio	90% Confidence Interval for Exp(B) Lower Bound	Upper Bound
Infant Survival Death at less than 1 year	Intercept	.315	118.825	1	.000			
	Has Electricity 0=no; 1=yes	.162	2.858	1	.091	1.315	1.007	1.716
	Maternal education in single years	.028	.448	1	.503	.981	.937	1.028
	Number of older siblings	.028	3.304	1	.069	1.052	1.005	1.102
	Number of younger siblings	.099	45.518	1	.000	1.949	1.657	2.294
	Sex of child 0=male; 1=female	.152	.001	1	.972	.995	.775	1.277
	Mother's marital status 1=married/coupled; 0=other	.274	1.548	1	.213	.711	.453	1.116

Older and Younger Siblings

The number of older and younger siblings a child has is significantly related to infant survival. Infants with one older sibling are about 5% more likely to survive infancy than those with none (Odds Ratio = 1.052, $p < .10$; Table 3). While the significance level of this finding varies slightly between the three regressions (Tables 3-5), it can be said that it is significant at $p<.10$. Why would children with greater numbers of older siblings be more likely to survive infancy? It could be argued that a greater number of older siblings would aid in infant survival through their abilities as additional caretakers of their younger sibling. Mothers with many children may not always be able to care for the infant, but older siblings can help to compensate for this disadvantage.

Table 4: Logistic Regression of Infant Survival (0=No; 1=Yes) on Type of Flooring Material and Other Predictors

		Std. Error	Wald	df	Sig.	Exp(B) (Odds Ratio)	90% Confidence Interval for Exp(B)	
							Lower Bound	Upper Bound
Infant Survival Death at less than 1 year	Intercept	.289	129.547	1	.000			
	Floor Material 1=earth/sand; 0=other	.162	.252	1	.615	.922	.706	1.203
	Number of older siblings	.027	4.026	1	.045	1.055	1.010	1.102
	Number of younger siblings	.099	45.526	1	.000	1.944	1.653	2.287
	Sex of child 0=male; 1=female	.152	.002	1	.968	.994	.774	1.276
	Mother's martial status 1=married/coupled; 0=other	.274	1.620	1	.203	.705	.449	1.107

Table 5: Logistic Regression of Infant Survival (0=No; 1=Yes) on Type of Household's Drinking Water and Other Predictors

		Std. Error	Wald	df	Sig.	Exp(B) (Odds Ratio)	90% Confidence Interval for Exp(B)	
							Lower Bound	Upper Bound
Infant Survival Death at less than 1 year	Intercept	.304	116.455	1	.000			
	Source of Drinking Water 1=surface water; 0=other	.230	.469	1	.494	.854	.585	1.247
	Maternal education in single years	.027	.077	1	.782	.993	.949	1.038
	Number of older siblings	.028	3.161	1	.075	1.051	1.004	1.100
	Number of younger siblings	.099	44.589	1	.000	1.932	1.642	2.272
	Sex of child 0=male; 1=female	.152	.004	1	.951	.991	.772	1.272
	Mother's marital status 1=married/coupled; 0=other	.274	1.595	1	.207	.707	.450	1.110

The more surprising result is that index children with higher numbers of younger siblings are also more likely to have survived infancy. This finding is consistent across the three regressions as well, only with a greater level of statistical strength ($p<.001$ in all cases). The odds ratio for the relationship between the number of younger siblings and the likelihood of infant survival is 1.949, 1.932, and 1.944, on the three regressions, respectively (see Tables 3, 4, and 5). These results indicate that the addition of each younger sibling nearly doubles the chance that the index child will survive infancy.

These results seem counter-intuitive. The idea of sibling competition would help us to think that greater numbers of younger siblings would decrease the index child's chances of surviving infancy. Why would children with greater numbers of younger

siblings be more likely to survive infancy? One possibility is that what we see in these statistical tests is the inverse of the likelihood of infant death as a woman progresses through her years of motherhood. First-born children are more likely to experience mortality as infants than are later children. Middle-born children are least likely to experience mortality, and later born children again have a higher likelihood of death (see Preston, 1985). Therefore, children with more younger siblings, provided that they are not the oldest sibling, would be much more likely to survive infancy, simply by virtue of being middle children. Such a pattern may be due to various maternal characteristics, including her inexperience and physical youth at her first birth, and her decreasing physical, psychological, and emotional stamina with births late in life (Preston, 1985).

As I am concerned with testing for surviving infancy, and not childhood in general, it is important to note that the likelihood of there being more than one other child while the older child is still under one year of age is very low (only possible in the case of a multiple birth, as I am discussing only biological siblings, and not children adopted or taken in by a child's parents). Even the likelihood of there being one sibling born prior to the index child's first birthday is quite low. Therefore the greater likelihood of children to survive to age one when greater numbers of siblings are involved is thought to be related to the J-shaped curve of infant mortality referred to by Preston, rather than by any direct effect of more younger siblings on the index child.

Household Characteristics

The only physical household variable that reached statistical significance is that of whether a household has electricity. The odds ratio for infants in households with electricity surviving to their first birthday is 1.315, telling us that infants in electrified

homes are 31.5% more likely to survive infancy than those who do not have electricity. These results support Hypothesis 2. It is possible that those houses with electricity may be able to circumvent the use of surface water by utilizing an electric pump for retrieving water from a well (the reader will note that the correlation between these two variables = -.342, $p < .001$; Table 2). Likewise, those households with electricity may also be able to avoid the deleterious effects of drinking surface water through boiling their drinking water, a process made simple by electricity. Parents of infants may also be able to generate income through the use of electricity in the home. Micro enterprises such as sewing with electric machines in the home could help to increase the household's, and the infant's, standard of living.

Each of the three variables that relate to the physical household's environment was used in a separate regression in order to decrease any effect one was having on another. Each separate regression was assembled so that one of the three variables was the first independent variable listed in the regression, in order to give it full opportunity to explain its relationship to the dependent variable. Contrary to Hypothesis 3, the variable regarding the type of floor material used in the home turned out to be insignificant in its effect on infant survival (see Table 4). In considering this variable, it was thought that homes with dirt or earth floors would be more prone to disease-bearing pests such as parasitic worms, mice, rats, and similar creatures, and to possible infant death related to disease borne by such intruders. On the other hand, I thought that homes with wood, tile, cement, brick, or other non-earth material for floors would be more likely to reduce infant deaths related to the intrusion of pathogenic organisms. The findings, however, do not support a significant relationship between having an earthen floor, as opposed to any

other type, and infant death or survival. Perhaps even in the 38% of homes with non-earthen floors, infants may still be exposed to disease-bearing insects or small animals. This could happen if screens are missing from windows or if animals freely wander in and out of the dwelling.

Contrary to Hypothesis 4, statistical significance was not achieved in the case of the source of drinking water (see Table 5). It is interesting to note, however, that only 13.4% of respondents used surface water as their main source of drinking water (see Table 1). Nevertheless, the large majority of those who drank groundwater might still have been exposed to E. coli and other pollutants such as mercury, arsenic, and PCBs. Runoffs of agricultural chemicals and animal wastes can contaminate groundwater and enter the human food chain. A stronger test for future research on the water-pollution infant mortality connection would chemically analyze samples of drinking water taken in the respondents' homes. The lack of a significant relationship between source of drinking water and infant survival goes against Palloni's findings regarding water-borne illness in particular and its influence on infant mortality.

Conclusion

The general findings of this study are that maternal education in Guatemala does not have the expected significant positive effects on infant survival, as supported in the writings of Caldwell and Mosley and Chen. The effect of having electricity in the household has a positive effect on infant survival. The benefits of electricity may include the possibility of pumped well water; the facility of boiling water to remove pathogenic microbes; greater likelihood of refrigeration of weaning foods; and the potential for micro enterprise within the home, such as sewing. Rural electrification as a development

initiative for the Guatemalan government, therefore, could help to increase infant survival in the country. The household variables of source of drinking water and type of floor material did not attain statistical significance in the regressions.

Sibship size was important. Greater numbers of older siblings increase an infant's chance of survival. It was also found that greater numbers of younger siblings also increase the index child's likelihood of surviving infancy to a great extent. This reflects the J-shaped relationship between birth order and infant mortality pattern observed by Preston (1985). A policy implication is that health clinics that are accessible, affordable, and that offer women and men a range of contraceptive choices will reduce infant mortality by reducing the number of unwanted and higher-order births.

The Centro Latinoamericano de Demografía, or Latin American Demographic Center (CELADE), emphasizes the importance of ethnic differentials among Latin American populations. "...The indigenous population is among the most vulnerable demographic groups... In Guatemala, for example, the probability of dying within the first two years of life for all indigenous children combined is estimated to be as high as that of children of salaried agricultural workers of all ethnicities" (19). Indigenous groups make up 41% of the Guatemalan population according to the 2002 Census of Guatemala (Instituto Nacional de Estadistica de Guatemala, National Statistics Institute of Guatemala) and rural demographic figures are often very similar to those for indigenous groups. The differentials between urban and rural areas are "...simply the external manifestation of what have been essentially inequitable development processes" (CELADE, 20). Therefore, further research may do well to include ethnic and rural/urban differentials in the study of development and infant mortality.

The intent of this study is to examine the relationship between development-related variables and infant survival in Guatemala. Further research is needed in the area of child survival beyond the first birthday, as this may be more affected by two of the variables reviewed here, source of drinking water and type of floor material, than are infants under one year of age. Various other aspects of the context of infant survival in Guatemala could also be taken into consideration, such as ethnicity, parents' occupations, urban versus rural residence, agricultural variables such as types of crops grown for sale or for consumption, the availability of healthcare, and prevalence of immunizations, for example. These are all variables that could shed further light on the subject of infant survival in the country.

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