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TRENDS IN GEOGRAPHICAL AND SOCIO-ECONOMIC DIFFERENTIALS IN EARLY AGE MORTALITY GUATEMALA, 1973 AND 1981

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1. Guatemala, socioeconomic situation and infant mortality

Guatemala is a Central American nation located to the south of Mexico, with Belice on the East and Honduras and El Salvador on the Southern border. The country has access to both the Pacific Ocean and the Caribbean. The area of Guatemala is a little over 100,000 sq. kms. giving a density in 1987 of around 85 inhabitants per sq. km. The country is highly rural with about two-thirds of the population living in rural areas. Guatemala City, the capital, represents approximately 20% of the nation's total population and is the only large metropolitan center. Per capita GNP in 1985 was estimated at US$1,240 (PRB 1987), placing it in 11th position among the 20 countries of Latin America. In Central American area, Guatemala's per capita GNP is the fourth largest, only slightly smaller than that of Costa Rica, but considerably smaller than the per capita GNP's of Mexico and Panama.

From a demographic perspective, Guatemala is relatively far behind the developed nations in terms of its mortality and fertility levels and trends (Table 1). Only in the current quinquenial is the life expectancy at birth expected to reach 60, a level that was attained in most West European countries some 40 years ago. Even by 2025 life expectancy is expected to reach only 70, a level already achieved by virtually all developed nations.

Similarly, fertility in Guatemala remains relatively high, although decreasing, with total fertility rates currently around 5 children per woman on average. This, however, could be an under-estimate since other measure of the total fertility rate are closer to 6 (for example, PRB 1987). The net reproduction rate (fertility, taking into account mortality) remains larger than 2, that is each generation is twice as large as the previous one. Even in the year 2025 it is not expected that Guatemala's net reproduction rate will have declined to replacement, or zero growth, levels.

As can be seen from Table 2, infant mortality rates in Guatemala have been decreasing steadily but even as late as the period 1970-1975, the rate was close to 100, or 1 birth out of 10 terminated in death within one year. In fact, there are indications that these rates are also under-estimates (for example, CELADE 1984, p. 7), nevertheless they can serve as a basis for comparison between Guatemala and other Latin American nations.

Table 1

Demographic Indicators
Guatemala, 1970 - 2025

	1970	1975	1980	1985	2025
Total Population (000)	5,353	6,243	7,262	8,403	21,717
	1970 -1975	1975 -1980	1980 -1985	1985 -1990	2020 -2025
Life Exp. at Birth	53.7	56.9	59.7	62.3	70.2
Total Fertility Rate	6.15	5.68	5.17	4.76	2.97
Net Reproduction Rate	2.34	2.25	2.12	2.02	1.39
Annual Growth Rate (%)	3.07	3.03	2.92	2.82	1.83

Source: United Nations 1983b, p.208.

Table 2

Infant Mortality Rates
Guatemala and selected countries, 1970 - 2025

Country	1970 -1975	1975 -1980	1980 -1985	1985 -1990	2020 -2025
Guatemala	90.2	79.0	67.7	57.3	26.6
El Salvador	101.0	84.8	71.0	59.9	27.2
Mexico	68.6	59.8	52.1	45.4	29.3
Costa Rica	50.9	29.3	25.7	23.1	17.9
Cuba	33.8	22.5	20.4	18.6	11.5

Source: United Nations 1983c, p. 36-39.

Currently, Guatemala's infant mortality rate is around 60 per thousand and is expected to decline to 26.6 by 2020-2025. Two other countries that are expected to reach the same levels by 2020-2025 are El Salvador and Mexico. Both, however, will have slightly higher levels than that of Guatemala. Historically, El Salvador has always had higher levels than Guatemala, albeit only slightly, whereas Mexico has tended to have lower levels. The difference between Mexico and Guatemala has been decreasing and is expected not only to disappear in the future but it is expected that the relative sizes will actually become inverted.

In contrast to the first three countries, Costa Rica and Cuba have considerably lower levels of infant mortality. Cuba, in particular, in 1970-1975 had levels about one-third that of Guatemala and by 2020-2025 is projected to have a level of 11.5, equal to some of the lowest levels seen now even in developed countries. All countries experienced important declines in infant mortality between the 1970-75 and 1975-80 quinquenials. For example, Costa Rica's infant mortality declined by almost 50% between these two periods. This is also the time frame in which Guatemala experienced important gains in infant mortality.

Another important aspect of Guatemala's infant mortality is that 67% of first-year deaths are post-neonatal, suggesting that it is primarily environmental and social factors that contribute to infant mortality (CELADE 1984, p.11).

In summary, it must be concluded that demographically speaking Guatemala is relatively less developed with high, albeit decreasing, fertility and mortality. The annual growth rate has hovered around 3% for some time and is only very slowly decreasing recently (Table 1). By 2025 it is expected that Guatemala will still have a growth rate of close to 2%, a level that translates into a population doubling time of 35 years.

The infant mortality rate is decreasing but it remains unacceptably high, with current levels indicating that almost 6 babies out of every 100 born die within the first year of life. The objective of this study is to shed light on the socioeconomic differentials of early age mortality in Guatemala and to study the trends in these differentials over time.

2. Data quality considerations

The data used in this analysis are derived from the 1973 and 1981 Censuses and it is important to understand something about the quality of these underlying data in order to correctly interpret the results. Two demographic techniques will be invoked first to estimate the quality of the data and then empirical results will be presented to compare a few key frequencies between the two Censuses.

The first results are based on errors in age reporting due to age heaping, or preference for certain ages. For example, it has been noted universally that there is a preference for ages ending in digits 0 or 5. In Table 3 are presented several indices of age preference that all have the same conceptual basis but vary in the details of calculation. In general the higher the index the poorer the quality of the age declaration.

Table 3

Indices of Age Preference (Myers, Whipple, and United Nations)
Guatemala, Mexico, Panama, Argentina
1950, 1960, 1970, and 1980 Rounds of Censuses

Country and Census	Indices		
	Myers	Whipple	United Nations
Guatemala			
1950 Census	32.5	196.8	42.3
1964 Census	19.5	158.3	27.8
1973 Census	22.2	164.0	24.9
1981 Census	21.7	165.0	26.2
Mexico			
1950 Census	35.8	188.7	35.4
1960 Census	36.7	174.0	25.8
1970 Census	17.0	148.0	18.0
1980 Census	-	-	-
Panama			
1950 Census	16.2	141.6	30.7
1960 Census	8.3	120.9	18.3
1970 Census	6.9	118.1	14.0
1980 Census	5.0	113.6	15.9
Argentina			
1947 Census	1.2	98.8	17.5
1960 Census	2.2	104.8	12.1
1970 Census	1.7	103.7	10.4
1980 Census	2.9	106.2	11.8

Source: DGE, CELADE 1985, Cuadro 6, p.11.

It is clear from the data in Table 3 that in comparison with other Latin American censuses, the Guatemala censuses have many problems. All the indices for all censuses are larger for Guatemala than for Panama and Argentina and in many cases larger by orders of magnitude. Only in the case of Mexico do Guatemala indices resemble those of another country except that even in this case by 1970 the Mexican indices are considerably lower.

In terms of inter-censal comparison for Guatemala there is some reason to believe that both the 1973 and 1981 Censuses suffer from data problems. Between 1950 and 1973 all indices decreased, whereas in 1973 they increased. There does not seem to be much difference between the 1973 and 1981 indices.

Another measure of data quality is the percentage undercoverage or omission rate, in other words, the estimated proportion of the eligible population that was not counted in the census. This index is measured using demographic methods of estimating population size and distibution based on underlying patterns of fertility, mortality, and migration. The difference between this estimated population and the census count is a measure of the undercount. Data for Guatemala are presented in Table 4.

Table 4

Measures of Undercoverage, Percentage Omitted
Guatemala: 1950, 1965, 1975, and 1980

Year	Source (1)			Source (2)	
	Total	Males	Females	Males	Females
1950	5.8	5.6	6.0	5.4	5.5
1965	4.8	4.9	4.6	3.9	3.6
1975	11.6	12.6	10.5	11.4	9.3
1980	15.2	16.5	13.9	15.1	12.4

Source (1): Gutiérrez 1983
Source (2): DGE, CELADE 1985.

The figures in the above table are consistent with another source which gives underenumeration rates for the 1973 Census equal to 2.8% in urban areas and 4.1% in rural areas and, independently, 9.5% for the country as a whole (Wilkie 1984, p. 272).

Once again there is evidence that the 1973 and 1981 Censuses are of poorer quality than the previous two in 1950 and 1965. This table also supports the argument that the 1980 Census is of worse quality that the 1973 Census. It should also be noted that this undercoverage does not equally affect all segments of the population since, in at least this particular case, in 1975 and 1980 the male undercoverage rates are higher than the female rates.

This apparent deterioraton of data quality between the 1973 and 1981 Censuses is particularly worrysome in the case of this study which has an important temporal component based on changes between these two time points. In particular, since it is mostly rates that are being compared, it is important to establish whether there were important changes in frequency distributions between the two censuses.

It has been suggested that the rural part of Guatemala was under-enumerated in the 1981 Census more so than in the 1973 Census and, in particular, Indians were especially under-enumerated. These hypotheses are based on the civil unrest that was present in Guatemala at the time of the 1981 Census. Table 5 was prepared to shed some light on this issue.

Table 5

Frequency Distributions - Guatemala - 1973 and 1981

Year	Percentage Urban	Percentage Indian
1950	25.0	53.7
1964	33.6	42.2
1973	36.4	43.8
1981	32.7	42.0

Sources: DGE (1971), Cuadro III (p.40), Cuadro IV (p.42)
DGE (1975), Cuadro I, p. 5
DGE (1984), p.21

The percentage urban increased steadily between 1950 and 1973 as a consequence of increased urbanization of Guatemala and there is little reason to believe that this universal aspect of the modernization process would have terminated or much less reversed itself in the following decade. And yet, in 1981, the percentage urban is smaller than in 1973. If there are data quality errors then they are exactly opposite to those hypothesized above. The indication is that, if any region was under-reported, it was the urban and not the rural part of the country. In the case of the Indian population there does not seem to be much evidence based on this minimal amount of data that there was a special problem of under-coverage of this population in the 1981 Census. In fact, the results for the last three Censuses are very similar, which may or may not represent reality but at least per se is not evidence of particular problems in 1981.

A thorough study of the 1981 Census of Guatemala would be required to get to the bottom of some of these issues, a task far beyond the scope of this study. Nevertheless, the above data do suggest that a great deal of caution should be exercised in drawing conclusions from these data especially with respect to the 1981 Census. There does not seem to be much evidence for differential errors in comparing the 1973 and 1981 Census, consequently the temporal change aspect of this study was executed and the results are presented and discussed below. However, readers should be ever attentive to the possible effects of problems with the original data on final conclusions.

As a result of the questionable quality of the 1981 data, results are presented only for the country as a whole without studying separately the urban and rural regions. However, an urban-rural residence variable was used to help shed light on the effect of this factor. Another victim of the 1981 data quality issue is the omission of estimation of attributable risk, a concept that decomposes the change in relative risk (see section 6) into change due to population composition and change due to real differences in differential mortality risk.

3. Data preparation

The analysis was based on a sample of data from the 1973 and 1981 National Censuses of Population and Housing in Guatemala. Advantage was taken of the availability of samples from the 1970 round of censuses as a result of the OMUECE project (Operación Muestreo Censal) which produced in standard format a sample on computer tape of census data from various countries in the region. In addition, a special sample was available on computer tape based on the 1981 Census of Guatemala.

In the case of the 1973 Census, the original random sample consists of 266,400 individual cases, representing a little over 5% of the total census population in 1973, namely 5,160,221. The sample based on the 1981 Census consists of 302,711 individual cases, representing 5% of the total population of 6,054,227.

From these samples, women aged 15-34 (inclusive) with at least one child born alive were selected. The resulting files consist of 33,382 individuals in the case of the 1973 Census and 37,328 individuals in the case of the 1981 Census. The list of original variables with their codes appears in Appendix 1.

Various steps had to be undertaken in order to derive the necessary variables for the regression analysis. In the first place, the independent, or explanatory, variables had to be created. In particular, these variables include education of the woman and the household head, urban-rural residence of the woman and occupation of the household head. The variable ethnicity of the woman did not change from its original version.

The following rules specify the data transformations that were performed. The rules apply to both the 1973 and 1981 Censuses although minor changes were necessary for the 1981 Census because of slight differences in the codes.

Education of the woman and the household head:

```
If EDUCW(H)= 0 -  9,EDUCW(H)= 1 (None)
            10 - 12           2 (One or two years of primary)
            13 - 15           3 (Three, four, or five years of
                                 primary)
            16 - 19           4 (Primary completed)
            20 and over       5 (At least some secondary)
```

Urban-rural residence of the woman:

```
If URW=2,               GURW=1 (Rural)
   DEPTOW≠1 & URW=1,    GURW=2 (Urban, except capital city)
   DEPTOW=1,            GURW=3 (City of Guatemala)
```

Occupation of the household head:

```
If (CATEGH=3   & OCUPH=411-453)                       THEN OCCH=1,
   (CATEGH=2,4 & OCUPH=411-453)                       THEN OCCH=2,
   (CATEGH=2,4 & OCUPH=224,226,231-236,321-339,
                       521-532,612-632,642,643,
                       711,716-961)                   THEN OCCH=3,
   (CATEGH=3   & OCUPH=  ---- " -----)                THEN OCCH=4,
   (CATEGH=3   & OCUPH=001-223,225,311-319,
                       611-641,651-653,712-715,
                       962)      OR CATEGH=1          THEN OCCH=5.

      (OCCH=1: Salaried agriculture workers - laborers
            2: Non-salaried agriculture workers - peasants
            3: Non-salaried non-agriculture workers
            4: Salaried non-agriculture workers
            5: Middle class)
```

In order to simplify the analysis and, more importantly, the interpretation of the results, input data were limited to women for whom all data were present. Consequently, a selection was made of women who were married (or common-law) with spouse present and for whom valid data were available for the variables education, occupation, and ethnicity. In addition, selected women had to have fewer than 20 children ever born and the number of children surviving had to be less than or equal to the number of children ever born. These selection criteria further reduced the effective sample size to 19,412 women from 33,382 in the case of the 1973 Census and to 17,851 from 37,328 in the case of the 1981 Census.

(The term houshold head is used in this study although, because of the above-mentioned selection procedures, the household head is actually the husband (legal or common-law) of the woman selected and father, biological or adopted, of the children in the household.)

4. Methodology

Since the derived explanatory variables are categorical (that is, their codes do not have a quantitative value), in order to introduce them into a regression framework they have to be transformed into dichotomous, or dummy, variables. For each variable, one code was selected as the reference category and for each of the remaining codes a separate dichotomous variable was created, with a value of 1 if the individual possesses a particular trait and 0 otherwise. The reference category chosen was always the one corresponding to the group with the lowest mortality. Consequently the dichotomous variables measure surplus mortality with respect to this reference category.

The reference categories for the independent variables are EDUCW=5 (At least some secondary), GURW=1 (City of Guatemala), ETNICOW=2 (Non-indian), and OCCH=5 (Middle class). In addition, 8 dichotomous variables were created for education (4 for women and 4 for household heads), 2 for residence, 1 for ethnicity, and 4 for occupation of household head.

The dependent variable which represents the phenomenon that is being studied, measures child mortality in the population. As a first step, the following intermediate variable was calculated:

PROPM = 1 - (No. surviving children/No. children ever born).

To derive a more appropriate variable, the expected or theoretical version of this variable was calculated, based on model life tables and the age of the woman (as a surrogate for the duration of exposure of children to the risk of dying). The final version of the variable is the ratio of the observed value to the theoretical value.

The United Nations program PROPDEAD (United Nations 1986a, 1986b) was used to calculate the theoretical values. The required input is the mean number of children ever born and children surviving by age group of the woman. The inputs were calculated based on the larger samples (33,382 women in 1973 and 37,325 in 1981). In addition, the number of women with no children was estimated both for 1973 and 1981 using census tabulations. The input data were:

Age of woman	Means: Children ever born	Means: Children surviving
	1973	
15-19	0.3245	0.2898
20-24	1.6863	1.4491
25-29	3.2914	2.7222
30-34	4.7588	3.8619
	1981	
15-19	0.3403	0.3152
20-24	1.7247	1.5484
25-29	3.2307	2.8230
30-34	4.5059	3.8405

PROPDEAD also requires as input the average childbearing age of women. In the case of Guatemala, for the 1973 Census the figure used was 28.89 and for 1981 the figure used was 28.76. Both these data are based on quinquennial (15-19,...,45-49) age-specific fertility rates that were estimated as part of an exercise whose objective was to calculate the most recent projections for Guatemala (DGE 1985). (The actual fertility rates do not appear in the publication referenced but are available on request from the author or from CELADE.)

A study was carried out to match the Guatemala empirical mortality tables (DGE and CELADE 1985, p.154-157) to the United Nations model life tables (United Nations 1983a) in order to select the appropriate results from the PROPDEAD program. The sum of absolute differences between corresponding values of ${}_nq_x$ were calculated for the five U.N. models selected using the male and female life expectancies from the empirical life tables. Based on all age groups, the Latin American pattern proved to be vastly superior for both sexes and for both time points. Based only on early ages (0-19), the Latin American model again most closely approximates the Guatemala mortality pattern for both sexes and both time points. In the case of early ages, the next best model is the General model, followed in order by the South Asia, Far East, and Chile, which provides the worst fit.

Using the Latin American pattern, the expected proportions dead for 1973 and 1981 by age group of mother are:

Age of woman	Expected proportion dead 1973	1981
15-19	.11757	.09038
20-24	.14950	.11301
25-29	.16740	.12489
30-34	.18483	.13616

The final version of the dependent variable, M, was derived as the quotient of the observed proportion, PROPM, divided by the expected or theoretical proportion dead.

5. Mortality at early ages

This section is based on calculated values of $_5q_0$ which are based on the M values described in the above section. The measure $_5q_0$ is equal to the probability of dying within the first five years of life. The transformation from M's to probabilities of dying was made for various sub-populations for each of which a mean value of M, say M_m, was calculated. For both the 1973 and 1981 Censuses, an overall mean of M, M_t, was calculated together with a global value of $_5q_0$, based on the observed life expectancy and the appropriate model life table. The global values of $_5q_0$ for 1973 and 1981 are 0.19181 and 0.14035, respectively. The formula used to calculate the probability of dying for a given sub-population, $_5q_0(s)$, is simply:

$$_5q_0(s) = M_m * (_5q_0 / M_t).$$

The mean values, M_m, used to calculate the $_5q_0$'s presented in this section are weighted means with number of children ever born used as the weights. However, the frequency distributions provided alongside the probabilities in the tables in this section are unweighted. Table 6 below includes probabilities of dying for 1973 and 1981 for all categories of all independent, explanatory, variables derived for this study.

Table 6

Probability of dying before age 5, $_5q_0$, for various sub-groups
Guatemala 1973, 1981

Variable and Category	$_5q_0$ 1973	$_5q_0$ 1981	Diff. (%)	Population 1973 (%)	Population 1981 (%)
Education of Woman					
None	.218	.163	-25	66.2	57.2
1-2 Yrs. Primary	.165	.128	-22	8.7	10.9
3-5 Yrs. Primary	.146	.118	-19	13.7	15.9
Primary Completed	.091	.077	-15	6.5	8.2
Some Secondary	.053	.040	-25	4.8	7.8
Education of Hhld Head					
None	.223	.167	-25	50.2	41.5
1-2 Yrs. Primary	.191	.146	-24	15.8	15.8
3-5 Yrs. Primary	.169	.127	-25	19.1	21.5
Primary Completed	.110	.100	- 9	8.1	10.5
Some Secondary	.066	.059	-11	6.8	10.7
Urban-Rural Residence					
Rural	.207	.150	-28	69.7	71.0
Urban w/o Capital	.188	.141	-25	16.4	15.7
Guatemala City	.108	.076	-30	13.9	13.2
Ethnicity					
Indian	.224	.157	-30	47.1	44.7
Non-Indian	.164	.127	-23	52.9	55.3
Occupation of Hhld Head					
Laborer	.224	.167	-25	23.8	20.0
Peasant	.210	.147	-30	37.4	40.3
Non-Salaried Non-Ag.	.176	.136	-23	10.4	9.8
Salaried Non-Ag.	.157	.119	-24	21.9	21.6
Middle Class	.087	.085	- 2	6.5	8.3

Starting with education of the woman it is obvious that there is a very strong negative relationship between mortality and education. The higher the level of education of the woman, the lower is the probability of that woman's children dying in early years. This result applies to both Censuses with consistently lower levels of mortality in 1981. There is, however, no indication that there is any convergence over the time period in question. Differences between 1973 and 1981, expressed as a percentage of the 1973 level, range between 15 and 25 with no clear relation to the level of education.

In the case of education of household head, there does seem to be some evidence that there have been more advances for the lesser educated categories than for the higher educated women. For women married to men with up to 5 years primary there was a 25% decrease in the value of $_5q_0$, whereas for the higher two categories there was only a 10% decrease. This result suggests that head's education may be more important than woman's education as a determinant of differential mortality trends.

Turning to the urban-rural residence variable, again there is evidence of a strong, negative relationship between urbanization and mortality. The capital city has the lowest mortality and rural areas experience the highest. The decrease between 1973 and 1981 is considerably higher than the decreases seen for the education groups. The decrease experienced by the capital city is the largest (30%) but again there is not much indication of convergence between the three groups.

In the case of ethnicity, there is evidence that the higher mortality groups, Indians, are approaching the non-Indian group. The Indians' mortality decreased 30% where for the non-Indians the decrease was only 23%. Should this differential tendency continue into the future, the Indians will sooner or later have the same mortality level as the rest of the population.

Finally, with respect to occupation of household head, there appears again the by now familiar strong negative relation between mortality and socioeconomic status of occupation. Levels in 1981 are uniformly lower than in 1973 with high decrease for the two "lowest" groups, laborers and peasants, namely, 25% and 30% respectively. The two non-agricultural groups have slightly lower mortality changes and the highest group, the middle class, experienced hardly any decline at all.

The objective of the preceding table was to give a global picture relating levels of mortality to various socioeconomic characteristics. To continue in this line, another type of analysis was carried in which the entire population was divided into 750 sub-population, defined by all possible combinations of the 5 independent variables. For each sub-population, a mean value of M was calculated together with the corresponding $_5q_0$. The sub-population were then ordered by size of this measure and five groups were created representing, as much as possible, quintiles (20% of the ordered population). The terms "Very High", "High", "Medium", "Low", and "Very Low" are only labels that have relative meaning and should not be interpreted in any more general sense or taken out of context.

Tables 7 and 8 provide summary information about the five groups. The frequencies (last column) are based on weighted counts, with weights based on children ever born. It is clear that there is very high variance in mortality in the population with the "Very High" group experiencing, on average, three times the mortality of the "Very Low" group.

Table 7

Probabilities of dying before age 5, $_5q_0$
Five groups based on level of $_5q_0$
Guatemala, 1973

Level of $_5q_0$		$_5q_0$	5q0 / Very Low	(%)
Very High	(above .240)	.267	2.97	9.7
High	(.230 - .240)	.235	2.61	23.3
Medium	(.200 - .230)	.215	2.39	29.3
Low	(.150 - .200)	.173	1.92	19.9
Very Low	(under .150)	.090	1.00	17.8

Table 8

Probabilities of dying before age 5, $_5q_0$
Five groups based on level of $_5q_0$
Guatemala, 1981

Level of $_5q_0$		$_5q_0$	5q0 / Very Low	Population (%)
Very High	(above .180)	.206	3.07	16.0
High	(.160 - .180)	.168	2.51	21.4
Medium	(.140 - .160)	.153	2.28	23.8
Low	(.110 - .140)	.128	1.91	20.3
Very Low	(under .140)	.067	1.00	18.4

Tables 9 and 10 summarize the socioeconomic characteristics of the five groups both for the 1973 and for the 1981 Census. For each Census and for each of the five groups the tables present the frequency distributions for the five independent variables. By reading the columns vertically it is possible to identify the primary factors that characterize each mortality group. The frequencies are weighted by children ever born but to facilitate the following explanation the frequencies will be referred to as if unweighted.

Table 9

Probabilities of dying before age 5, $_5q_0$
Characteristics of sub-groups with various levels of $_5q_0$
Guatemala, 1973

	Frequency Distribution				
	Very High	High	Medium	Low	Very Low
Education of Woman					
None	82.3	98.3	94.6	51.2	9.9
1-2 Yrs. Primary	7.2	1.6	3.4	19.7	14.7
3-5 Yrs. Primary	7.6	.1	1.2	28.1	36.2
Primary Completed	1.9	.0	.5	.9	23.1
Some Secondary	1.0	.0	.3	.1	16.1
Education of Hhld Head					
None	76.9	94.0	62.5	21.6	6.6
1-2 Yrs. Primary	10.2	4.2	24.9	26.9	12.3
3-5 Yrs. Primary	8.0	1.8	10.9	46.6	28.6
Primary Completed	3.9	.0	1.3	3.7	29.2
Some Secondary	.9	.0	.3	1.1	23.2
Urban-Rural Residence					
Rural	54.5	89.3	91.7	71.7	28.8
Urban w/o Capital	40.7	10.7	5.4	18.3	25.0
Guatemala City	4.8	.0	2.9	10.0	46.2
Ethnicity					
Indian	31.9	95.7	54.7	24.8	8.1
Non-Indian	68.1	4.3	45.3	75.2	91.9
Occupation of Hhld Head					
Laborer	71.8	.5	48.4	11.8	2.9
Peasant	7.6	79.8	33.2	46.5	9.4
Non-Salaried Non-Ag.	3.0	13.1	8.4	5.8	19.8
Salaried Non-Ag.	15.2	6.6	9.3	31.5	47.2
Middle Class	2.3	.0	.7	4.3	20.6

For 1973, in the "Very High" early age mortality group, the vast majority of women (82%) have no education, almost 80% of husbands have no education, over 95% live outside the capital city, 32% are Indian, and 72% are laborers. At the other extreme, in the "Very Low" mortality group, only 10% have no education, 6.6% of husbands have no education, 46% live in Guatemala City, only 8.1% are Indian, and only 3% belong to the "lowest" occupation category, laborer. The contrast between the groups is remarkable, almost as if two different societies living within the same population.

Table 10

Probabilities of dying before age 5, $_5q_0$
Characteristics of sub-groups with various levels of $_5q_0$
Guatemala, 1981

	Frequency Distribution				
	Very High	High	Medium	Low	Very Low
Education of Woman					
None	52.8	90.6	82.4	46.2	7.6
1-2 Yrs. Primary	21.1	2.7	10.9	21.0	13.7
3-5 Yrs. Primary	19.7	6.3	6.6	28.8	28.0
Primary Completed	4.8	.4	.1	3.7	26.4
Some Secondary	1.6	.0	.0	.2	24.4
Education of Hhld Head					
None	25.8	62.6	78.2	12.0	2.7
1-2 Yrs. Primary	23.3	22.4	10.6	31.2	6.2
3-5 Yrs. Primary	2.5	14.7	6.2	52.2	27.5
Primary Completed	7.0	.1	4.5	3.2	30.0
Some Secondary	41.4	.2	.5	1.4	33.7
Urban-Rural Residence					
Rural	26.0	94.3	94.7	80.3	32.3
Urban w/o Capital	49.7	5.7	4.8	11.3	26.6
Guatemala City	24.2	.1	.5	8.4	41.1
Ethnicity					
Indian	47.2	55.0	81.8	26.7	12.9
Non-Indian	52.8	45.0	18.2	73.3	87.1
Occupation of Hhld Head					
Laborer	33.9	46.8	11.5	12.3	3.6
Peasant	12.8	46.9	75.3	56.8	11.5
Non-Salaried Non-Ag.	20.3	4.6	3.3	4.8	17.3
Salaried Non-Ag.	27.2	.6	9.7	22.1	45.1
Middle Class	5.7	1.0	.2	4.0	22.6

In 1981, the contrast between the "Very High" and "Very Low" groups is equally noteworthy although maybe slightly less extreme. In particular, the "Very High" includes a surprisingly high number of husbands with "Some Secondary" (41.4%) and a much lower percentage of laborers than in 1973 (34% in 1981 vs 72% in 1973).

In both 1973 and 1981, the "High" and "Medium" groups exhibit more skewed distributions than the "Very High" group. For example, in 1973 98.3% of women in the "High" group had no education whereas the figure for the "Very High" group is only 82.3%. The majority of "High" group are peasants whereas the majority of the "Very High" group are laborers.

Care must be taken in interpreting these results since it must be kept in mind that almost half the original data set has records with a value of 0 for M and consequently $_5q_0$. This is because for 83.4% of the women in the 1973 Census, the number of children surviving is equal to the number born. Essentially the issue is one associated with a rare characteristic and this results in many of the sub-groups' means being based to a large degree on "zero" records. The problem is discussed in more detail in Appendix 2.

6. Regression estimates of differential mortality

a. Univariate

Before estimating coefficients in the multivariate framework, each group of dichotomous variables was considered individually and run as independent explanatory variables with M as the dependent variable. Standard linear least-square regression was run using the SPSS/PC+ microcomputer package with a number of variations on the basic model. In the case of both Censuses the highest explanatory power (R^2 values) was obtained for weighted data using the children ever born as the weight.

The resulting regression coefficients provide an indication of excess mortality with respect to the reference group, selected as the one with lowest mortality. With some minor modifications, these b's were than used as measures of relative mortality risk of a given group with respect to a reference group. In the ensuing tables in this section all frequencies are weighted by children ever born. In addition, all results based on univariate regression are highly significant, statistically speaking. The explanatory power of the univariate regressions is never very high, with a maximum of 3% of the total variance of the dependent variable explained by the model.

Relative risks are presented in a slightly altered form to allow for easier interpretation. The actual values of the relative risks center around 1 with values larger than 1 indicating surplus mortality with respect to the reference group and values smaller than 1 indicating mortality lower than the reference group. Since the reference group was intentionally chosen to be the group with lowest mortality, the relative risks are almost always larger than 1. A relative risk for a given sub-group of, say, 1.40 indicates that this sub-group experiences mortality rates 40% higher than the reference group. In the tables it is these percentages that are presented. The difference between the 1973 and 1981 relative risks are calculated as a percentage of the 1973 level. The population frequencies are weighted by number of children ever born.

The results are presented in Table 11. The expected strong relationship between mortality and education is once again evident, with the exception of the "1-2 Years Primary" category which has a lower value than expected in relation to the "3-5 Years Primary" group. In 1973, women with no education had 86% higher early-age mortality than did wome with some secondary. The interesting point is that in 1981 this differential increased to 102.4%. In fact, there is strong evidence based on these data that differentials in early age mortality are actually increasing. There is not much of a pattern but there seems to be a tendency for the lower mortality groups to experience larger increases between 1973 and 1981.

The relative risks for education of household head exhibit patterns similar to those seen in the case of education of woman. Relative risks decrease monotonically with increase in level of education again with the exception of the "1-2 Years Primary" group. In 1973, women married to husbands with no education experience 82% higher mortality than woman whose husbands have some secondary education. In 1983 the corresponding figure is almost 89%. As with education of the woman, the relative risks for categories of education of household head are all larger in 1981 than in 1973. This suggests an increasing divergence in the levels of mortality between the various education groups of the population. The major difference between 1973 and 1981 occurs for the "Primary Completed" group whereas the other groups experience minimal changes, albeit always positive.

In the case of urban-rural residence, in 1973 the "Urban w/o Capital" group has 42% higher early age mortality than the capital and the figure for the rural areas is 51.6%. In 1981 the corresponding risks are 54.6% and 61%, respectively. Again, there is evidence of increasing diversity and the higher mortality group ("Rural") experiences the lowest increase in mortality risk.

Indian early age mortality is 31.3% higher than for the Non-Indian group in 1973, and 25.2% higher in 1981. The is the first evidence of a convergence of mortality levels between two social groups.

Table 11

Relative Mortality Risks
Univariate Regression Model
Guatemala, 1973 and 1981

Variable and Category	Relative Risk (%) 1973	1981	Diff. (%)	Population 1973 (%)	1981 (%)
Education of Woman					
None	86.0	102.4	19	70.0	62.8
1-2 Yrs. Primary	48.4	61.4	27	8.8	11.0
3-5 Yrs. Primary	58.6	72.0	23	13.1	14.8
Primary Completed	20.1	30.1	50	4.9	6.3
Some Secondary	0.0	0.0	-	3.3	5.0
Education of Hhld Head					
None	82.1	88.7	8	52.8	45.6
1-2 Yrs. Primary	53.6	54.7	2	16.8	16.8
3-5 Yrs. Primary	65.3	71.1	9	18.8	21.2
Primary Completed	23.1	32.3	40	6.9	8.8
Some Secondary	0.0	0.0	-	4.7	7.5
Urban-Rural Residence					
Rural	51.6	61.0	18	72.0	74.2
Urban w/o Capital	42.0	54.6	30	16.2	15.6
Guatemala City	0.0	0.0	-	11.8	10.3
Ethnicity					
Indian	31.3	25.2	-19	47.6	46.5
Non-Indian	0.0	0.0	-	52.4	53.6
Occupation of Hhld Head					
Laborer	64.0	49.7	-22	24.1	21.3
Peasant	71.5	66.6	- 7	39.8	43.2
Non-Salaried Non-Ag.	46.3	40.8	-12	10.5	9.6
Salaried Non-Ag.	36.7	26.1	-29	20.4	19.4
Middle Class	0.0	0.0	-	5.2	6.5

The occupation variable also contains evidence of convergence of different social groups. The relative risks descend in expected order with the exception of the "Laborer" values which are smaller than the "Peasant" values. The largest mortality risk occurs for the "Peasant" group with excess mortality equal to 71.5% in 1973 and 49.7% in 1981. The largest gain between 1973 and 1981 occurred for the "Salaried non-agricultural workers" whose relative risk decreased from 36.7% to 26.1%.

b. Multivariate

The multivariate regression model is the following:

$$M_i = \text{Constant}$$
$$+ EDUCW1_i + EDUCW2_i + EDUCW3_i + EDUCW4i$$
$$+ EDUCH1_i + EDUCH2_i + EDUCH3_i + EDUCH4i$$
$$+ SURW2_i + SURW3_i$$
$$+ ETNICO1_i$$
$$+ OCCH1_i + OCCH2_i + OCCH3_i + OCCH4i + e_i$$

Results based on the multivariate regression model are provided in Table 12. The frequency distributions are the same weighted frequencies presented in the table above with the univariate regression results. Relative risks in the multivariate model are smaller than the univariate results because of the presence of other explanatory variables that act as controls.

Very little of the total variance in child mortality is being explained by the model (4.4% in 1973 and 3.5% in 1981). Nevertheless, it is important to note that the results, both overall and for individual variables, are highly significant. Presumably this is in large part due to the very large sample sizes involved.

In this model, as in the univariate case, with the exception of occupation and ethnicity, the values for 1981 are higher than in 1973 indicating an increase in mortality differentials with respect to child mortality over the period 1973-1981.

As far as individual explanatory variables go, the results are consistent over time. For both Censuses it is clear that education (both woman's and that of the household head) and urban-rural residence are the principal explanatory factors almost all with very high significance levels. It is interesting to note that the highest levels of education have lower levels of significance. The suggestion is that discriminating between low education levels is important in explaining child mortality differentials. Urban-rural residence is highly significant in both Censuses.

There is a marked difference between 1973 and 1981 concerning the ethnicity and occupation variables. In 1973 all results are highly significant whereas in 1981 only one occupation category shows significance.

Table 12

Relative Mortality Risks - Education of Woman
Multivariate Regression Model
Guatemala, 1973 and 1981

Variable and Category	Relative Risk (%) 1973	1981	Diff. (%)	Population 1973 (%)	1981 (%)
Education of Woman					
None	40.1	63.0	57	70.0	62.8
1-2 Yrs. Primary	24.6	43.8	78	8.8	11.0
3-5 Yrs. Primary	20.7	39.5	91	13.1	14.8
Primary Completed	8.4	19.3	130	4.9	6.3
Some Secondary	0.0	0.0	-	3.3	5.0
Education of Hhld Head					
None	27.7	33.6	21	52.8	45.6
1-2 Yrs. Primary	18.1	23.0	27	16.8	16.8
3-5 Yrs. Primary	13.4	13.4	0	18.8	21.2
Primary Completed	1.1	7.9	718	6.9	8.8
Some Secondary	0.0	0.0	-	4.7	7.5
Urban-Rural Residence					
Rural	14.8	17.1	16	72.0	74.2
Urban w/o Capital	21.0	25.7	22	16.2	15.6
Guatemala City	0.0	0.0	-	11.8	10.3
Ethnicity					
Indian	10.5	9.9	-6	47.6	46.5
Non-Indian	0.0	0.0	-	52.4	53.6
Occupation of Hhld Head					
Laborer	23.0	2.8	-821	24.1	21.3
Peasant	14.1	-12.6	*	39.8	43.2
Non-Salaried Non-Ag.	10.5	0.0	*	10.5	9.6
Salaried Non-Ag.	14.9	- 1.8	*	20.4	19.4
Middle Class	0.0	0.0	-	5.2	6.5

The actual values of the relative risks are also of interest. In 1973 and 1981 both education variables exhibit the expected decline in mortality risk with the largest value occurring for "no education" and the smallest for "Primary Completed". In other words, the highest mortality relative to the reference category ("Some Secondary") occurs for those women who themselves have no education and whose spouses have no education. The large values for education of woman in 1981 are especially noteworthy. The relative risks for education of household head are similar to the results for education of woman except that the levels are lower, in fact much lower, and the difference between 1973 and 1981 is much less marked. In several cases the 1981 value is actually lower than the 1973 value.

In the case of urban-rural residence, contrary to expectation, "urban w/o capital" has higher mortality than "rural". This result is common to both Censuses. The relatively large values of these relative mortality risks especially in 1981 underline the importance of this variable in explaining child mortality differentials.

Unanticipated results occur in the case of ethnicity and occupation. These results need to be interpreted with great care since the multivariate regression model produced negative results for the beta coefficients in 1981. These negative values represent an anomaly which, as is argued in Appendix 2, is due more to methodological than substantive considerations. The small value for the Indian group suggests that ethnicity may play a relatively minor role in the explanation of variance in mortality in early ages. In the case of occupation for 1973 the value for "Salaried Non-Agricultural Worker" does not follow the predicted pattern. More information would be required to study the relative importance of this category.

7. Summary and conclusions

- Based on historical and current socio-demographic data, Guatemala remains, demographically speaking, a nations still in the midst of the demographic transition with high, albeit decreasing, levels of mortality and fertility.

- Infant mortality in Guatemala is decreasing although it is currently still around 6 deaths per 100 live births.

- The data used in this study are based on the 1973 and 1981 Censuses and are far from being problem-free. Special caution should be exercised in drawing conclusions using the 1981 data.

- Probabilities of dying before age 5, $_5q_0$, were estimated. There is a strong negative relationship between all variables and these probabilities in the sense that higher mortality was found for the more underprivileged segments of society (low education, rural, Indian, and low occupation).

- The values of $_5q_0$ are all lower for 1981 than for 1973 indicating that gains have taken place in early age mortality over this period. However, there is little pattern in the change and it is not clear whether differences between socio-economic groups are increasing or decreasing.

- The methodology used was based on a regression framework with dummy variables based on the categories of various independent explanatory variables: education of woman and household head, urban-rural residence, ethnicity, and occupation of household head. The dependent variable is a measure of early age mortality based on the number of children surviving compared to the number ever born. The resulting coefficients serve as measures of mortality risk between various sub-populations exposed to the risk of early age mortality.

- The regression results are all highly significant although the explanatory power of the models is never very high.

- There is evidence of tremendous disparity between social groups with respect to early age mortality. For example, women with no education experience twice the infant mortality as do women with some secondary.

- With some minor exceptions, there is a uniform increase in mortality risk that parallels the social distance between the group in question and the reference group, the one with lowest mortality.

- Relative early age mortality risks in 1981 are all larger than the corresponding risks in 1973. This indicates that the social disparities are increasing over time and that there is little convergence between social groups with respect to early age mortality.

APPENDIX 1

Original variables and their codes

(The letters W and H at the end of variable names indicate wife and husband respectively.)

DEPTOW Department of residence of the woman

1 - Guatemala
2 - El Progreso
3 - Sacatepequez
4 - Chimaltenango
5 - Escuintla
6 - Santa Rosa
7 - Sololá
8 - Totonicapan
9 - Quezaltenango
10 - Suchitepequez
11 - Retalhuleu
12 - San Marcos
13 - Huehuetenango
14 - El Quiche
15 - Baja Vera Paz
16 - Alta Verapaz
17 - Peten
18 - Izabal
19 - Zacapa
20 - Chiquimula
21 - Jalapa
22 - Jutiapa

URW Residence (urban-rural) of the woman

1 - Urban
2 - Rural

RELW Relationship of woman to head of household (The 1981 codes are slightly different.)

0 - Head
1 - Wife or companion
2 - Son or daughter
3 - Parent or in-law
4 - Grandchild
5 - Other relative
6 - Servant
7 - Other non-relative
9 - Unknown

EDADW	Age of woman	
	15-34	
EDUCW	Education of woman	
	0 - None	
	1x - x years of primary	
	2x - x years of secondary	
	3x - x years of post-secondary	
	99 - Unknown	
ETNICOW	Ethnic origin of woman	
	1 - Indian	
	2 - Non indian	
	9 - Unknown	
ESTCIVW	Marital status of woman (The 1981 codes are slightly different.)	
	1 - Single	
	2 - Married	
	3 - Common-law	
	4 - Widow	
	5 - Divorced	
	6 - Unknown	
HIJTENW	Children ever born	
	1 - 33	
	98 - Unknown	
	99 - Unknown	
HIJSOBW	Children surviving	
	0 - 33	
	98 - Unknown	
	99 - Unknown	
SEXOH	Sex of household head	
	1 - Male	
	2 - Female	

EDUCH Education of household head

See the EDUCW codes above

CONDH Economic activity of household head
("What did you do the week prior to the census?")

1 - Worked
2 - Did not work but had job
3 - Worked earlier and looked for work
4 - Looked for work for the first time
5 - Studied
6 - Household chores
7 - Other
8 - Unknown

OCUPH Ocupation of household head

001-999 Professionals, technicians, etc.
100-199 Businessmen, administrators, managers
200-299 Office workers, secretaries, etc.
300-399 Sellers
400-499 Agriculture and livestock
500-599 Mines
600-699 Transport
700-799 Artesans
800-899 Laborers
900-971 Services
999 Unknown

CATEGH Occupational category of household head
(The 1981 codes are slightly different.)

1 - Employer
2 - Self-employed
3 - Salaried employee
4 - Unpaid family worker
5 - Unknown

APPENDIX 2

Methodolical Considerations

a. Variations on the basic regression model

In an attempt to increase the explanatory power of the model, it was run using only women with non-zero values for PROPM, that is at least one child did not survive. The resulting R^2 value was considerable lower than for the model based on all women and only ethnicity turned out to be significant. The global model was highly significant probably in large part due to the large sample size.

In order to explain the phenomenon of the negative beta coefficients for the 1981 Census, the model was rerun using, first, only the four occupation dummy variables as the dependent variables. Not only did the model produce positive coefficients but the relative sizes followed the expected pattern (highest for OCCH1 down to lowest for OCCH4). Next, the model was rerun adding ethnicity to the occupation variables. Again, positive and reasonable coefficients were obtained. Similar results are obtained by adding urban-rural residence. However, as soon as education is added the first negative coefficients appear. The suspicion is, and it has yet to be verified, that there is a great deal of multicollinearity (education and occupation are traditionally highly related) and this is provoking the abnormal results.

Of course, this raises ugly doubts about the general validity of the model. If the model is so sensitive that the choice of independent variables can affect the interpretability of the results, it behoves users to consider the sensitivity of the model with respect to more subtle, substantive conclusions. Further investigation of this phenomenon should be carried out on an individual case by case basis and for the project as a whole.

b. On the explanatory power of the model

It is important to realize that the explanatory power of the model is weak in spite of the presence of a large number of supposedly related independent variables. One possible explanation for this phenomenon might be the behavior of the dependent variable, the relation between the observed and expected values of dead children. In order to use the classical regression model the dependen variable must be continuous. In principle, M satisifies this condition of continuity but it is interesting to study the distribution of the variables on the basis of which the final dependent variable, M, was created.

The distribution of children ever born is:

Value	Percentage
1	31.7
2	25.5
3	18.0
4	11.4
5+	13.4

(These and the following data are based on the 1973 Census, but similar arguments apply to the 1981 data.)

The first four values together account for 86.6% of the total population

The distribution of surviving children is similar in its concentration pattern:

Value	Percentage
0	1.0
1	33.7
2	26.6
3	18.8
4	10.2
5+	9.7

Again, the first four values together represent 89.3% of the total population.

However, the most concentrated variable is the relation between surviving children and children ever born, whose distribution is:

Value	Percentage
0.0	1.0
0.33	0.6
0.50	3.3
0.60	0.7
0.67	3.3
0.75	3.2
0.80	1.4
0.83	0.8
1.00	83.4
Other	2.3

It is important to note that not only is almost the entire population concentrated in one value, 1.00, but also that the rest of the population is concentrated in fewer than 10 values. There exists very little variation in the dependent variable to be explained by the model and the collection of independent variables.

Dividing this variable (or its complement, PROPM) by the expected value does not go very far towards solving the problem since it is done for only four age groups and within each group the divisor is a constant.

c. Alternative strategies

One strategy that might be more appropriate is to divide the problem in two parts. The first would study the difference between women with zero proportion children dead and all other women. This analisis would have as its objective to look for variables that discriminate between the two groups of women. Basically, this would be an exercise in categorical discriminant analysis. The second part of the analysis would focus on women with a non-zero proportion dead. Nevertheless, there remains the problem that it is impossible for a woman to have 0.34 children surviving. Consequently, the values of proportion surviving are very unlikely to behave anywhere near a normal distribution.

Another approach would be to use the probit or logit method of regression which can be used when the dependent variable is not continuous.

Another way in which the dependent variable could be studied more appropriately is to consider the problem as an ecological study in which both dependent and independent variables are collected and analysed at a more macro level than the individual or the household. This could be the community or any other easily identifiable, preferably homogeneous, geographical area. This would also allow for the inclusion of variables such as availability of health care facilities. Under this scenario, it would still be possible to draw policy-oriented conclusions concerning changes that need to be effected in the independent variables.

Finally, the possibility has to be entertained that the weak explanatory power of the model is not methodological in nature but one of substantive content. It could be conjectured that the selected explanatory variables are not sufficiently related to the dependent variable in order to explain more completely the behavior of the dependent variable. It has, for example, been suggested that a key explanatory variable is the quality and availability of health care, a variable that obviously is not available from census data.

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