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Socio-Demographic Factors and Intergenesic Interval in Nicaraguan Immigrant Mothers in Costa Rica

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ABSTRACT

Adequate birth intervals are considered a positive factor in the health of mothers and their children. One of the objectives of this study is to compare the birth interval between Nicaraguan immigrant women and local mothers in Costa Rica. Birth intervals among Nicaraguan women are significantly shorter than the local ones ($p < 0.001$). Half of the children of the Nicaraguan mothers have birth intervals of a minimum of 335 days (less than one year). Half of the local children have birth intervals of a minimum of 881 days (2.4 years). A second objective in this study is to fit a Cox's proportional stratified hazard model of the type $\lambda_s(t,X) = \lambda_0(t)\exp(\beta_{i_s}'X_i)$ in order to model the birth interval as a time-to-event variable (pregnancy of the next child). Fitting by nationality of the mother, age, and age on first birth-delivery, the hazard ratios are respectively 1.3 ($p < 0.001$), 0.93 ($p < 0.001$), and 1.02 ($p > 0.05$). Nicaraguan women are 30% more likely to recur in the following pregnancy as compared with local women. The study of population minorities permits the preparation of public policies on international migration issues.

Keywords: Birth interval, survival analysis, Cox's proportional stratified hazards model, recurrent events, Nicaraguan immigrants.

RESUMEN

Un adecuado intervalo intergenésico se considera un factor positivo en la salud de las madres y de los hijos. Un objetivo de este estudio es comparar el intervalo intergenésico entre madres nicaragüenses y costarricenses en Costa Rica. El intervalo intergenésico entre las madres nicaragüenses es significativamente inferior al de las madres costarricenses ($p < 0.001$). El 50% de los hijos de las madres nicaragüenses tienen un intervalo intergenésico de al menos 335 días (menos de un año) con respecto al hijo anterior versus 881 días (2,4 años) para el caso del 50% de los hijos de las madres costarricenses. Un segundo objetivo es ajustar un modelo estratificado de riesgos proporcionales de Cox del tipo $\lambda_s(t,X) = \lambda_0(t)\exp(\beta_{i_s}'X_i)$ para modelar el intervalo intergenésico, como variable de tiempo a la concepción del siguiente hijo. Al ajustar los modelos por nacionalidad de la madre, edad y edad al primer hijo se obtiene razones de riesgo de 1,3 ($p < 0.001$); 0.93 ($p < 0.001$) y 1,02 ($p > 0.05$) respectivamente. Una madre nicaragüense tiene un 30% veces más riesgo de recurrir en el siguiente embarazo con respecto a las madres costarricenses. El estudio comparativo de grupos de la población permite el conocimiento para el diseño de políticas públicas en el tema de las migraciones internacionales.

Palabras clave: Intervalo intergenésico, análisis de sobrevivencia, modelo de riesgos proporcionales estratificados de Cox, eventos recurrentes, inmigrantes nicaragüenses.

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1. INTRODUCTION

The intergenesic interval is the time lapse between birth of one child and conception of the following child in mothers with at least two children. An adequate intergenesic interval is considered to be a positive factor in the health of the mothers and their children. (Setty-Venugopal & Upadhyay, 2002; Al-Nahedh, 1999) The Pan-American Health Association (PAHO) has set a minimum of two years as an adequate intergenesic interval. An adequate interval has a positive effect on the physical and mental health of the child and a reduction in the probabilities of suffering a fetal death, premature birth, low birth weight, neonatal death, and muscular dystrophy. Adequate intervals have a positive effect on the mother as well, such as a lowered risk of maternal mortality, hemorrhaging, anemia, malnutrition, and endometritis. (CATALYST, 2003)

The factors influencing the intergenesic interval are varied. Setty-Venugopal & Upadhyay (2002) conclude that the health condition of the previous child is a determining factor for the decision of the mother to become pregnant again. Other factors associated with the intergenesic interval are the mother's personal characteristics, such as age (Setty-Venugopal & Upadhyay, 2002; Polo, Luna & Fuster, 2000; Al-Nahedh, 1999; Knodel & Hermalin, 1984; Mineau & Trussell, 1982), education (Al-Nahedh, 1999), occupation, family income, place of residence, as well as the cultural norms such as breast-feeding and puerperal abstinence, age of the first child, age of the couple (Al-Nahedh, 1999), the mother's parity or "birth order" (Al-Nahedh, 1999; Knodel & Hermalin, 1984), among others.

There are few studies in Costa Rica that include the mother's nationality as a factor influencing her reproductive practices. In a study by Chen *et al.* (2001), the authors conclude that the fertility of the Nicaraguan immigrant mothers exceeds that of the Costa Rican mothers. This study analyzes the intergenesic interval among Nicaraguan mothers in Costa Rica and the effect of related socio-demographic factors.
The study makes a comparison between Nicaraguan and Costa Rican mothers and proposes Cox's proportional stratified hazards model for modeling the intergenesic interval as a time to an event variable (conception of the following child).

The comparative study of groups in the population provides information for the design of public policies relating to international migration.

2. MATERIALS AND METHODS

2.1 Intergenesic Interval in Nicaraguan Immigrant Mothers

The database from the November 1999 National Reproductive Health Survey was used. The survey was carried out under the auspices of the University of Costa Rica, by the Centro Centroamericano de Población, and is available online at:
<http://encuestas.ccp.ucr.ac.cr/camerica/cr99.htm>. It was a *retrospective* study, since each mother was queried regarding the date of birth of the live-born children she had given birth to in the past. The database is of the *recurring* type, since the same mother may have had one or

several children. Intergenesic intervals can be defined when the mother has had at least two children.

Of all of the mothers interviewed, 76% had two or more children. Each one of these intergenesic intervals defines an *event*[3]. The time elapsed from the birth of the last child to the moment of the Survey was declared as *censure*[4], since the interval is unknown. The remaining 183 mothers with a single child had time lapses declared as censured at the time of the survey, since their intergenesic interval is unknown (Figure 1). Women without children were excluded from the survey, since they added no information insofar as they had no defined intergenesic interval. The date defined for initiating the study was January 15, 1972, the date of the oldest birth existing in the database.

Intergenesic intervals were measured as the time (in days) between the birth of one child and the time of conception of the following child, estimated on the basis of the birth of the following child, minus nine months (274 days). The study took only Nicaraguan and Costa Rican mothers into account (for purposes of comparison). The nationality question is self-declaratory (Question 108). From the date the study began through the Survey date there were 1976 intergenesic intervals, for a total of 765 mothers between 18 and 44 years of age. Eleven percent of the mothers were Nicaraguan. Women pregnant on the Survey date were excluded, since they represented less than 1% of the sample total.

The mother's identification, in the form of a code, was obtained for each intergenesic interval, as well as her nationality, age, age of the first child of the mother, and her parity. Variables such as education in each recurring event, survival of the preceding child, and so forth, were not included in the analysis since the questionnaire did not permit direct access to this information.

The calculations were carried out with the STATA package (Release 8, StataCorp, 2005). The program was run on a 2.80 GHz Pentium PC.

2.2 Cox's proportional stratified hazards model

In order to model the intergenesic interval as a time to an event variable (conception of the next child), a Cox proportional hazards model was used, which is defined as:

$$\lambda(t, X) = \lambda_0(t)\exp(\beta_i ' X_i),$$

where X_i is the covariant vector for each mother (i). This is a *semi-parametric* model due to the fact that $\exp(\beta_i ' X_i)$ is the parametric and independent part of time *t*, known as the *hazard score*, and β_i is the vector of the regression parameters. The $\lambda_0(t)$ part is non-parametric, since it depends on time and is known as the *basic hazard function*. It is called a *proportional hazard model* because the hazard quotient for two mothers with the same covariant vector is constant over time.

3 An *event* is defined as an incident of interest that may occur to an individual. In this study, conception is the event of interest.
4 *Censure* is defined as ignorance of the exact time at which the event occurred. In this study, upon completion of the study there are women that are still not pregnant, so that the time of conception is unknown, so that it is defined as censure.

During the study period, there may be recurrent events for the same mother (multiple conceptions). There are variables that change over time that influence the time to an event for each new conception. Mahe & Chevret (2001), Wang & Chang (1999), and Therneau (1997) suggest considering *Cox's extended model* to reduce errors that may be incurred when dealing with a basic Cox proportional hazard model. The present study includes only a single variable that changes over time (parity). Furthermore, a situation may arise where the variable that changes over time (parity) is correlated with the time of exposure, as is the case in our study (intraclass correlation). For this paper, each parity interval is considered as a *stratum*. The mothers with just a single child (parity=1) have differential characteristics from the mothers that have two children (parity=2), and so forth. The authors call this *maternal exhaustion* (PAHO, 1998). This study is stratified on the basis of the parity variable. Cox's proportional stratified hazard model was used to model the time to pregnancy of the next child defined as:

$$\lambda_s(t, X) = \lambda_0(t)\exp(\beta_{i_s}' X_i)$$

Where x_1 is the mother's nationality, categorized as 0 and 1 (1 = Nicaraguan mothers), x_2 is the mother's age (in years), and x_3 is the age of the mother at the birth of the first child. This model allows us to obtain an estimate in the presence of a stratifying variable on which it is possible to obtain survival functions for each study stratum.

Figure 2 provides an historic representation of a recurrent event model with the respective exposure times by strata, where the arrows represent the transition to a recurrent event, where it takes into account the proportional size of the time factor between events.

Interactions were not included in the model since the variables X_i are all fixed in time and due to the lack of theoretical support for including the interaction effect.

Robust estimators were obtained to minimize the intraclass correlation that could appear. Two models were adjusted, one which included the covariants (Model 1) and an alternate model (Model 2), which excluded the non-significant variables according to Wald's test.

3. RESULTS

3.1 Univariate Analysis

Table 1 provides the descriptive statistics for the variables used in the analysis. The mean age for the mothers in the study was 32 years. On the average, the mothers in the study had their first child at age 21 years. The youngest mother had her first child at age 13 years and the oldest at age 37 years. The mean number of children (parity) is 2.7. Fifty percent of the mothers in the study had one or two children. The maximum number of children reported is 14. The mean intergenesic interval for the mothers is 1118 days (3.06 years). One-half of the mothers waited 2.66 years or less before having their next child, which makes one reflect that in general the mothers are meeting the two-year norm recommended for intergenesic intervals by PAHO.

3.2 Bivariate Analysis

Table 2 provides the descriptive statistics for the variables used in the analysis, making a comparison between the Costa Rican and Nicaraguan mothers. On the average, the Nicaraguan mothers are younger than the Costa Rican mothers (p = 0,06). The mean ages are 30.6 and 32.2 respectively. The Nicaraguan mothers enter reproductive life earlier than the Costa Rican mothers (19.5 and 20.9). This difference is significant ($p < 0.001$). The mean number of children is higher among the Nicaraguan mothers than the Costa Rican mothers (almost one child). The intergenesic interval among the Nicaraguan mothers (2.3 years) is lower than that among the Costa Rican mothers (3.2 years). To summarize, the Nicaraguan mothers in Costa Rica are younger, enter reproductive life at a younger age, have more children, and wait less time for their next child with respect to Costa Rican mothers. These aspects make the study of Nicaraguan mothers a topic of interest for fertility and reproductive health concerns in Costa Rica.

3.3 Survival Analysis

Figure 3(a) presents the survival (time to event) curves for the Nicaraguan and Costa Rican mothers. The difference between the survival curves is significant at 10% using the log-rank test ($p < 0.001$). Fifty percent of the children born to Nicaraguan mothers have an intergenesic interval of at least 335 days (less than one year) with regards to the previous child versus 881 days (2.4 years) for the case of 50% of the children of the Costa Rican mothers. Other tests, such as Wilcoxon, Peto & Peto, and Tarone & Ware provided similar results.

To compare the effect of age on the intergenesic interval in the children of these mothers, the sample was divided into two groups: mothers aged above or equal to the median age (32 years) and aged less than the median age. Figure 3(b) presents the survival curves for the mothers with ages above or equal to 32 years and those below that age. The difference in the survival curves is significant at 10% using the log-rank test ($p < 0.001$). Fifty percent of the children of the mothers over 32 years of age have an intergenesic interval of at least 638 days (1.7 years) with regard to the previous child versus 1126 days (3 years) in the case of the 50% of the children of the younger mothers (less than 32 years of age). Other tests, such as Wilcoxon, Peto & Peto, and Tarone & Ware provided similar results. This can be interpreted as a *generational cohort effect*, this means that the intergenesic intervals have increased with the passage of time and the younger mothers have benefited from the family planning programs and as a result have longer intervals.

The survival analysis for the age of the first child also shows the *generational cohort effect*, but is not presented in this study.

3.4 Cox's proportional stratified hazard models.

Table 3 provides the hazard ratios for the two proposed Cox proportional stratified hazard models.

There is a 30% greater hazard for a Nicaraguan mother to recur in the following pregnancy as against the Costa Rican mothers. This hazard ratio is significant; the 95% confidence interval does not include 1. Age has a *protective* effect on recurrence of the following pregnancy. Unit increases in age decrease the hazard of recurring in the following pregnancy by 7%. Age is a significant factor. Unit increments in the age at first birth make for a minimal increase in the hazard of recurring in the following pregnancy (by 2%).

The reduced model eliminated the age at first birth variable and the results can be seen in the second part of Table 3. There was practically no change to the hazard ratios for the nationality and age variables, with the advantage that the variables in this model are significant.

4. DISCUSSION

The results from this study show that intergenesic intervals among mothers are not a random process, but rather they are explained by several socio-demographic factors. Two significant factors were determined (nationality and age) that lead to the differences occurring in intergenesic intervals between population groups.

To what point are these results valid and reliable? One element that could reduce the validity arises from the problem of using recurrent data, where it is difficult to measure the covariants for each recurrent event in the time interval. In retrospective studies, the number of covariants for each recurrent event is limited, since the models have few explanatory variables associated with time. A second element is that there are variables that change over time that explain the intergenesic interval, whose measurement is difficult, such as, for example, education and income. Ideally, for each recurrent event, covariants would be available; however, they are obtained only for one time point (the survey date).

Notwithstanding, this study is consistent with the literature available. This study complements the results provided by Chen *et al*. (2001), which affirm that there are differential fertility patterns for Nicaraguan and Costa Rican mothers. Furthermore, this study is consistent with that of Al-Nahedh (1999), who found a negative relation between age and intergenesic intervals.

One remaining question is: Do Nicaraguan mothers in Nicaragua have intergenesic intervals similar to those of the Nicaraguan mothers in Costa Rica? There is a geographic determinant here, since the Nicaraguan and Costa Rican mothers in this study live on Costa Rican soil.

This study contributes by presenting evidence that the intergenesic interval may be explained by a series of covariants based on Cox proportional stratified hazard models. It complements traditional statistical analyses and strengthens the decision-making process with regard to international migrations.

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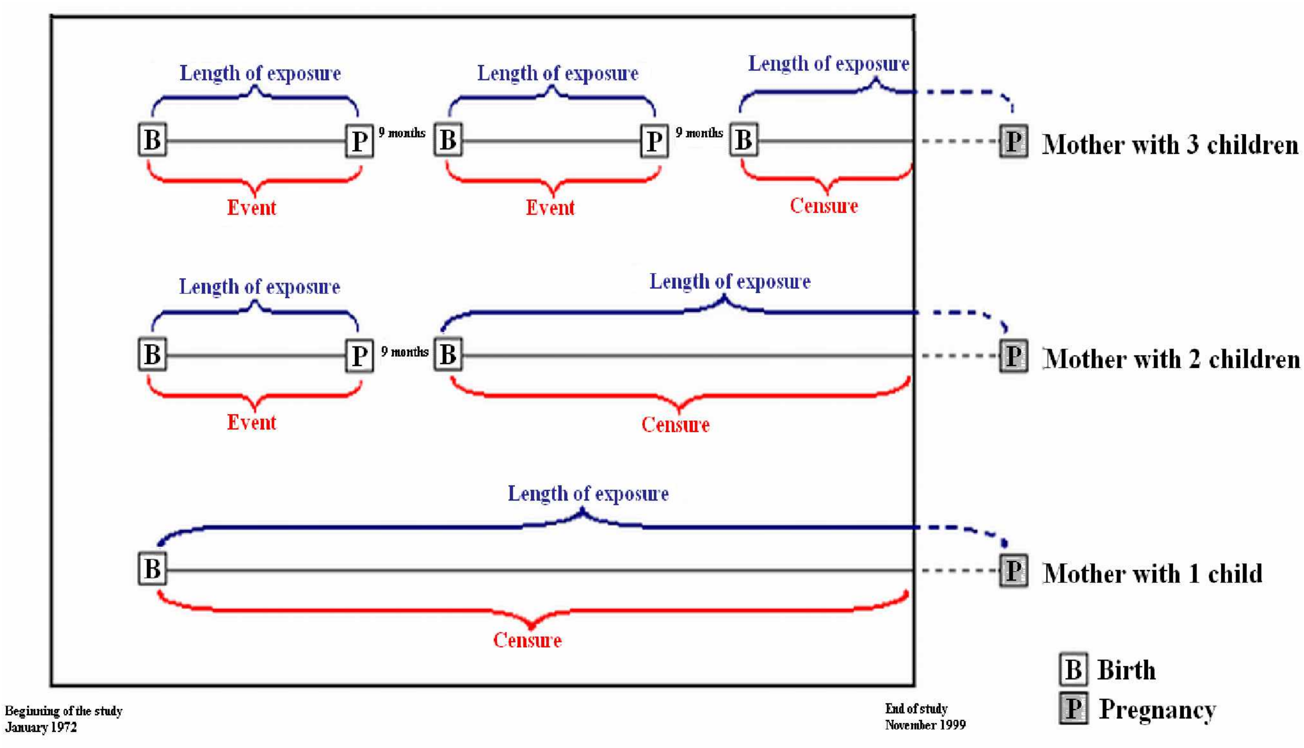
Figure 1: Possible situation of three mothers in this study. Costa Rica, 1999.



For mothers with one child, the time runs from the birth of her child to the end of study date and is censured.
For mothers with two children, there is one time and one event (intergenesic interval after her first child). The second time is censured, and runs from the birth of her second child until the end of study date.
For mothers with three children, there are two times and two events (intergenesic intervals after the first two children). The third time is censured and runs from the birth of the third child to the end of study date.

Figure 2: Recurrent event scheme with strata.

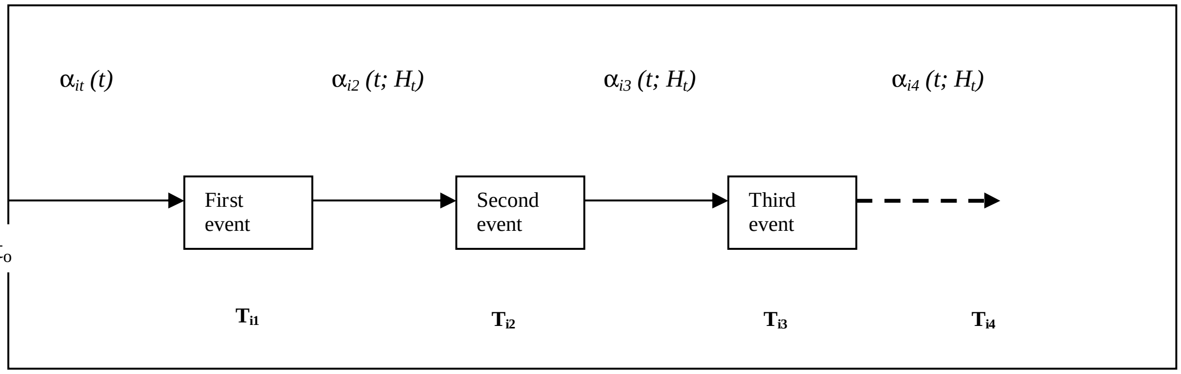


Figure 3: Estimated survival (time to event) functions for Nicaraguan and Costa Rican mothers (left) and for mothers aged less than and more than 32 years (median age) (right). Costa Rica, 1999.

3(a) 3(b)

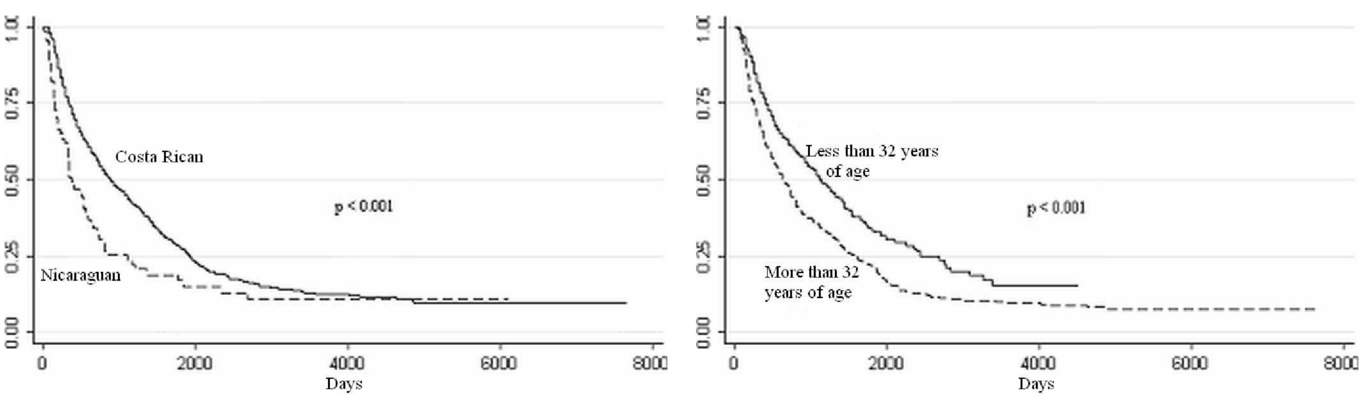


Table 1. Descriptive statistics for the variables used in the analysis. Costa Rica, 1999.

Socio-demographic Variables	Mean	Median	St. Dev.	Minimum	Maximum
Age (in years)	32.0	32.0	7.1	18	44
Age at first birth (in years)	20.8	20.0	4.0	13	37
Parity	2.7	2.0	1.6	1	14
Intergenesic Interval (in days)[1]	1118.2	973.8	733.2	30	4069

n=765 [1] Mothers with two or more children (n=575)

Table 2: Descriptive statistics for the variables used in the analysis by nationality of the mother. Costa Rica, 1999.

	Costa Rican mothers (n=681)		Nicaraguan mothers (n=84)		
Socio-demographic Variables	Mean	St. Dev.	Mean	St. Dev.	t (p>|z|)[2]
Age (in years)	32.2	7.1	30.6	7.3	1.9 (0.06)
Age at first birth (in years)	20.9	4.0	19.5	3.5	3.2 (0.00)
Parity	2.6	1.5	3.3	2.3	-3.6 (0.00)
Intergenesic Interval (in days)[1]	1157.4	746.4	831.4	553.1	3.50 (0.00)

n=765
[1] Mothers with two or more children: Costa Ricans 506, Nicaraguans 69.
[2] The Mann-Whitney non-parametric test was significant at 10% for all variables.

Table 3: Hazard ratios for the two proposed Cox proportional stratified hazard models for predicting intergenesic intervals. Costa Rica, 1999.

Stratified by order

	Model 1			Model 2		
Socio-demographic variables	Hazard Ratio	z	95% Interval	Hazard Ratio	z	95% Interval
Nationality [1]	1.30	2.84*	1.08 to 1.56	1.29	2.70*	1.07 to 1.56
Age	0.93	-6.40*	0.91 to 0.95	0.94	-7.65*	0.93 to 0.96
Age at first birth	1.02	1.62	1.00 to 1.05			
Wald Chi	77.24*			73.34*		
Log pseudo-likelihood	-5185.13			-5186.5		

[1] 0=Costa Rican mother, 1=Nicaraguan mothers
* Significant at 10%. n = 763, Intergenesic Intervals = 1976