Infant feeding patterns in Mexico were analyzed using data from the 1988 National Nutrition Survey. The prevalence of breast-feeding among infants declined from 86% at birth to approximately 40% after three months of age. The hazard rate of terminating breast-feeding increased by 38% at the national level and by 87% in the northern region with each increment in household living conditions, decreased 50% in rural municipalities in the south and decreased by 20% in all regions for each month that the introduction of other milk was delayed. The rate of other milk introduction increased by between 16% and 20% at the national level and within the central and southern regions with each household living condition increment that decreased by between 20 to 30% within indigenous or rural. Finally, the probability of solid food introduction increased by between 8 and 15% with each household living condition increment.

Key words: breast feeding; weaning; milk substitutes; infant; nutrition surveys; Mexico

ABSTRACT


RESUMEN

De acuerdo con la Encuesta Nacional de Nutrición de 1988 se analizaron los patrones de alimentación de niños mexicanos, encontrando que la prevalencia de lactancia materna disminuyó de un 86% al nacer a un 40% a los tres meses de vida. El destete aumentó en un 38% a nivel nacional y en 87% en el región norte con el mejoramiento de las condiciones de vivienda, cayó a un 50% en los municipios rurales de la zona sur, y en todas las regiones aumentó en un 20% por cada mes que se demoró la introducción de otras leches. La introducción de otras leches aumentó entre un 16% y un 20% dependiendo de las condiciones de vivienda a nivel nacional y en los regiones centro y sur, aunque fue menor en los municipios rurales y en la población indígena: 20% y 30%. Finalmente, la probabilidad de introducir alimentos sólidos aumentó entre un 8% y un 15% dependiendo de las condiciones de vida.

Palabras clave: lactancia materna; destete; sustitutos de la leche materna; lactantes; encuestas nutricionales; México


NEAT FEEDING PATTERNS are important determinants of childhood health and survival. The methods used to introduce solid foods as well as the timing of the introduction of supplemental foods and liquids greatly determine the nutritional status of children. Patterns of infections diseases, and infant mortality. Research in the last decade has documented that, worldwide, the proportion of infants ever breast-fed as well as the length of breast-feeding du-
rations have remained the same or have actually in-
creased. However, studies conducted in Mexico have repeatedly found that between 15 to 23% of all infants surveyed never were breast-fed; that approximately half of all breast-fed children were not breast-fed for more than six months, and that many children also received supplemental foods and liquids within two to three months after birth. These are some of the lowest rates of breast-feeding recorded in the developing world.

Efforts to understand what factors are responsible for such patterns in different countries have found that women are less likely to initiate breast-feeding and breast-feed for a shorter period of time in urban areas, are of high socio-economic status, and are employed in the work force. In Mexico, the mother’s perception of insufficient milk production also may influence infant feeding patterns.

In this article, we present results of a descriptive and analytical study of infant feeding patterns in Mexico using data collected in 1988 by the Secretary of Health as part of the Nutrition Survey of the National Nutrition Survey (SOH). It attempts to update and more adequately characterize infant feeding patterns within Mexico by first presenting the break-
down of different feeding modes by various socio-economic, cultural, and demographic factors. Then, multivariate hazard models were fitted to adjust for time survival dura-
tions for the onset of weaning and for the introduction of milks and solids.

DESIGN AND METHODOLOGY OF THE SURVEY

In 1988, the General Epidemiology Unit of the Secre-
tary of Health conducted the National Nutrition Survey (SOH) as part of the larger National System of Health Surveys. The studied sample is part of the master sam-
ping frame of dwelling units developed in 1985 and drawn from a data base provided by the 1980 National Census of Population and Housing. The sample base and geographic coverage of the survey were at a regional level. A multi-stage, stratified sampling design was used in the survey with the probability of being selected for the first stage proportional to the size of the censu-
sity; while, a systematic sampling scheme with equal probability of being selected was used for the third stage. Each region is considered as a domain within the study in such a way that the results are representative of the regional level; while, the sum of the results from the four regions provides information at the national level.

The regions are structured in the following manner: the northern region is made up of the states of Baja California, Baja California Sur, Chihuahua, Coahuila, Durango, Nuevo León, Sinaloa, and Tamaulipas. The cen-
tral region includes Aguascalientes, Colima, Guanajuato, Jalisco, Mexico (except for the municipalities surrounding the District Federal), Michoacán, Morelos, Nayarit, Querétaro, San Luis Potosí, Sinaloa, and Zacatecas. The southern region consists of the states of Campeche, Chiapas, Guerrero, Hidalgo, Oaxaca, Puebla, Quintana Roo, Tlaxcala, Tlaxcala, Veracruz, and Yucatán.

The last region, called the Metropolitan Zone, consists of the District Federal and the surrounding municipalities.

The universe of this study consists of children less than five years of age and women between 12 and 49 years of age who lived in the sampled houses. Information was obtained on 7,426 children and 19,278 women from a total of 13,236 surveyed households. Families were classified as living in a rural municipality if more than half of the population of the l/ed in communities with fewer than 15,000 inhabitants at the time they were classified as living in an urban municipality when more than half of the population lived in communities with greater than 15,000 inhabitants. Municipalities in which more than 40% of the inhabitants spoke an indigenous language were classified as indigenous.

The ENS obtained information about the number of household members and their education levels. The types of household flooring, water supply, drainage, toilet, and the manner of waste disposal were recorded for each household. Finally, household members were asked to enumerate the number and types of household ap-
piances they possessed.

 Mothers were asked to describe when children less than one year of age were completely weaned and when they began to receive other milks and solid foods. The current feeding status was noted when any one of these transitions had not yet occurred at the time of the inter-
view. It was not possible to identify children who were...
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exclusively breast-fed since the survey did not investi-
gate the children’s consumption of non-nutrient liquids. Children who were breast-fed but were not yet receiving other milks and solid foods were classified as fully breast-fed regardless of whether they were receiving non-
nutrient liquids.

More detailed information regarding quality control procedures for the data collection and data entry phases of the survey may be found in the articles by Sepúlveda et al.1 and Rivera et al.2

ANALYSIS OF DATA

All children under the age of one year were selected for the subsequent analysis. The percentage of infants who were never breast-fed was obtained, and subsequently the percentages of children who were completely weaned or currently still being breast-fed were calculated by month of age. The percentage of infants who were intro-
duced to other milks and solids was also calculated for each month. All percentages were unweighted.

Feeding patterns of infants less than four months of age were then analyzed by classifying them in the following manner: a) children who never received breast milk; b) children who received a mixed diet of breast milk and supplemental foods; c) children who received breast milk for less than four months; and d) children who were fully breast-fed during the first four months.

The resulting percentages were analyzed at the natio-
nal and regional levels by sex of the child, household conditions, rural or urban status, indigenous or non-
indigenous status and educational level of the mother. Tertiles were constructed for household conditions by performing a factor analysis of household characte-
ristics using the factor program in SAS.3 Household characteristics included the type of flooring, source of household water, type of drainage, and possession of appliances (radio, television, refrigerator, telephone, and car). The combined assigned score derived from the factor analysis for the entire sample of households were then divided into tertiles. A maternal education variable was created by classifying the mother’s edu-
cation into three levels: no education, a maximum of a primary school, and greater than primary school.

HAZARD ANALYSIS

Three separate hazard analyses of infant feeding pat-
terns were conducted for all children under one year of age. First, models were adjusted to durations of time until the cessation of breast-feeding among breast-fed children. Children who were not weaned at the time of the interview were recorded as right censored. Nonbreast-
fed children were excluded from this analysis to avoid biasing the analysis. Models were also adjusted for time intervals until introduction of other milks (second ana-
lysis) and introduction of solid foods (third analysis). Children who still were not receiving other milks in the second analysis or solid foods in the third analysis were recorded as right censored.

An exponential model, specifying the probability of an event as being time independent, and a Weibull model, specifying a time-dependent probability, were first fit to intervals in the three separate analyses at the national level (sample sizes, 1136-1349 children) and within each of the four regions (sample sizes 277-347 children). Each of the three analyses described above included the following covariates: urban (reference) or rural status; indigenous or nonindigenous (reference) status; maternal education (low=1, med=2, high=3); the household living condition (low=1, med=2, high=3); and, month other milks were introduced. Dummy variables for the northern, central, and southern regions were included in models at the national level, using the Metropolitan Zone out as a reference category. The LIFEREG SAS4 program was used to adjust all models to each durations. Conventional likelihood methods were used to compare the fit of these models. Odds ratios (OR) were calculated for each variable included in the best fitting model by taking the exponential of the variable in coefficient.

RESULTS

In the analysis 1518 children under one year of age were included. Approximately 52% of these child-
ren were male, and 48% were female. Fifteen percent of the children’s mothers had no formal education, 56% had only completed a primary school, and the remaining 29% had a greater than primary school education.
At the national level, the percentage of children who were breast-fed decreases rapidly from a prevalence of 86% at birth to a prevalence of 48% by three months and, thereafter, levels off between 30 and 40% (figure 1). The percentage of children who were fully breast-fed is much lower at one month of age and declines to zero by nine months (figure 1).

At the national level, approximately 13.8% of the children less than four months of age at the national level never received maternal milk and only 34.6% were breast-fed for less than four months (figure 1). The majority of the remaining 60% of the children who received maternal milk for at least four months consumed other foods besides maternal milk during this period, while only 11.5% of the children were fully breast-fed.

Similar infant feeding patterns were found between tertiles of living conditions and between predominantly indigenous and non-indigenous municipalities (figure 2). A lower percentage of children who were fully breast-fed and a higher percentage of children who were never breast-fed were found within the middle and upper tertile of living conditions, and non-indigenous municipalities. However, the differences in the percentage of infants in the mixed feeding group between the indigenous and non-indigenous communities is much greater than the differences seen between tertiles of household living conditions (figure 2). At the national level, the proportion of children who are fully breast-fed is low in the high and median household living condition tertiles (3.5% and 5.8%) but is approximately 20.9% in the lowest tertile.

FIGURE 1. Percentage of children less than one year of age who are breast-fed and fully breast-fed by age

FIGURE 2. Infant feeding patterns during the first four months of life at the national level, by household living conditions and by type of municipality

Hazard analysis

1. Termination of breast-feeding

A Weibull model with an increasing function provided the best fit to time intervals until the end of breast-feeding at the national level (figure 3) and for intervals within the northern and central regions (not shown). The northern region had the most rapidly increasing function with time. An exponential model provided the best fit for durations within the Distrito Federal and in the southern region. The selection of different models for the separate regions indicates that children are fully weaned much more rapidly in the north relative to other regions of Mexico.

The variable indicating the timing of the first introduction of other milks was important for all models explaining the termination of breast-feeding at the national and regional levels. The reductions in the rate of terminating breast-feeding for each month that the introduction of other milks is delayed was 20% at the national level (OR=0.8) and between 18% and 25% (OR=0.75-0.82) in the different regions (table 1).
The covariate capturing household living conditions was also initially found to explain changes in this rate at the national and regional levels. However, the impact of this covariate was eliminated with the inclusion of the timing of the introduction of other milks in the central and southern regions and in the Metropolitan Zone. This finding indicates that the impact of household living conditions (a proxy of socio-economic status) on the hazard of terminating breast-feeding is mediated by the introduction of other milks in these regions. In contrast, household living conditions remained significant in the northern region and at the national level after adjusting for the introduction of other milks. The rate for terminating breast-feeding increases by 38% at the national level for each increment in the household's category of living conditions and by 87% in the north (table I).

The dummy variable for the northern region was also significant at the national level. A child living in the northern region has a 70% greater rate compared to a child in the Metropolitan Zone (table I).

The mother's education level is important in models adjusted to durations in the southern region (table I). Each increment in the education category of the mother increases the rate of complete weaning by 12%. Finally, the urban-rural variable was also important in the model for the southern regions (table I). The rate of complete weaning decreases 50% among rural children in the southern region.

2. Introduction of other milks

An exponential model provided the best fit to durations until the introduction of other milks at the national and regional levels indicating that the probability that other milks will be introduced is unchanging through time (figure 3). At the national level, the best-fitting model included the covariates indicating whether the municipality was classified as urban or rural and indigenous or non-indigenous, the household living conditions covariate and, finally, the southern region dummy variable (table II). If a child was from a municipality classified as indigenous or rural, the rate of introduction of other types of milk is reduced by 30% and 19%, respectively, relative to non-indigenous or urban municipalities. Similarly, this rate is decreased by approximately 16% in the southern region relative to the Metropolitan Zone. In contrast, the rate of other milks being introduced is increased by 16% and 10% with each increment in the household living conditions and the mother's education level, respectively. The covariate capturing household living conditions is significant for models in the central and southern regions (table II). For these two regions, the rate of introducing other milks to the infant increases between 13 and 20% with each increment in the household living conditions tertile. The urban-rural variable by itself was important in models fit to durations in the Metropolitan Zone and was also important in models for the central region when included along with the household living conditions variable. The rate that other milks would be introduced to a child decreases 26% in rural areas relative to urban areas in the central region and 36% in rural areas surrounding the Metropolitan Zone. No covariates were found to significantly improve the fit of the model adjusted to durations in the northern region.

3. Introduction of solid foods

A Weibull model with a decreasing function provided the best fit to time intervals until the introduction of solid foods at the national level (figure 3). The high rate of solid food introduction after birth and its subsequent rapid decline to low levels after three months suggests that solid foods were introduced rapidly to a sub-population of children but that this introduction was delayed among...
the remaining children. Three variables (household living conditions and the dummy variables for the central and southern regions) significantly improved the model’s fit when included together (table III). The rate that solid

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### TABLE I

Models adjusted to durations of time until the introduction of other milks among children in the National Nutrition Survey, Mexico 1988

<table>
<thead>
<tr>
<th>Level</th>
<th>N</th>
<th>Covariate</th>
<th>Odds ratio*</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>National</td>
<td>1136</td>
<td>Household living conditions</td>
<td>1.38 (1.32 to 1.43)</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Northern region</td>
<td>1.70 (1.6 to 1.8)</td>
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<tr>
<td></td>
<td></td>
<td>Household living conditions</td>
<td>1.87 (1.75 to 1.98)</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Delay in the introduction of other milks</td>
<td>0.80 (0.77 to 0.82)</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Northern region</td>
<td>1.82 (0.78 to 0.85)</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Household living conditions</td>
<td>1.76 (0.71 to 0.8)</td>
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<tr>
<td></td>
<td></td>
<td>Delay in the introduction of other milks</td>
<td>0.75 (0.71 to 0.78)</td>
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<tr>
<td></td>
<td></td>
<td>Mother's level of education</td>
<td>1.12 (1.07 to 1.16)</td>
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<tr>
<td></td>
<td></td>
<td>Rural municipality</td>
<td>0.90 (0.25 to 0.74)</td>
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<tr>
<td>Southern region</td>
<td>287</td>
<td>Household living conditions</td>
<td>2.85 (1.75 to 1.98)</td>
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<tr>
<td></td>
<td></td>
<td>Northern region</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Household living conditions</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Delay in the introduction of other milks</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Southern region</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Household living conditions</td>
<td></td>
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<td></td>
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<td>Northern region</td>
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<td></td>
<td></td>
<td>Household living conditions</td>
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<tr>
<td></td>
<td></td>
<td>Delay in the introduction of other milks</td>
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<td></td>
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<td>Southern region</td>
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<tr>
<td></td>
<td></td>
<td>Household living conditions</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rural municipality</td>
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<td></td>
</tr>
</tbody>
</table>

* Number of children in sample
Number in parentheses, 95% confidence interval
Urban municipality is reference category

### TABLE II

Models adjusted to durations of time until the introduction of other milks among children in the National Nutrition Survey, Mexico 1988

<table>
<thead>
<tr>
<th>Level</th>
<th>N</th>
<th>Covariate</th>
<th>Odds ratio*</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>National</td>
<td>1349</td>
<td>Mother's level of education</td>
<td>1.10 (1.08 to 1.11)</td>
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<td></td>
<td></td>
<td>Indigenous community</td>
<td>0.70 (0.56 to 0.85)</td>
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<tr>
<td></td>
<td></td>
<td>Rural municipality</td>
<td>0.81 (0.74 to 0.85)</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Household living conditions</td>
<td>1.16 (1.12 to 1.19)</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Southern region</td>
<td>0.84 (0.77 to 0.91)</td>
<td>0.01</td>
</tr>
<tr>
<td>Northern region</td>
<td>347</td>
<td>Household living conditions</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Northern region</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Household living conditions</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rural municipality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central region</td>
<td>298</td>
<td>Household living conditions</td>
<td>0.74 (0.61 to 0.86)</td>
<td>0.01</td>
</tr>
<tr>
<td>Southern region</td>
<td>326</td>
<td>Indigenous community</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rural municipality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distrito Federal</td>
<td>334</td>
<td>Household living conditions</td>
<td>1.13 (1.07 to 1.18)</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rural municipality</td>
<td>0.64 (0.43 to 0.84)</td>
<td>0.04</td>
</tr>
</tbody>
</table>

* Number of children in sample
Number in parentheses, 95% confidence interval
Non-indigenous community is reference category
Urban municipality is reference category

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foods would be introduced increased by 8% for each increment in the family’s household conditions. This rate decreased approximately 13% for infants living in the central and southern regions relative to infants living in the Metropolitan Zone (table III).

A similar pattern of solid food introduction was found within the four different regions (not shown). The covariate for the families household living conditions significantly improved the fit of models in the central and southern regions and in the Metropolitan Zone, although the OR for the Metropolitan Zone was not statistically significant (p>0.05, table III). For these three regions, the increment of the socio-economic status of the infant’s family increases the rate that solid foods will be introduced by between 7% and 15% with the lowest increases occurring in the central region and the highest occurring in the southern region. The education level of the mother significantly improved the fit of the model in the northern and southern regions. With each increment in education level, the rate that solid foods would be introduced increased by between 3.5% and 6%.

**DISCUSSION**

This study is one of several which have begun to analyze temporal durations of breast-feeding using multivariate hazards models and may be the first to apply such an analysis to intervals until the introduction of other milks and solid foods. It is important to note that our data was collected in 1988 and that most likely changes in infant breast-feeding patterns have occurred since then, due to the initiation of various government programs concerned with the promotion of breast-feeding. The results document that, at the time of the survey, the percentages of children ever-breast-fed, fully breast-fed, and partially breast-fed, reported by age were well below the World Health Organization (WHO) recommendations and were only slightly different than those reported in the 1986 National Health Survey or those reported by studies from the 1980s. However, these findings contrast with the 1987 Mexican Demographic and Health Survey which found that 23% of all children were never breast-fed while 50% of children were still being breast-fed at six months. Factors responsible for these differences need to be investigated further.

The inference of trends in infant feeding patterns from data collected retrospectively may be subject to recall bias. An additional concern in this study is the impact of large sample sizes on findings of significance. This potential bias is the most important in the analysis of the introduction of solid foods where a number of variables were just barely significant.

The differences found between socio-economic groups and geographic regions in terms of the percentages of children who were never breast-fed is similar to the differences found by Gomez Dantes et al.
Similarly, the relationship between urban-rural classification of the municipalities and feeding patterns agrees with other studies from Mexico. The differences found between the living conditions territories and indigenous/non-indigenous communities may reflect the adoption of a "modernized" lifestyle among more affluent, latino households, which has detrimental effects on breast-feeding.

The increased rate of terminating breast-feeding found at the national level in the hazard analysis is due primarily to the large increases in this probability in the north. In the remaining regions the rate is much lower and largely unchanged through time. These differences suggest that there are basically two patterns of breast-feeding cessation: one in the north, and one for the rest of the country.

The association found between the delay in the introduction of other milks and the prolongation of breast-feeding may be related to the decline in maternal milk production produced when the child receives other milks and thus suckles less. This decreased milk production may lead the mother to want to introduce more milk and, thus, to further decreases in milk production, a cycle which finally ends with the early discontinuation of breast-feeding. This process is delayed with the delayed introduction of other types of milk. The introduction of solid foods, in contrast, appears to have little effect on the termination of breast-feeding as indicated by the lack of importance of this variable in these models.

The elimination of the household living conditions variable from three of the regional models by the inclusion of the other milks covariate suggests that lactation duration is determined largely by a household's ability to supplement the child's diet with other milk. Households within higher living conditions can afford to introduce other milks to the infant; while lower conditions provide supplementation. This leads to the early discontinuation of breast-feeding among the former and more prolonged breast-feeding among the latter. The association may also reflect a more general life style which may involve the mother's need to work or her desire to be free of the demands of breast-feeding. The reduction in breast-feeding and the introduction of other milks would then be a reflection of that lifestyle.

The continued importance of the household living conditions in the north suggests that there may be other determinants mediating the impact of the household's economic status. Living in rural municipalities in the northern region is also not associated with prolonged breast-feeding. This pattern contrasts with rural areas of the southern region where children are breast-fed for a longer period than children living in urban areas; a finding similar to studies in Mexico and other countries.

The temporally uniform pattern of introducing other milks, their early introduction in the Metropolitan Zone, and their late introduction in the south contrasts with patterns of breast-feeding cessation. The lack of importance of the household living conditions variable in the north and in the Metropolitan Zone may reflect that the provision of these other milks is not so dependent on household income as it is in less affluent areas. The delay in the introduction of other milks among households located in a rural or indigenous areas reflects the tendency for such households to rely more strictly on maternal breast milk.

The timing of the introduction of solid foods appears to be somewhat uniform throughout Mexico as indicated by the modest impact of the different covariates. However, an exploration of other models may be necessary for this interval, since the selected Weibull model may not capture the more complex distributions of time intervals involved in the introduction of solid foods.

These findings emphasize the continuing need for health education programs in Mexico which promote both breast-feeding of all children and full breast-feeding of children less than four months of age. The northern region should be specifically targeted by such programs given the unique breast-feeding patterns encountered there. It is also important that programs which freely distribute formula be eliminated. These initiatives would greatly reduce the tendency to prematurely terminate breast-feeding in Mexico.
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