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# Breastfeeding and Postpartum Amenorrhea in Rural Guatemala

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**Abstract**

The association between breastfeeding patterns and resumption of postpartum menstruation was examined in rural Guatemalan women from the INCAP longitudinal study (1969-1977). It was distinguished among women who experienced infant mortality before menses resumed, women who weaned before menses resumed, and women who had return of menses while still breastfeeding. Weaning and infant mortality before menses resumes are significant risk factors for resumption of postpartum menstruation. Among those women whose menses resumed while still nursing or who remained amenorrheic and nursing at lose to follow-up or the end of the study, low number of nursing bouts per 24-hr day and the early introduction of supplements to the child were significant risk factors for the return of postpartum menstruation.

**Resumen**

La asociación entre los patrones de lactancia y el retorno de la menstruación de posparto es estudiada en mujeres rurales de Guatemala a partir del estudio longitudinal INCAP (1969-1977). En el estudio se distinguen entre mujeres que experimentaron la muerte de un infante antes del regreso de la menstruación, mujeres que quitaron la leche materna a sus hijos antes del regreso de la menstruación y mujeres que menstruaron mientras estaban lactando a sus hijos. Se encontró que el destete y mortalidad del infantil antes de la menstruación son factores de riesgo para el retorno de la menstruación. También se encontró que el bajo número de episodios de lactancia por día y una introducción temprana de alimentos sólidos en la dieta del infante son factores de riesgo significativos para el retorno de la menstruación de posparto.

**Key words:** INCAP, Amenorrhea, Breastfeeding

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## INTRODUCTION

Studies from many parts of the world consistently demonstrate that breastfeeding is associated with delayed return of menstrual cycles and ovulation, reduced fecundability and long birth intervals. Reviewing empirical evidence accumulated through the mid-1970's, van Ginneken (1974), Santow (1978), Corsini (1979), and Bongaarts and Potter (1983) showed that, at least at the aggregate level, when regressing average durations of postpartum amenorrhea on average durations of breastfeeding, the two are significantly and positively related.

Demographic research in this area has been strongly influenced by the work of Jean-Pierre Habicht and colleagues (1985) (we refer to this as the Habicht model in the rest of the paper). Their article was one of the first to question the essentially correlational approach of previous investigators. They pointed out that it is incorrect to use the total duration of breastfeeding as an explanatory variable when, in most developing country settings, amenorrhea typically ends well before breastfeeding is terminated. Thus simply knowing that the duration of breastfeeding is highly correlated with the duration of postpartum amenorrhea reveals little about the underlying causal relationship between the two (Habicht et al., 1985:220). This is the case whether or not aggregate or individual level data is used in the regression analysis.

Santow (1987) also expressed skepticism about the usefulness of correlational approaches. She went on to correctly point out a fallacy in the assumption that the relationship between breastfeeding and postpartum amenorrhea is unidirectional, that is, that breastfeeding affects amenorrhea, but amenorrhea does not affect breastfeeding. She pointed to cases where some women may stop nursing soon after their menses returns, while others may stop breastfeeding soon after they recognize they are again pregnant following a previous birth. In these situations the duration of breastfeeding is a function of the duration of postpartum amenorrhea, not the reverse (Santow, 1987:149).

Jones (1989), using prospectively collected information on nursing behavior and resumption of postpartum menstruation from a longitudinal study in Indonesia (the NGAGLIK study), presented empirical evidence for the causal nature of the relationship between breastfeeding duration and resumption of postpartum menstruation. Mirroring the arguments of Habicht and Santow, the Indonesian study demonstrated the importance of knowing the timing of critical events such as infant death and weaning which can terminate breastfeeding in relation to the timing of resumption of menses.

The Habicht model represents an important milestone in demographic research for another reason as well, in that it was one of the first attempts to integrate information on breastfeeding behavior with the underlying physiology of human lactation in order to gain a greater understanding of the demographic consequences of lactation and breastfeeding. Although today the model is recognized to have certain limitations (for example, it is deterministic and not stochastic, it assumes a threshold level for a key hormone above which nursing mothers are not fecund, and it assumes incorrectly that this hormone is prolactin), it nonetheless retains many important elements of the process of return of postpartum fecundity as it is presently understood (Tay et al., 1993; 1996; McNeilly et al., 1994; Gordon et al., 1995).

One of the key elements in the Habicht model is that all the slopes from the time of discontinuation of breastfeeding to resumption of fecundity are equal (Habicht et al., 1985:217). In other words, the model assumes that the time to resumption of ovulation (or menses) once breastfeeding has been discontinued is the same no matter when during the postpartum period breastfeeding is stopped. Moreover, the statistical analysis provides an indirect estimate of 1 to 2 months for the time from discontinuation of breastfeeding to first menses. An additional feature of the model is the way it divides nursing behavior, minimally, into three categories representing full breastfeeding (unsupplemented), partial breastfeeding (when supplements are started) and none (cessation of breastfeeding) (Habicht et al., 1985:217). This represents a significant advancement over previous work in demography which usually refers to breastfeeding as an all-or-none process.

To date, however, the research by Jones (1989) in Indonesia is the only study that has been able to confirm empirically, using demographic data, certain of the important elements of the Habicht model. The purpose of this paper, therefore, is to further test the assumptions in the model and to reaffirm earlier findings from the NGAGLIK study from Indonesia regarding the causal relationships among the timing of breastfeeding events, breastfeeding behavior, and the duration of postpartum amenorrhea (Jones, 1989; 1990). These issues are explored here using appropriate life table techniques on monthly prospective breastfeeding and resumption of menses data from rural Guatemalan women who participated in the INCAP longitudinal study (Habicht and Martorell, 1993). In doing so we provide additional support for the conclusion that: (1) menses resumes in about two months in the absence of suckling, (2) that this figure holds true no matter when or for what reason during the postpartum period suckling is suspended before menses resumes (i.e., following weaning or an infant death), (3) intensive nursing practices delay the postpartum return of menstruation, and finally (4) the introduction of supplements to the child represents a significant risk factor for the early return of postpartum menstruation.

## DATA AND METHODS

The research presented here uses data from the Institute of Nutrition of Central America and Panama's (INCAP) Longitudinal Study of Nutrition and Mental Development carried out in a chronically malnourished population in four rural farming villages in Guatemala between 1968 and 1977. The original study was not designed to directly investigate the determinants of postpartum fecundity. But because of the unique nature of the data collected, that is, prospective information on breastfeeding behavior, timing of resumption of postpartum menstruation, timing of second and additional births, and maternal and child health and nutrition, in addition to information on mental development, it is possible to use the longitudinal INCAP study for this purpose. Indeed, the INCAP study stands side-by-side with only a handful of more recent but similar special studies which had as their goals, among others, the direct investigation of the relations among postpartum fecundity, breastfeeding and nutrition. These unique studies include the MATLAB study (Huffman et al., 1987), the NGAGLIK study (Ngaglik Study Team, 1978; Jones, 1989), and the more recent CEBU study (Cebu Study Team, 1992). The INCAP study has been described in detail elsewhere (Habicht and Martorell, 1993; Martorell et al., 1995), so only features relevant to the return of postpartum fecundity are presented here.

The INCAP longitudinal study began in 1969 and eventually included a sample of over 700 women who were followed prospectively by regular visits for nearly eight years. Women entered the study on the basis of their reproductive histories, that is, those who had at least one child aged less than seven years old at the initiation of the longitudinal study were included. Mothers, at pre-determined intervals, regularly provided data throughout their pregnancy and postpartum period. In the research presented here, women who had a live delivery, stillbirth, or spontaneous abortion between January 1, 1969 and February 28, 1977, and were followed up over all or a portion of this period, are included in the analysis. Under this constraint, 608 women and 1430 birth intervals were selected for study, although not all birth interval data could be used in each individual analysis because some or all of the relevant data are missing.

The duration of postpartum amenorrhea, duration of breastfeeding, and breastfeeding practices (suckling frequency in the morning, at noon, in the evening, and at night was the only quantitative measure of nursing intensity directly elicited during the INCAP study) were obtained by monitoring menstruation and lactation every two weeks for all women who were pregnant and subsequently gave birth during the longitudinal phase of the study. For women who had already given birth, but whose child was less than 7 years old at the start of the longitudinal phase of the study, the duration of lactation and amenorrhea was determined by maternal recall at the beginning of the study period (January 1969). For these mother/child pairs, if the child was still breastfeeding at the start of the study, suckling frequency data was collected prospectively during subsequent bimonthly home visits. This protocol led to incomplete data on breastfeeding practices (suckling frequency) for those children already born, less than 7 years old, and still breastfeeding when the study started; and no data on breastfeeding practices for those children less than 7 years old who were weaned or had died before the start of the study.

Breastfeeding frequency data was gathered prospectively at regularly scheduled bimonthly visits throughout the study. At these interviews mothers were asked to recall the number of nursing episodes they experienced over the previous 24-hour period. For the analysis presented here we summed the total number of nursing episodes reported from birth to return of menses, infant death or weaning which preceded menses, loss to follow-up or the end of the study, whichever occurred first. We then divided this sum by the total number of relevant observations to obtain a single measure of breastfeeding intensity which we designate as the average suckling frequency per 24-hours. This was a similar strategy to the one employed in the NGAGLIK longitudinal study referred to earlier (Jones, 1985; 1988; 1989). Breastfeeding variables calculated in this manner provide a much more credible, accurate and direct measure of the biological and behavioral effects of nursing on postpartum amenorrhea than information encapsulated in the total duration of breastfeeding. This approach is also consistent with the underlying causal relationships implied by the Habicht model (Habicht et al., 1985; Jones, 1989).

The unit of analysis or observation in this paper is woman-months of exposure to the risk of return of menses for every birth interval in the segment of a woman's reproductive history captured by the survey. A woman may contribute more than one observation to the study as a consequence of this definition.

Because the INCAP study did not collect hormonal data, the duration of postpartum anovulation cannot be detected directly. Thus, despite the fact that the duration of postpartum amenorrhea and anovulation are not perfectly correlated, we use the interval from birth to the first postpartum menstruation as a proxy for the return of postpartum fecundity, but with the following restriction: (1) an interval of less than three months must contain at least two menstrual events to be considered return of normal menstruation, (2) the number of months between a birth and the first incidence of menses beyond the third month after delivery is taken to indicate return of normal menstruation, and (3) the number of months between a birth and subsequent conception without menstruation having resumed is taken to indicate time to return of menstruation. The first two cases are considered failures while the latter is considered a censored observation in subsequent life table analysis. The first restriction was applied so as not to confuse the normal pattern of return of menstruation with spotting which frequently occurs in the first few weeks and months following a birth and often reported as menstruation. Finally, in prospective studies such as this, a women may leave the study for various reasons before it finishes or the study may end before the event of interest (in this case the resumption of postpartum menstruation) is observed. Such cases are considered to be right-censored observations and are retained throughout the analysis by the use of appropriate life table procedures.

Using life table methods, we consider three types of estimates: (1) the survival function for postpartum amenorrhea, breastfeeding, and full breastfeeding, (2) the median survival time (or median duration), and (3) the mean survival time (or mean duration), along with their standard errors. The survivorship distribution functions in this study represent the expected proportion of women who have not yet experienced postpartum menstruation, not yet weaned their children, or not yet begun to supplement their children's diet, respectively. These estimates are calculated, when appropriate, for the 1392 women in our sample who had a live birth and initiated breastfeeding, for 38 women who had a stillbirth, spontaneous abortion or who had a live birth but did not breastfeed, and for various sub-populations (defined below) considered in the study.

## RESULTS

Universal and long durations of breastfeeding are the norm in most rural areas of developing countries. Guatemalan mothers who participated in the INCAP study were no exception. Only nineteen women in the INCAP study for whom data is available did not initiate breastfeeding of their live born infant. An additional 19 women had their pregnancies end in either still-births or miscarriages. Figure 1 shows life table estimates of the cumulative proportion of women amenorrheic, breastfeeding, and breastfeeding without supplementation (either liquids or solids) excluding the 19 who did not initiate breastfeeding and the 19 who had either a miscarriage or still-birth (a total of 38 women). As expected, these survival functions decrease steadily with time. The median duration of postpartum amenorrhea for the breastfeeding women at risk of resumption of menses during the postpartum period is 14.34 months (14.28 mean). The median duration of breastfeeding for these women is 16.94 months (16.64 mean). While the survival function of amenorrhea and breastfeeding show a gradual monotonic decline, the survival function for supplementation describes a much steeper decline reflecting, in part, the early introduction of supplements to the children's diet that was an integral part of the INCAP study protocol (Habicht and Martorell, 1993). The median duration of full breastfeeding is 3.93 months (4.44 mean) (Table 1).

Figure 1 and Table 1 also show that the proportion of women who wean their children is greater than the corresponding proportion who have yet to resume menses at every monthly duration during the first two years following a birth. In other words, the duration of breastfeeding exceeds the duration of postpartum amenorrhea for the majority of women in the population, a universal finding in research on breastfeeding women in developing countries. The estimated survival function of full breastfeeding lags behind the other two by several months reflecting, as we mentioned above, the early introduction of supplements that was part of the INCAP study protocol. Thus, for most women in the study, it appears that the correlation between breastfeeding and amenorrhea is due to the type of breastfeeding, i.e., frequency and/or intensity of nursing, and the type and timing of supplementation, not to the direct effect of delayed weaning.

In Figure 2 we introduce another dimension to the analysis of postpartum amenorrhea. We estimate the survival functions for resumption of postpartum menstruation for five groups of women in the study that we are able to identify. We specify these five groups in order to investigate causal relationships, as opposed to correlational ones, of the effects of breastfeeding on the resumption of menstruation. These are the same groups that were described in the Indonesian study referred to previously (Jones, 1989), and are also clearly reflected in the Habicht model (Habicht et al., 1985). They are: (1) women who completely weaned their children before menses returned (**weaning group**); (2) women who resumed menstruation while still breastfeeding, or were still amenorrheic and breastfeeding at the end of the survey or loss to follow-up whichever occurs first (**breastfeeding group**); (3) all women in the study who had a live birth and initiated breastfeeding (**all women group**); (4) women whose children died before menses returned (**infant mortality group**); and last, (5) women who never breastfeed their children because they either had experienced a still-birth or miscarriage, or because they chose not to breastfeed their live-born infant (**non-breastfeeding group**). In Table 2 we present median and mean values corresponding to Figure 2 for the duration of postpartum amenorrhea for these groups and the number of women in each for which data is available.

Results, presented in Figure 2 and Table 2, indicate that there are several different phenomena relevant to resumption of postpartum menstruation for these women. Furthermore, it is important to stress that these sources of variation in the duration of postpartum amenorrhea are almost always masked in cross-sectional data on resumption of postpartum fecundity. First, the amenorrhea survival function for all women in the study who initiated breastfeeding and for women in the breastfeeding group are quite similar because the majority of women, 975 out of 1392 for which breastfeeding data is available, are in the latter category. The median time to resumption of menstruation in these two groups of women is 14.34 and 13.41 months, respectively (Table 2). Quite simply, the majority of women in the study experience resumption of postpartum menstruation while they are still breastfeeding (see Table 1). This, however, leaves a not insignificant number of women, almost 30 percent of the sample, who are not in this category. Second, as expected, women who do not initiate breastfeeding have the shortest waiting-times to resumption of menses with a median of 2.75 months (Table 2). Third, the infant mortality and weaning groups have very different patterns of postpartum amenorrhea even though both infant mortality and weaning (before menses resumes) terminate the suckling stimulus to the hypothalamus. The former group has a median waiting-time to menses of 4.57 months while the latter has a median waiting-time of 16.03 months (see Table 2). Infant mortality and weaning deserve closer scrutiny because the significance of these differences is frequently overlooked in demographic research, especially in cross-sectional studies (Jones, 1989).

Table 3, Panel 1 presents mean and median values of the survival functions for: (1) breastfeeding for women in the weaning group, (2) amenorrhea for women in the weaning group, and (3) breastfeeding for all women in the study. Women in the weaning group stopped breastfeeding their children at various times over 24 months of the postpartum period, not as one might have predicted, only near the beginning of the birth interval. The breastfeeding survival function for women in the weaning group is simply a reflection of the normal pattern of weaning for all women in the study, except that for some reason these women chose to wean their children before their menses resumed. The difference in the median duration of breastfeeding for all women in the study and for women in the weaning group is approximately 2 months. As a consequence, the median duration of amenorrhea for women in the weaning group, 16.03 months, reflects the median duration of breastfeeding for these women, 14.02 months, with a lag of approximately two months. The median duration of breastfeeding for all women in the study is 16.94 months (Table 3, Panel 1).

A similar relationship but a quite different pattern of return of postpartum menstruation exists for women in the infant mortality group (Table 3, Panel 2). Here, failure is defined as a child death, and exposure to risk is determined by the number of months from birth to the child's death over the course of the study for those children. Table 3, Panel 2 presents estimated median survival values for: (1) children who died before menstruation resumed, (2) median amenorrhea survival values for women in this infant mortality group, and (3) median survival values for all children who died during the study. It is clear from this table that the estimated survival function for children who die before their mother's menses resumes (median 1.88 months) reflects the infant survival function for the entire sample (median 4.64 months). Women in this group did, however, experience infant mortality on average somewhat earlier than women in the sample as a whole. As a consequence, the median duration of amenorrhea for women in the infant mortality group (median 4.57 months) reflects the group's survival function (median 1.88 months) with a lag of approximately two and a half months (Table 3, Panel 2).

Although the pattern and the timing of weaning and infant mortality appear to be directly responsible for the subsequent pattern of return to menses in these two groups, the difference in the magnitude of the survival functions, i.e., median resumption of menses of 16.03 and 4.57 months respectively (Table 3, Panel 1 and 2), masks underlying physiological phenomenon that are common to both. In order to investigate this aspect of postpartum fecundity, Table 3, Panel 3, presents the median waiting-times from weaning and infant death to resumption of menses where the waiting-times for both are rescaled to identical zero starting points. Mothers who wean before menses returns have a median waiting-time from weaning to return of menses on the rescaled axis of 1.89 months. Mothers who experience infant mortality before menses returns have a median waiting time from infant death to return of menses on the rescaled axis of 1.98 months. In addition, the median recovery from pregnancy to menses for the nineteen non-lactating women and the nineteen women who experienced a still-birth or miscarriage is 2.75 months on the same rescaled axis (Table 3, Panel 3). The survival functions of the waiting-times to menses for the infant mortality and weaning groups are not significantly different from one another, nor are they significantly different from the amenorrhea survival function for women who did not breastfeed (Table 3, Panel 3) ($P>0.40$, Log-Rank test).

The relative contribution of variability in breastfeeding intensity (intensity is defined by the average number of nursing episodes/24-hr) to the variability in return of postpartum menstruation could only be investigated directly for 763 women in the breastfeeding group for whom breastfeeding data was available. These are the women who experienced return of menses while still breastfeeding or were still amenorrheic and breastfeeding when the study ended. To properly assign causality in the relationship between breastfeeding behavior (as distinct from breastfeeding duration) and the duration of postpartum amenorrhea for these cases we truncate the prospectively collected breastfeeding frequency data at the month when their menses resumes, or we include all breastfeeding frequency data up to the end of the study if their observation is censored. We do this because breastfeeding information beyond the point when menses resumes for non-censored cases cannot in any way be causally related to resumption of postpartum menstruation.

The simple and most direct method to identify significant breastfeeding variables within the context of life table analysis is to examine individually the relationship of each variable to the duration of postpartum amenorrhea. In this study we are limited to only a single breastfeeding intensity measure, which we have defined at the average number of nursing episodes per 24-hour day. This information about breastfeeding intensity is numerical and continuous. In order to be consistent with previous research we categorized the intensity measure. We initially estimated life tables for return of postpartum amenorrhea over the range of the average intensity measure reported (1 to 22 nursing episodes per 24/hrs.). Optimal splits were arrived at by repeating the life table analysis after segregating women at the points where the differences appeared the greatest. This somewhat ad hoc procedure leads to an unambiguous three category variable for average breastfeeding frequency/24 hrs. defined as follows: (1) low intensity breastfeeders are mothers who nursed their children on average from one to seven times a day over the course of the study, (2) intermediate intensity breastfeeders are the mothers who nursed their children on average from eight to eleven times a day over the course of the study, and (3) high intensity breastfeeders are mothers who nursed their children on average from 12 to 22 times a day over the course of the study. Twenty two was the highest average frequency reported by nursing mothers in the INCAP study.

Table 4, Panel 1 presents median and mean life table estimates for resumption of postpartum menstruation for the breastfeeding intensity measure. Other factors being equal, women who breastfeed their children less frequently (less than eight times a day on average) have the fastest resumption of menses with a median duration of postpartum amenorrhea of 12.14 months (mean of 12.12). Women who breastfeed at an intermediate level (eight to eleven times a day on average) resume menses more slowly at a median duration of postpartum amenorrhea of 14.74 months (mean of 14.58). Women who breastfeed at the highest frequency (twelve or more times a day on average) resume menses more slowly than those in the other two groups with an average duration of postpartum amenorrhea of 17.71 months (mean of 16.99) (Table 4, Panel 1). The median duration of postpartum amenorrhea for mothers who breastfeed most frequently is almost 6 months longer than the median duration among women who breastfeed the least. We also calculated median and mean life table estimates for the women with missing breastfeeding intensity data. Overall these differences were found to be significant using standard statistical tests for survival data, with the missing category falling near the low intensity nursing group (Table 4, Panel 1).

Finally, the effect of supplementation on resumption of postpartum menstruation for women in the breastfeeding group is examined. An optimum split maximizing the difference in duration of postpartum amenorrhea was found at the 7th postpartum month. Women in the breastfeeding group who introduce supplements (either solids or liquids) before 8 months have a median duration of postpartum amenorrhea of 15.98 months (mean of 15.61), while those who introduce supplements after 7 months have a median duration of postpartum amenorrhea of 19.62 months (mean of 20.89) (Table 4, Panel 2). These differences were also found to be significant using standard statistical tests for survival data.

## DISCUSSION

The physiological mechanism which underlies the process of return of postpartum fecundity and fertility represented by the Habicht model is found in the hypothalamus of the human brain. This is the area of the brain where central regulation of reproduction is mediated by the activity of an endogenous hypothalamic pulse generator (HPG). Here during a normal menstrual cycle hypothalamic nuclei release gonadotropin-releasing hormone (GnRH) in a pulsatile manner, which in turn, results in the pulsatile secretion of the pituitary gonadotropins, follicle stimulating hormone (FSH) and luteinizing hormone (LH). The integrity of this endogenous system is necessary for normal ovarian function (Knobil, 1980).

Following birth and with the initiation of breastfeeding, stimulation of the mother's nipple by the nursing infant provides the controlling signal that suppresses postpartum fertility in normally nourished, healthy women. Nursing sets up a neuroendocrine reflex from the breast to the hypothalamus which disrupts the ability of the HPG to maintain a normal pattern of GnRH/LH pulsatile secretion. FSH concentrations return to near normal levels within approximately 30 days postpartum in spite of the continued disruption of GnRH signals by nursing. As a consequence, FSH levels are sufficient to begin to induce follicle growth. However, in the majority of nursing mothers, the continued suckling induced disruption of the pulsatile GnRH/LH signal results in GnRH-secreting neurons being hypersensitive to estradiol negative feedback. Reduced estradiol production by the FSH stimulated follicles inhibits the normal positive ovarian feedback of estradiol to the hypothalamus. Disruption of LH signals continue until the suckling stimulus declines sufficiently to allow for the generation of a normal preovulatory LH surge. Only then can ovulation take place with the formation of normal corpus luteum (Glasier et al., 1984; McNeilly et al., 1985; Tay et al., 1993; McNeilly et al., 1994; McNeilly, 2001).

The Habicht model, as others before it, proposed a physiological mechanism for postpartum amenorrhea involving the pituitary hormone prolactin (PRL). Under this model, the authors assumed that recurrence of postpartum menstrual bleeding occurs when the plasma level of the key hormone PRL drops below a threshold value. As we have seen above, however, the mechanism of postpartum lactational infertility does not involve PRL directly, nor does it involve dopamine or endogenous opioids such as beta-endorphin which have in the past been proposed to be responsible for the amenorrhea of nursing women (Tay et al., 1993; 1996). Instead it is the direct suckling induced failure of the central mechanisms of the HPG and pituitary to secrete GnRH/LH in normal frequencies that is directly responsible for postpartum lactational infertility (McNeilly et al., 1994; McNeilly, 2001). Nonetheless, by simply substituting a critical suckling threshold (some measure of suckling frequency such as the total duration of sucking during any 24-hour period that we use in this study) for a critical PRL threshold above which menstruation and/or ovulation cannot occur, the overall integrity of the Habicht model is essentially maintained.

The results we derive in the present analysis are totally consistent with such a modified Habicht model. We summarize our findings as follows: first, in the Guatemalan population, or in any other population for that matter, all other factors being equal, the association between the duration of postpartum amenorrhea and breastfeeding is not due to the direct effect of prolonged lactation implied by the strong correlation between the two in Figure 1. From Figure 1 it is clear that the duration of postpartum amenorrhea is less than the duration of breastfeeding over the first 24 months following birth. Second, the time to resumption of ovulation and/or menses once suckling has been discontinued before menses resumes is the same, no matter when or for what reason (either infant death or weaning) during the postpartum period nursing is discontinued. Third, the time it takes to experience the first postpartum menses following the discontinuation of breastfeeding is approximately 2 months, which is also approximately the same time it takes normal reproductive function to return following birth when the mother, for what ever reason, chooses not to breastfeed at all. Fourth, the strong association (correlation) between breastfeeding and the duration of postpartum amenorrhea implied by Figure 1 is determined by the combined, additive effects of nursing intensity (here defined as average nursing frequency per 24-hours), the timing of the introduction of supplements, the timing of weaning and infant death if these events occur, and possibly other unmeasured factors not considered in the present analysis, factors such as maternal nutrition status, maternal energy depletion or maternal work loads.

Finally, these results also confirm earlier findings from the NGAGLIK study in Indonesia (Jones, 1989) where we first demonstrated empirically that the timing of weaning and infant death before menstruation resumes is directly responsible for the subsequent pattern of resumption of menstruation in these groups of women (Table 3). By contrast, other women with a pattern of intense and prolonged nursing tend to have longer durations of postpartum amenorrhea than women who nurse less frequently and intensely. Supplementation also represents an additional risk factor for early return to menses. Lastly, the time it takes for menses to return following the discontinuation of nursing, approximately 2 months, is nearly identical in the NGAGLIK and INCAP studies and in other studies where this has been investigated (McNeilly, 2001).

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**Table 1. Duration of Postpartum Amenorrhea, Breastfeeding and Full Breastfeeding. Guatemala, 1969-1977.**

| Life Table Indicator | Postpartum Amenorrhea | Breast-feeding | Full Breast-feeding |
|---|---|---|---|
| Median | 14.34 | 16.94 | 3.93 |
| (s.e.) | (0.17) | (0.19) | (0.26) |
| Mean | 14.28 | 16.64 | 4.44 |
| (s.e.) | (0.21) | (0.19) | (0.11) |
| N | 1392 | 1392 | 1392 |
| Failures | 1068 | 1076 | 1368 |

Source: INCAP Longitudinal Study.

**Table 2. Duration of postpartum amenorrhea for women in the breastfeeding, weaning, infant mortality, and nonbreastfeeding groups. Guatemala, 1969-1977.**

| Life Table Indicator | Groups | | | | Postpartum Amenorrhea For All Women Who Breastfed |
|---|---|---|---|---|---|
| | Breast-feeding | Weaning | Infant Mortality | Nonbreast-feeding | |
| Median | 13.41 | 16.03 | 4.57 | 2.75 | 14.34 |
| (s.e.) | (0.21) | (0-35) | (0.36) | (0.22) | (0.17) |
| Mean | 13.53 | 15.90 | 5.78 | 2.32 | 14.28 |
| (s.e.) | (0.23) | (0.38) | (0.43) | (0.17) | (0.21) |
| N | 975 | 313 | 104 | 38 | 1392 |
| Failures | 686 | 280 | 102 | 38 | 1068 |

Source: INCAP Longitudinal Study.

**Table 3. Duration of postpartum amenorrhea, breastfeeding and mortality for women in the breastfeeding, weaning, infant mortality, and non-breastfeeding groups. Guatemala, 1969-1977.**

| Groups | Median (s.e.) | Mean (s.e.) | N | Failures | Pr>Chi-Sq |
|---|---|---|---|---|---|
| PANEL 1 | | | | | |
| Breastfeeding for weaning group | 14.02 | 13.37 | 313 | 313 | |
| | (0.38) | (0.34) | | | |
| Amenorrhea for weaning group | 16.03 | 15.90 | 313 | 280 | |
| | (0.35) | (0.38) | | | |
| Breastfeeding for all groups | 16.94 | 16.64 | 1392 | 1076 | |
| | (0.19) | (0.19) | | | |
| PANEL 2 | | | | | |
| Mortality for Inf. mort. group | 1.88 | 3.92 | 104 | 104 | |
| | (0.09) | (0.45) | | | |
| Amenorrhea for Inf. mort. group | 4.57 | 5.78 | 104 | 102 | |
| | (0.36) | (0.43) | | | |
| Mortality for all group | 4.64 | 8.53 | 143 | 143 | |
| | (0.82) | (0.94) | | | |
| PANEL 3 (Rescalled) | | | | | |
| Amenorrhea for weaning group | 1.89 | 2.32 | 313 | 280 | |
| | (0.05) | (0.15) | | | |
| Amenorrhea for Inf. mort. Group | 1.98 | 1.87 | 104 | 102 | |
| | (0.10) | (0.12) | | | |
| Amenorrhea for non-breastf. Group | 2.75 | 2.32 | 38 | 38 | |
| | (0.22) | (0.17) | | | |
| Log-Rank | | | | | 0.3987 |
| Wilcoxon | | | | | 0.0139 |
| -2 Log(LR) | | | | | 0.2395 |
| d.f. | | | | | 2 |

Source: INCAP Longitudinal Study.

**Table 4. Summary of life table analysis of the duration of postpartum amenorrhea for breastfeeding variables. Guatemala, 1969-1977.**

| Breastfeeding Variables | Median (s.e.) | Mean (s.e.) | N | Failures | Pr>Chi-Sq |
|---|---|---|---|---|---|
| PANEL 1 | | | | | |
| NURSING EPISODES PER DAY | | | | | |
| 1 - 7 times | 12.14 | 12.12 | 200 | 147 | |
| | (0.94) | (0.43) | | | |
| 8 - 11 times | 14.74 | 14.58 | 346 | 226 | |
| | (0.18) | (0.33) | | | |
| 12 - 22 times | 17.71 | 16.99 | 217 | 160 | |
| | (0.23) | (0.39) | | | |
| Missing | 12.98 | 13.72 | 629 | 524 | |
| | (0.23) | (0.33) | | | |
| Log-Rank | | | | | 0.0001 |
| Wilcoxon | | | | | 0.0001 |
| -2 Log(LR) | | | | | 0.0063 |
| d.f. | | | | | 3 |
| PANEL 2 | | | | | |
| PARTIAL BREASTFEEDING | | | | | |
| Less than 7 mos. | 15.98 | 15.61 | 508 | 310 | |
| | (0.36) | (0.42) | | | |
| Greater than 7 mos. | 19.62 | 20.89 | 255 | 176 | |
| | (0.47) | (0.61) | | | |
| Log-Rank | | | | | 0.0001 |
| Wilcoxon | | | | | 0.0001 |
| -2 Log(LR) | | | | | 0.0026 |
| d.f. | | | | | 1 |

Source: INCAP Longitudinal Study.

**Figure 1. Estimated survival functions of the duration of postpartum amenorrhea, breastfeeding and supplementation. Guatemala, 1969-1977.**

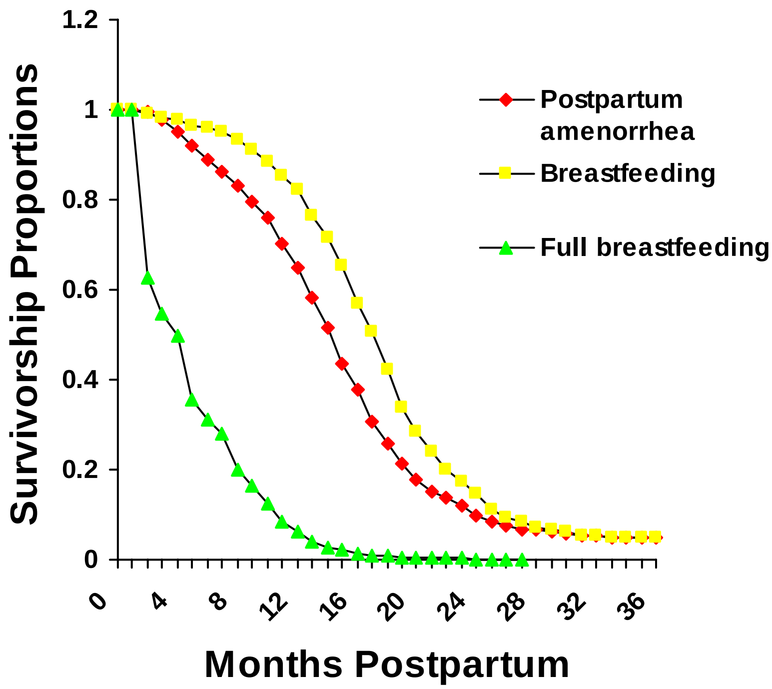

**Figure 2. Estimated survival functions of the duration of postpartum amenorrhea for all breastfeeding women, all non-breastfeeding women, and for the various groups defined above. Guatemala, 1969-1977.**