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THE ROLE OF BREASTFEEDING VIS-À-VIS CONTRACEPTIVE USE ON BIRTH SPACING IN INDIA: A REGIONAL ANALYSIS

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ABSTRACT

Birth spacing is one of the important aspects of reproductive health. Therefore, it is felt by demographers that birth spacing needs to be studied from time to time in view of the epidemiological transition taking place worldwide. Using the third round of National Family Health Survey-3 data, the central hypothesis of this paper is to find out the relative advantages of breastfeeding over other methods of contraception among non-sterilized women by using simulative approach of the Cox regression analysis in India and its regions. The results show that if women were not having amenorrhea period and had a high level of breastfeeding, the chance of not having next live birth was only two percent lower than those women who were using spacing methods in India. This pattern was found to be almost similar in all the regions of India except central and southern regions. There is no significant gain in postponing the next live birth has been observed in using the contraceptives than breastfeeding. An effort has also been made to apprise the policymakers of the interrelation between breastfeeding, postpartum amenorrhea, contraceptive use and birth spacing. Nonetheless, policymakers should promote programs that encourage both breastfeeding and contraceptive use. Breastfeeding has direct benefits for infant health in addition to its role in lengthening birth intervals beyond postpartum amenorrhea.

Key words: breastfeeding, birth spacing, contraception, Cox regression, simulation analysis.

1. Introduction

The numerous advantages of breastfeeding have been accepted by the health and family planning policy makers and various initiatives have been taken to promote breastfeeding. In addition to the benefits to child from many illnesses, it protects mother against another pregnancy. Further, it increases child survival and suppresses ovulation during which the chances of conception are virtually nil. These important roles of breastfeeding have been well documented in the literature of demography/and public health. Therefore, it is felt by

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demographers/epidemiologists working in the areas of public health that the issues related to the advantages of breastfeeding need to be studied from time to time in view of the epidemiological transition that has been taking place worldwide.

Previous investigations of postpartum amenorrhea (PPA) in developing countries suggest that the distribution of amenorrhea is bimodal composed of a “normal” duration subgroup and a short duration subgroup that resumes menses within 3 or 4 months (Henry, 1961; Saxena and Pathak, 1977; Holman *et al.,* 2006). The duration as well as the nature of breastfeeding are the major determinants of prolonged PPA and are well documented in both aggregate and individual level analyses. This phenomenon has been verified by eminent researchers (Saxena, 1977; Howie and McNeilly, 1982; Bongaarts, 1983; Srinivasan *et al.,* 1989; Nath *et al.*, 1994; Singh *et al*., 1999; Arokiasamy, 2002). Further, prolonged PPA works as a catalyst in increasing the birth interval. Many studies found the contraceptive effect of breastfeeding, especially regarding the circumstances when it becomes more effective and safe. But, contraceptive role of breastfeeding is not fully established. In a consensus statement, (Family Health International, 1988) a group of international societies put forward the view that when mothers breastfeed exclusively or near to that, there is a higher chance that a woman remains under amenorrhea. Under such conditions, almost 95 percent women are protected against pregnancy.

Birth spacing is defined as an interval between termination of one completed pregnancy and the termination of the next (Last, 1988). The study on birth spacing pattern not only determines the pace of childbearing but also reflects the likelihood of progressing to a higher parity, which further determines the completed family size. The high levels of fertility, especially in the central region of India, are the major concern to the planners and policy makers. Therefore, analysis of birth spacing is of interest in this context since it can provide further insight into the mechanism underlying fertility change (Potter, 1963; Sheps, 1964; Pathak, 1966; Sehgal, 1971; Srinivasan, 1980; Njogu & Martin, 1991). Studies also revealed that birth spacing is preferred over other conventional measures of fertility because of its sensitiveness to small and short term changes in the reproduction rate (Singh, 1964; Sheps & Menken, 1972; Namboodiri, 1974; Namboodiri, 1983). Further, birth spacing provides the mechanism of reproductive process and, therefore, it can be considered as a major determinant of population change (Mturi, 1997). A study of birth interval length with various socio-economic and demographic variables helps in finding out the relative importance of factors that contribute to fertility decline. Further, it may also help in identifying the factors that create obstacles to further reduction in the fertility.

There are many hypotheses that have been tested in the areas of public health/demography that are solely based on analytical research on birth spacing. Hypotheses related to birth spacing have generated various important clues towards public health programs and have important implications for a number of reasons. For example, “to what extent does the length of the preceding birth interval affects the risks of infant and child mortality?” has been examined with the help of birth spacing data (DaVanzo et al., 2004). A study between birth spacing and breastfeeding may also help in deciding the need for an individual woman to initiate contraception at proper time (Anderson, 1986). Further, a hypothesis may be framed in relation to the benefits of breastfeeding over other methods of contraception in the context of extending the subsequent birth spacing.

Using birth spacing data of three Southeast Asian countries, the researcher concluded that the length of previous birth interval is an important covariate in explaining the risk of pregnancy leading to a live birth after controlling the breastfeeding behaviour and the use of contraception (Trussell, 1985). Others also derived the same findings that duration of breastfeeding has a significant effect on the likelihood for a woman to go on to have a second or third birth in Vietnam (Swenson & Thang, 1993). The study compared results of identical structural models for nine countries and also found that the woman's education and the length of the previous birth interval had a substantial effect on birth interval (Rodriguez et al., 1983). They also concluded that parity is a relatively unimportant covariate. Finally, one of their general conclusions (Rodriguez et al., 1983) is that "It seems likely that many of the differences are the consequence of differing patterns of breastfeeding and contraceptive use." However, they have not included these variables in their analyses.

Using Malaysian Family Life Survey-1979-77 data, authors have investigated the contribution of different factors in elucidation the short birth interval (less than 15 months) in Peninsular Malaysia. Further, they have also explored how factors relate to breastfeeding and the use of contraceptive affect birth spacing (Da Vanzo and Starbird, 1991). They came out with the findings that breastfeeding had a considerably greater aggregate protective effect against early subsequent conceptions as compared to the use of contraceptives because more women breastfed than use contraceptives. They have also found that breastfeeding and contraceptive use are negatively related. Analysing the data from National Family Health Survey for Uttar Pradesh and Tamil Nadu, India, authors developed the hazards life table models for parity specific live birth intervals (Dwivedi and Singh, 2003). They came out with the findings that in each state, breastfeeding emerged as an important protective covariate that extended the birth spacing, irrespective of parity. However, another study found that breastfeeding is a statistically significant covariate in determining the length of birth interval (Ojha, 1998).

2. Objectives

Previous research on breastfeeding and contraceptive use has shown that the main determinants of breastfeeding and contraceptive use often act in opposite directions. For example, variables associated with modernization have a negative impact on breastfeeding but positive effects on contraceptive use (Potter, 1987b; Potter et al., 1987a; DaVanzo and Habicht, 1986; Butz, and Da Vanzo, 1981). Therefore, there is a need to investigate the impact of extended breastfeeding beyond PPA has an advantage in extending the birth spacing over the use of other methods of contraception. The main objective of the paper is to determine the impact of breastfeeding on birth spacing in India and its regions, among non-sterilized women who gave birth(s) during the last five years from the date of survey. An attempt has also been made to find out the relative advantages of breastfeeding over other methods of contraception in relation to birth spacing among amenorrheic and non-amenorrheic women in India and its regions. An appropriate simulation analysis will be carried out to explore important clues for the policy planners involved in population control/public health programs.

3. Methods

3.1. Data

To accomplish the objective, the relevant data have been taken from National Family Health Survey (NFHS), conducted in 2005-06. The analysis was carried out for India and its six regions: the northern region, which includes Delhi, Haryana, Himachal Pradesh, Jammu and Kashmir, Punjab and Rajasthan; the central region, which consists of Chhattisgarh, Madhya Pradesh, Uttaranchal and Uttar Pradesh; the eastern region, which comprises Bihar, Jharkhand, Orissa and West Bengal; the north-eastern region, which consists of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura; the western region, which includes Goa, Gujarat and Maharashtra; and the southern region, which comprises Andhra Pradesh, Karnataka, Kerala and Tamil Nadu.

The dependent variable is birth spacing, that is interval (in months) between one live birth and next live birth. The absence of later birth, the birth spacing is considered to be the censored observation. The information on breastfeeding is available only for those women who gave birth(s) during last five years prior to the survey. Therefore, women who are not sterilized and gave birth(s) during last five years prior to the survey are included in the analysis. There were 40,905 women who had live births during last five years prior to the survey; of these 73 percent were censored observations at India level. The censored observation varies from 68 percent in the central India to 81 percent in the southern India.

There are also women in the sample who had more than one child during the last five years prior to the date of survey. In this paper, wherever women or mothers have been mentioned, these women/mothers actually refer to mothers of the index child.

The combined variable of women currently breastfeeding and women in amenorrhea is the independent variable. The categories of this variable are as follows:

(i) currently breastfeeding and amenorrheic;

(ii) currently not breastfeeding and amenorrheic;

(iii) never breastfed and amenorrheic;

(iv) currently breastfeeding and non-amenorrheic;

(v) currently not breastfeeding and non-amenorrheic; and

(vi) never breastfed and non-amenorrheic.

3.2.1. Kaplan-Meier (K-M) methods

For bivariate analysis, Kaplan-Meier (K-M) survival analysis has been used to determine the mean duration of birth spacing. The differences in the mean duration of birth spacing among different combined categories of breastfeeding and amenorrhea status (as stated above) have been examined by log-rank test.

3.2.2. Cox proportional hazards model and its Simulation Analysis

The Cox proportional hazards model was used to examine the adjusted impact of combined variables of breastfeeding and amenorrhea on birth spacing. Further, to find out the relative advantages of breastfeeding over other methods of contraception among amenorrheic and non-amenorrheic women, the simulation approach has been adopted.

There are several important reasons why the Cox model is more widely adopted in the field of demography/public health. The exponential part of the Cox model is appealing because it ensures the validity of the definition of hazard function, that is, the estimated hazard will be always non-negative. Another appealing property of the Cox model is that the unknown coefficient in the exponential part of the model can be estimated without specifying the baseline hazard. In the absence of the specific baseline hazards function, the hazards function and its corresponding survival curve can also be estimated for the Cox model. Thus, the primary information desired for a survival analysis, namely, a hazard ratio and a survival curve, may be obtained using a minimum of assumptions. This model is also preferred over the logistic model when survival time information is available and there is censoring (Kleinbaum, 1996a; Klienbaum, 1996b). The Cox model uses more information-the survival times-than the logistic model, which considers a (0, 1) outcome and ignores survival times and censoring. Therefore, analysis of survival time, the time to next live birth for a non-sterilized currently married woman has been carried out through the use of the Cox hazards model (Cox, 1972).

The simulation exercise of the Cox hazards model has been done in the four steps.

Step 1: The exponential expression of the Cox model, also known as 'Risk score' and generally denoted by R, may be defined as follows:

$$R = \beta_1 X_1+\beta_2 X_2+.......+\beta_p X_p \tag{1}$$

where X_1 , X_2 , ..., X_p are the defined levels of p predictor variables and β_1 ,β_2 , ….β_p are respective unknown regression coefficients.

Risk score R has been calculated for every woman included in the data set after substituting the observed values of the covariates for each individuals using maximum likelihood estimates of regression coefficients. Further, the average risk score (R_1), which is a constant for a given data set, has been computed.

Step 2: The next step is to calculate the average value of risk score R_2 after changing the levels of included variables in Step 1 by using the equation (1). Risk score will be obtained after substituting the changed levels of the selected variable. However, the changed level will remain the same for every woman. The value of risk score may be varied from woman to woman as a result of variation in the levels of the selected variable.

Step 3: The baseline survival probabilities ($S_0(t)$) at different time points for a woman with average risk score R_1 may be obtained using the Kaplan-Meier method.

Step 4: The gain in survival probability may be worked out by

$$S(t) = S_0(t)^{\exp(R_2 - R_1)} \qquad (2)$$

The survival probabilities in relation to R_1 are listed in the first row of the concerned table, whereas the survival probabilities due to change in the level (R_2) of the selected variable are listed in successive rows. The difference between the two probabilities provides gain or loss as a result of proposed change in the levels of the selected variable or set of variables.

4. Results

4.1. Kaplan-Meier/Survival Analysis

Table 1 shows the mean duration of next birth intervals (in month) with 95% confidence interval (CI) estimates for India and its regions. The mean duration of next birth interval for India (all regions combined) was 42 months. The central region had the lowest mean duration of next birth interval (39.3 months). However, the highest figure was observed for the south region (Mean: 45.8, C.I. 45.0 – 46.5) followed by the western region (Mean: 44.3, C.I. 43.6 – 45.0). The other three regions were all between 42 and 43 months (see Table 1). Table 2 shows the mean duration of next birth intervals (in month) with their 95% confidence interval (CI) estimates for India and its regions found by the current states of breastfeeding and amenorrhea of the women as classified in different states (i) to (vi).

The mean duration of next birth interval appears to increase when mothers were not having amenorrhea period in comparison with those mothers who were amenorrheic, irrespective of the breastfeeding status as found for women in India and its regions. For example, mothers who were still breastfeeding and were not amenorrheic had a significantly longer mean duration of next birth interval in comparison with those mothers who were also still in state (i) for breastfeeding and amenorrhea.

Similarly, the impact of breastfeeding in postponing the next live birth can be seen for women in India and its regions, irrespective of whether women were having or not having postpartum amenorrhea. For example, women who were still breastfeeding and were in amenorrhea period had a significantly longer duration of birth interval than those women who were currently not breastfeeding at the time of survey but were amenorrhic. These findings have been found to be consistent for women in India and its regions.

Taking India as a whole, 45 percent of women were not having next live birth at least by 48 months - the same was true for women of the eastern region, whereas 44 percent and 37 percent of mothers belonging to the northern and central regions respectively, did not give birth up to 48 months. In the case of 48 percent of women of the north-eastern, 51 percent of western and 57 percent of southern regions did not give birth up to 48 months from previous birth. These rates at 48 months were found to be highest among those mothers of index children who were still breastfeeding but not found to be amenorrheic at the time of the survey.

4.2.1. Multivariate Analysis

To identify important factors affecting birth spacing among women in India and its regions, a host of possible covariates were considered in the Cox proportional hazards model. The choice governing the selection of explanatory variables of the Cox proportional hazards model was that each variable considered should show at least moderate association ($p < 0.05$) in bivariate analyses for at least one out of six regions considered. However, in some cases, more importance was given to theoretical rather than purely statistical considerations. The analysis has been carried out separately for India and its six regions and the results are presented in terms of rate ratio/relative risks (exponential of regression coefficients) and their 95% confidence intervals in Table 3 and 4.

Table related to India clearly shows that mothers of index children from the northern and central regions had a significantly higher likelihood to experience the next live birth in comparison with the southern region. Mothers of index children other than the northern and central regions had not statistically significant association with birth spacing as opposed to the southern region.

With regard to breastfeeding and postpartum amenorrhea, mothers who were still breastfeeding and were having amenorrhea period were not found statistically significant association with birth spacing (RR: 1.05, C.I. 0.89 – 1.23). However, women who were amenorrheic but either never breastfed or were currently not breastfeeding had significant risk factor against the next live birth. It is also true for those women who never breastfed and were not having amenorrhea period (RR: 1.31, C.I. 1.20 – 1.43). Surprisingly, women who were still breastfeeding and were not having amenorrhea period had a lower chance of having next live birth as compared to those women who were currently not breastfeeding and were not having amenorrhea period (RR: 0.16, C.I. 0.14 – 0.18). A regional analysis showed that mothers who were still breastfeeding and were amenorrheic (state-i) at the time of survey had not statistically significant higher chance as compared to those mothers who were not breastfeeding and were not found to be amenorrheic (state-v) at the time of survey except for women of the central region where probability of having next live birth was found to be less than one (RR: 0.79, C.I. 0.58 – 1.09). Further, the table shows that the adjusted chance of having next live birth was found to be significantly high among those mothers who were having amenorrhea period at the time of survey and had never breastfed or were not breastfeeding at the time of survey. The association was found to be poor in the southern region ($p>0.05$). However, in the western region, the risk was not statistically significant for those mothers who were amenorrheic but never breastfed. Mothers who were still breastfeeding and had resumed menstruation cycle had significantly less chance of having next birth in comparison with those women who were not breastfeeding and were not in amenorrhea period in all the regions of India. The lowest value of relative risk was found to be in the central region (RR: 0.09, C.I. 0.06 – 0.12). Women who had never breastfed and were not found in amenorrheic state had a significantly greater likelihood to experience the next live birth as compared to the women who were currently not breastfeeding and were not in amenorrhea period. However, the association was found to be poor in the central and south regions ($p>0.05$).

4.2.2 Simulation Analysis

The results of the Cox proportional hazards model discussed in the earlier section can be found useful for policy planners who are primarily responsible for public health management. The utilities of the Cox proportional hazards model to the policy planners may be easily shown by calculating the predicted survival probabilities at a considered level of a variable by holding all other variables at their average level in the model. In a similar way, the survival probabilities at considered levels of various variables at a time can also be calculated by keeping all other variables at their prevailing average level. It may, however, be noted that the probability of survival in the present context means the probability of not attaining the next live birth. The probabilities of not having next live birth may help in finding the expected gain by changing the level of the selected predictor and keeping other factors on their average value. This additional gain can easily be obtained by subtracting the probabilities found for a given level of a variable from that reported for the average level.

The selected predictors and their combinations considered in the present prediction analysis are: (i) primary education of woman; (ii) secondary education of woman; (iii) survival of index child; (iv) current use of contraceptive; (v) breastfeeding and postpartum amenorrhea; (vi) breastfeeding and postpartum amenorrhea with survival of index child; (vii) breastfeeding and postpartum amenorrhea with current use of contraceptive.

The categories of breastfeeding are: (i) never breastfed (ii) currently not breastfeeding and (iii) still breastfeeding. The present states and the changed states of breastfeeding for the given level of breastfeeding are defined as:

Level of breastfeeding	**Present status of breastfeeding**	**Changed status of breastfeeding**
Lowest	Never breastfed	Currently not breastfeeding
Low	Never breastfed	Still breastfeeding
Moderate	Currently not breastfeeding	Still breastfeeding
High	Never breastfed and currently not breastfeeding	Still breastfeeding

In this section, the lowest level of breastfeeding is defined for those mothers who never breastfed and are considered in the category of currently not breastfeeding. The low level stands for mothers who never breastfed and are considered in the category of still breastfeeding, whereas the moderate level of breastfeeding refers to those mothers who were currently not breastfeeding and are included in the category of still breastfeeding by keeping the original value of the third left out category of the three categories defined as above for different levels of breastfeeding. However, the high level of breastfeeding is defined for those mothers who never breastfed and were currently not breastfeeding. They were included in the category of still breastfeeding.

The probabilities of not having next live birth by selected variables as well as their combinations were worked out for various durations of birth spacing (considered months were 12, 18, 24, 30, 36, 42, and 48) for India and its regions. It may, however, be noted that the results related to the above mentioned variables and their combinations are possible only if these variables are present in the finally considered model. The prediction results in relation to the considered variables and their combinations are presented in Table 5 and Figures 1, 2 and 3 for India and all the six regions. These results give the probabilities of not having the next live birth for women by their selected characteristics or their combinations keeping the remaining variables as constant at their average value.

If it is assumed that all mothers of index children had a high level of breastfeeding and were not amenorrheic, the maximum benefit of birth spacing can be derived only after the period of 24 months. The gain in the birth spacing at the 48 months was found to be highest in the central and southern regions of India. The least benefit at the 48 months has been observed in the northern part of India. However, if mothers of index children had a moderate level of breastfeeding, the probability of not having next live birth at 48 months was higher than the average value in India for all the regions of India. The gain from the average value was found to be highest in the north, eastern and western regions (23 percent) followed by the north-eastern (21 percent), central (20 percent) and southern regions (12 percent). The benefit reaches its minimum value if the simulation of data is done only on those mothers of index children who have never breastfed and are treated as still breastfeeding (low level of breastfeeding).

If it is considered that all mothers of index children were amenorrheic, a large benefit was not found compared to the average value according to the different levels of breastfeeding over different time periods of birth spacing for mothers in India and its regions. A comparison can also be made between mothers who were amenorrheic and those who were not by different levels of breastfeeding with survival status of the index child. The results clearly exhibit the importance of breastfeeding when women were found to be non-amenorrheic as opposed to their counterparts who were in the postpartum amenorrhea period, irrespective of survival status of the index child. These findings were found to be consistent in all the regions of India, but the magnitude varied from one region to another. For example, in the central region, mothers who were not amenorrheic but having a high level of breastfeeding had 28 percent higher chance of not having next live birth at 48 months than those mothers who were amenorrheic with a high level of breastfeeding. The value for the northern, eastern and western regions was 24 percent whereas for the north-eastern and southern regions, the values were 22 percent and 12 percent, respectively. It clearly reflects the importance of breastfeeding beyond the amenorrhea period. These results are also found to be consistent, irrespective of the current use of contraceptives.

However, the impact of different levels of breastfeeding in postponing the next live birth has not been observed among those mothers who were amenorrheic, irrespective of the survival of index child or current use of contraceptives. But still, the probability of not having next live birth according to the different levels of breastfeeding among those mothers who were having amenorrhea over a different time period was slightly higher than the average value in all the regions of India.

All those women who were not sterilized and were protected by using any birth spacing method (traditional and/or modern), were amenorrheic and had a high level of breastfeeding, had only two percent higher chance of not having next live birth as compared to its average value. The figure for this group of women in the central region was four percent higher than its average value and was found to be highest. It is interesting to note that this value was lower than the average value in the southern region. It clearly suggests the argument that overlapping of different methods of contraception does not help in further postponing the next live birth.

If women were not amenorrheic and had a high level of breastfeeding, the chance of not having next live birth was only two percent lower than those mothers who were using spacing methods in case of India. This pattern was found to be almost similar in all the regions of India except the central and southern regions. Further, the value for those regions where the pattern was similar to India was one percent lower for the northern and northeastern regions and two percent lower for the eastern and western regions. No difference could be found between these two different groups of women in the central region. However, the value was three percent higher among those mothers of index children who were not amenorrheic and had a high level of breastfeeding as compared to those mothers who were using spacing methods in the case of mothers of the southern region. It can be reasonably argued that breastfeeding is one of the important factors in postponing the next live birth.

5. Discussion and Conclusions

The relationship between breastfeeding and birth spacing has important implications for public health programs for a number of reasons. These include the direct health benefits of breastfeeding for the child, the maternal and child health benefits of birth spacing, the aggregate impact of breastfeeding on the birth rate and the need for individual women to initiate contraception at the proper time. Birth spacing, that is the timing between two live births, is also a major determinant of population growth. It is observed that the shorter the spacing between successive live births, the narrower the interval between generations and the faster would be the rate of population growth. In areas where the practice of contraception is not widespread, the spacing of births may be the primarily responsible factor for population growth. Being an important component of reproductive process, birth spacing is sensitive to small and short term changes in the reproduction. Therefore, analytical research on birth spacing may help in testing several hypotheses relating to population issues and in generating various important clues towards public health programs. The determinants of changes in the pace of child-bearing can also provide more immediate feedback for administrators dealing with population problems. Similar arguments have been made in relation to important public health indicator-child nutritional status.

In an attempt to demonstrate the utility of the proposed models for policy planners, the expected survival probabilities for a subject (woman/child) with some selected characteristics were worked out. At the outset, using a particular final model, the average survival probability has been worked out by keeping all the variables in the model at their average levels. Further, these probabilities for a subject with a particular level of a variable (or a particular combination of variables) may be calculated by holding all remaining variables in the models constant, that is, at their average levels. Thus, difference in one of these probabilities with average survival probability will provide expected gain/loss from the proposed changes.

The findings clearly reveal the benefits of breastfeeding over other methods of contraception in postponing the next live birth beyond the PPA period. The explanation is that many more women breastfed for longer duration than using contraception. If it is assumed that all women in the sample were breastfeeding beyond the PPA period, around 11 percent additional women compared to the average value were able to postpone their next birth until 24 months. If all the women had breastfed, the gain in extending the period due to the use of contraceptives would not have been noticed. A study also came out with the results that breastfeeding had a considerably greater effect on preventing short birth intervals than did contraceptive use (Da Vanzo, and Starbird, 1991). Some researchers also found that breastfeeding beyond the PPA period had a positive correlation with the waiting time to conception (Nath et al., 1994).

If a woman is still breastfeeding and continues to do so after menstruation has resumed, it appears to decrease her chances of conceiving. One possible explanation of this finding is that breastfeeding may make women less available for sexual relations than would otherwise be the case (Anderson et al., 1986). The inverse relationship could be observed between breastfeeding and the use of contraceptive in all the six regions of India. Further, simulation results suggest that women who both breastfed and practiced contraception did neither as effectively as women who did only one.

After controlling the important socio-economic and demographic confounders, the effect of region was found to be significant. It clearly indicates that there were some unobserved factors that might be contributing to lengthening/shortening of the birth spacing. For example, the desire for another child may be varied from one to another regions and it may affect the women's behaviour regarding the use of contraception and prolonged breastfeeding.

It appears that place of residence, mother's education and standard of living were not found significantly associated with birth spacing. Studies clearly showed that place of residence, education and standard of living are significant predictors of breastfeeding behaviour and contraceptive adoption (Sahu, 1998; Shekhar, 2004; Dwivedi et al., 2007). They affect these two proximate determinants of interval length in opposite directions and essentially offset each other in their effects on the likelihood of having next live birth. However, in the case of central, north-eastern and western regions, the standard of living had positive impact on extending the birth spacing, therefore, the same results were also found at India level. The possible reason might be that as standard of living increases, the use of contraceptive also increases significantly in these regions.

Table 1. Summary of significant findings

Variables	India	North	Central	East	Northeast	West	South
Place of residence							
Urban®							
Rural	0	0	0	0	-	0	0
Religion							
Hindu®							
Muslim	0	0	0	+	0	0	+
Others	+	0	0	0	+	0	0
Mother's education							
Higher®							
Illiterate	0	+	0	0	0	0	0
Primary	0	0	0	0	-	0	0
Secondary	0	0	0	0	-	0	0
Standard of living							
Richest®							
Poorest	+	0	+	0	+	+	0
Poorer	+	0	+	0	+	0	0
Middle	+	0	+	0	+	+	0
Richer	+	0	0	0	+	+	0
Sex of index child							
Male®							
Female	+	+	0	+	0	+	0
Survival status of index child							
Alive®							
Dead	+	+	+	+	+	+	+
Mother's age at birth of index child (yrs.)							
20-24®							
< 20	+	0	+	+	+	0	0
25-29	-	-	-	-	-	-	-
30-34	-	-	-	-	-	-	-
35+	-	-	-	-	-	-	-
Current use of contraceptive							
Yes®							
No	+	0	0	0	0	0	0
Previous birth interval							
24-36 months®							
First birth	+	+	+	+	+	+	+
<24 months	+	0	+	0	+	0	+
>36 months	-	0	0	0	-	0	-

Table 1. Summary of significant findings (cont.)

Variables	India	North	Central	East	Northeast	West	South
Number of surviving children							
Two®							
None	-	-	-	-	-	-	-
One	-	-	-	-	-	-	-
Three	+	+	+	+	+	+	+
Four and above	+	+	+	+	+	+	+
Maternal BMI							
>=18.5Kg/m^2®							
<18.5Kg/m^2	+	0	0	+	0	0	0
Missing	0	0	0	0	0	0	0
Breastfeeding (BF) and postpartum amenorrhea(PPA)							
Currently not BF and not in PPA®							
Currently BF and not in PPA	-	-	-	-	-	-	-
Never breastfed and not in PPA	+	+	0	+	+	+	0
Currently BF and in PPA	0	0	0	0	0	0	0
Never BF and in PPA	+	+	+	+	+	0	0
Currently not BF and in PPA	+	+	+	+	+	+	0

Note: 0= not statistically significant at the 0.05 level. - = negative influence, significant at 0.05 level (2-tailed test). + = positive influence, significant at 0.05 level (2-tailed test).

It may be noted that women who were found to be sterilized at the time of survey were excluded from the analysis. However, if these women were included in the analysis, their inclusion would have resulted in an increase in the proportion of birth intervals that are very long, including those which remained open. This possibility could not be ignored that the proportion of long birth intervals would be reduced because Indian women has tendency to go for sterilization just after birth.

Muslim women from the eastern and southern regions; whereas other than Hindus and Muslims from the north-eastern region were more likely to experience the next live birth. Hindu-Muslim differentials in fertility, to an extent, may be due to duration of sexual abstinence after child birth (Bhat and Zavier, 2005). However, among all the predictors of Hindu-Muslim growth differentials, less use of contraceptives among eligible Muslim women has repeatedly been cited as the pivotal factor (Ram et al., 2007). Further, an increase in the fertility in the north-eastern states was also observed (Marbaniang, 2003). One of the important reasons was the increase in the level of wanted fertility (Shekhar et al., 2006).

In few cases, the relationships of a particular variable with breastfeeding and with contraceptive use reinforce one another in affecting the likelihood that the birth interval is either short or long. A child death reduces both the probability that the child is breastfed and the likelihood that contraception is practiced. Both the reasons are associated with a shorter birth interval. Female index child reduces the likelihood of breastfeeding and of contraceptive use, and is associated with a greater incidence of subsequent short intervals. The result was not found to be significant in the case of the central, north-eastern and southern regions; the possibility that in the southern and north-eastern regions the preference for sons over daughters is virtually nil. However, in the central region where preference for sons exists, chances were high that women might not be aware of contraceptive effect of breastfeeding; therefore, they preferred to go for longer duration of breastfeeding, irrespective of sex of the child. Further, the use of spacing methods was relatively low as resulted into no effect on birth spacing.

The mother's age at birth of the index child has a direct effect on birth interval in addition to its influence on breastfeeding or contraceptive use. For example, although women aged 35 and over are less likely to use spacing methods than younger women (Dwivedi et al., 2007), they are also significantly less likely to have next live birth. The possible reason may be due to their lower fecundity or frequency of intercourse. Women who had three or more children had a greater likelihood to have next live birth as compared to those women who had two children. The possible reasons for shorter birth spacing may be due to the preference for particular sex combinations of child or desire for a higher number of children by women. Chances are also high that a particular group of women might be living in the high fertility states. Women who had no living child or had one child were less likely to move to the next birth. These women may be experiencing primary or secondary sterility. The possibility is also that highly educated women have longer birth spacing after first birth. There could also be possibility that they desire no more children and such birth intervals remain open.

Results of 'previous birth interval' show that women who had shorter preceding birth interval, had a greater chance to have next child, whereas women who had longer preceding birth interval had their succeeding birth interval to be longer. This could be because the women would like to have next child due to loss of the index child or may desire to have a higher number of children. The nutritional status of mother was poorly associated with birth spacing in all the regions except in the eastern region. However, undernourished women were more likely to have longer duration of PPA after certain duration of breastfeeding but the effect on birth spacing was not observed.

The findings of the paper underscore how important it is for policymakers concerned with fertility reduction, health promotion of both mother and the child to monitor the level and trends in breastfeeding. An effort has been made to apprise the policymakers of the interrelation between breastfeeding, postpartum amenorrhea, contraceptive use and birth spacing. Nonetheless, policymakers should promote programs that encourage both breastfeeding and contraceptive use. Breastfeeding has direct benefits for infant health in addition to its role in lengthening birth intervals beyond PPA. Contraceptive use permits women to recuperate from the depleting effects of both pregnancy and breastfeeding (Merchant and Martorell, 1998), and also helps in increasing the birth interval.

In summary, in terms of policy implications, this study has revealed the importance of region specific epidemiological understanding of public health issues like postpartum amenorrhea and birth spacing. Within a region, findings may be helpful in planning that showed more region specific strategies. Child loss extended the birth spacing in each region significantly. Modifications in the behaviour of extended breastfeeding may also improve child survival leading to extended birth spacing. The results have reaffirmed the interrelationship between breastfeeding and birth spacing. In other words, extended birth spacing is necessary to ensure the survival of a child. In the same way, the survival of a child is necessary for extending the birth spacing.

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APPENDIX

Table 1. Mean duration of succeeding birth interval (in months) and its 95% confidence interval (CI) estimates for India and its regions -2005-06.

Country/Regions	Mean	95% CI	
		Lower	Upper
India	42.0	41.8	42.2
North	41.5	40.9	42.1
Central	39.3	38.9	39.8
East	42.6	42.1	43.2
Northeast	42.7	42.2	43.1
West	44.3	43.6	45.0
South	45.8	45.0	46.5

Table 2. Mean duration (Me) of succeeding birth interval (in months) and its 95% confidence interval (CI) estimates with respect to combination of breastfeeding and postpartum amenorrhea (PPA) for India and its regions -2005-06.

Country/ Regions	PPASBF-State (i)			PPACNBF-State (ii)			PPANEBF-State (iii)		
	Me	95% CI		Me	95% CI		Me	95% CI	
		Lower	Upper		Lower	Upper		Lower	Upper
India	36.1^{a}	34.3	38.0	29.8^{e}	29.5	30.1	26.3^{d}	25.2	27.4
North	32.9^{a}	29.3	36.5	29.1^{e}	28.2	30.0	25.7^{d}	23.2	28.2
Central	40.7^{d}	36.5	45.0	29.7^{f}	29.1	30.3	24.6^{e}	22.7	26.6
East	33.5^{a}	30.7	36.3	31.1^{e}	30.3	31.9	26.5^{d}	24.3	28.7
Northeast	33.7^{a}	30.7	36.7	29.6^{d}	28.8	30.3	26.0^{c}	23.6	28.3
West	35.0^{a}‡	28.9	41.2	29.4^{d}ns	28.2	30.6	31.0^{a}ns	25.8	36.2
South	38.1^{a}‡	31.8	44.4	29.7^{c}	28.2	31.2	32.0^{c}‡	26.7	37.2
India	57.1^{b}	56.8	57.4	43.1^{a}	42.9	43.4	36.2^{c}	35.1	37.4
North	55.4^{b}	54.0	56.7	42.8^{a}	42.1	43.5	36.0^{c}	33.3	38.8
Central	57.6^{a}	57.1	58.1	40.0^{c}	39.4	40.6	35.9^{b}	33.7	38.1
East	57.5^{b}	57.0	58.0	42.9^{a}	42.1	43.6	34.1^{c}	31.5	36.8
Northeast	57.0^{b}	56.5	57.5	43.3^{a}†	42.6	43.9	37.0^{a}†	34.2	39.7
West	57.0^{b}	55.7	58.3	46.9^{c}‡	46.0	47.7	34.8^{a}	30.7	38.9
South	55.0^{b}	53.6	56.4	48.0^{a}†	47.1	48.8	39.2^{a}†	35.7	42.8

Note: Means without common superscript letters are significantly different within row, P<=0.05

(Log-rank test) except few cases then it is denoted by †, ‡ and ns.

† Significantly different from other value, P<=0.05.

‡ Significantly not different from other value, P<=0.05.

ns Significantly not different from other value, P<=0.05.

State (i): PPASBF denotes mothers of those index children who were currently in PPA and breastfeeding.

State (ii): PPACNBF denotes mothers of those index children who were currently in PPA but not breastfeeding.

State (iii): PPANEBF denotes mothers of those index children who were currently in PPA but never

breastfed.

State (iv): NPPASBF denotes mothers of those index children who were currently not in PPA but breastfeeding.

State (v): NPPACNB denotes mothers of those index children who were currently not in PPA and not breastfeeding.

State (vi): NPPANEB denotes mothers of those index children who were currently not in PPA and never breastfed.

Table 3. Cox Hazards model for birth spacing by selected characteristics for India-2005-06

Variables	**Exp(β)**	**95% CI**	
		Lower	**Upper**
Region of residence			
South	1.00	-	-
North	1.19	1.09	1.30
Central	1.14	1.05	1.24
East	0.99	0.91	1.09
Northeast	1.03	0.94	1.13
West	1.02	0.92	1.12
Place of residence			
Urban	1.00	-	-
Rural	0.97	0.93	1.02
Religion			
Hindu	1.00	-	-
Muslim	1.04	0.99	1.10
Others	1.23	1.16	1.31
Mother's education			
Higher	1.00	-	-
Illiterate	1.01	0.91	1.13
Primary	0.95	0.85	1.07
Secondary	0.97	0.88	1.08
Standard of living			
Richest	1.00	-	-
Poorest	1.25	1.15	1.37
Poorer	1.29	1.19	1.40
Middle	1.29	1.20	1.39
Richer	1.20	1.12	1.29

Table 3. Cox Hazards model for birth spacing by selected characteristics for India-2005-06 (cont.)

Variables	Exp(β)	95% CI	
		Lower	Upper
Sex of index child			
Male	1.00	-	-
Female	1.08	1.04	1.12
Survival status of index child			
Alive	1.00	-	-
Dead	3.97	3.72	4.24
Mother's age at birth of index child (yrs.)			
20-24	1.00	-	-
< 20	1.10	1.04	1.15
25-29	0.63	0.60	0.67
30-34	0.42	0.38	0.45
35+	0.23	0.21	0.27
Current use of contraceptive			
Yes	1.00	-	-
No	1.08	1.03	1.13
Previous birth interval			
24-36 months	1.00	-	-
First birth	6.01	5.60	6.45
<24 months	1.16	1.10	1.23
>36 months	0.88	0.82	0.94
Number of surviving children			
Two	1.00	-	-
None	0.05	0.04	0.07
One	0.11	0.10	0.12
Three	2.90	2.73	3.07
Four and above	4.26	3.97	4.57
Maternal BMI			
>=18.5Kg/m^2	1.00	-	-
<18.5Kg/m^2	1.06	1.02	1.10
Missing	0.92	0.84	1.01
Breastfeeding (BF) and postpartum amenorrhea (PPA)			
Currently not BF and not in PPA	1.00	-	-
Currently BF and not in PPA	0.16	0.14	0.18
Never breastfed and not in PPA	1.31	1.20	1.43
Currently BF and in PPA	1.05	0.89	1.23
Never BF and in PPA	1.51	1.36	1.68
Currently not BF and in PPA	1.31	1.25	1.37

Table 4. Cox Hazards model for birth spacing by selected characteristics in the different regions of India-2005-06

Variable	North	Central	East	Northeast	West	South
Breastfeeding (BF) and postpartum amenorrhea (PPA)						
Currently not BF and not in PPA	1.00	1.00	1.00	1.00	1.00	1.00
Currently BF and not in PPA	0.23 (0.17 0.32)	0.09 (0.06 0.12)	0.13 (0.10 0.18)	0.18 (0.14 0.24)	0.24 (0.14 0.41)	0.38 (0.21 0.66)
Never breastfed and not in PPA	1.27 (1.04 1.55)	1.10 (0.93 1.29)	1.45 (1.18 1.78)	1.58 (1.28 1.94)	1.96 (1.42 2.70)	0.87 (0.61 1.24)
Currently BF and in PPA	1.03 (0.66 1.60)	0.79 (0.58 1.09)	1.23 (0.88 1.72)	1.23 (0.90 1.68)	1.22 (0.60 2.49)	1.12 (0.57 2.21)
Never BF and in PPA	1.40 (1.07 1.84)	1.74 (1.44 2.10)	1.67 (1.32 2.10)	1.49 (1.17 1.89)	1.03 (0.64 1.67)	0.73 (0.45 1.18)
Currently not BF and in PPA	1.23 (1.10 1.38)	1.24 (1.14 1.34)	1.45 (1.30 1.62)	1.41 (1.28 1.56)	1.25 (1.07 1.47)	1.12 (0.93 1.34)

Note: All the covariates mentioned in the Table 4 were controlled.

Table 5. Estimated probabilities of not having next live birth at specific months by selected characteristics for India -2005-06

Characteristics	**Probability of not having next live birth at months**						
	12	**18**	**24**	**30**	**36**	**42**	**48**
Average	0.98	0.90	0.77	0.64	0.54	0.46	0.40
Primary educated women[a]	0.98	0.90	0.77	0.65	0.55	0.47	0.41
Secondary educated women[b]	0.98	0.90	0.77	0.64	0.54	0.46	0.40
Survival of index child[c]	0.98	0.91	0.78	0.66	0.56	0.49	0.43
Current use of contraceptives[d]	0.98	0.91	0.78	0.65	0.55	0.48	0.41
In postpartum amenorrhea							
+Currently breastfeeding[e]	0.98	0.90	0.77	0.64	0.54	0.46	0.40
+Currently breastfeeding[f]	0.98	0.90	0.77	0.65	0.55	0.47	0.40
+Currently breastfeeding[g]	0.98	0.90	0.77	0.65	0.55	0.47	0.41
+Currently not breastfeeding[h]	0.98	0.90	0.77	0.64	0.54	0.46	0.40
Not in postpartum amenorrhea							
+Currently breastfeeding[e]	0.98	0.91	0.78	0.66	0.56	0.48	0.42
+Currently breastfeeding[f]	0.99	0.95	0.88	0.81	0.74	0.69	0.64
+Currently breastfeeding[g]	0.99	0.95	0.89	0.82	0.76	0.71	0.66
+Currently not breastfeeding[h]	0.98	0.90	0.77	0.64	0.54	0.46	0.40

Table 5. Estimated probabilities of not having next live birth at specific months by selected characteristics for India -2005-06 (cont.)

Characteristics	**Probability of not having next live birth at months**						
	12	**18**	**24**	**30**	**36**	**42**	**48**
Breastfeeding and postpartum amenorrhea (PPA) with survival of index child							
In PPA							
+Currently breastfeeding[e]	0.98	0.91	0.78	0.66	0.57	0.49	0.43
+Currently breastfeeding[f]	0.98	0.91	0.79	0.67	0.57	0.49	0.43
+Currently breastfeeding[g]	0.98	0.91	0.79	0.67	0.57	0.50	0.43
+Currently not breastfeeding[h]	0.98	0.91	0.78	0.66	0.57	0.49	0.43
Not in PPA							
+Currently breastfeeding[e]	0.98	0.91	0.80	0.68	0.59	0.51	0.45
+Currently breastfeeding[f]	0.99	0.96	0.89	0.82	0.76	0.71	0.67
+Currently breastfeeding[g]	0.99	0.96	0.90	0.83	0.78	0.73	0.68
+Currently not breastfeeding[h]	0.98	0.91	0.79	0.67	0.57	0.49	0.43
Breastfeeding and postpartum amenorrhea (PPA) with current use of contraceptives							
In PPA							
+Currently breastfeeding[e]	0.98	0.91	0.78	0.66	0.56	0.48	0.42
+Currently breastfeeding[f]	0.98	0.91	0.78	0.66	0.56	0.48	0.42
+Currently breastfeeding[g]	0.98	0.91	0.78	0.66	0.56	0.49	0.42
+Currently not breastfeeding[h]	0.98	0.91	0.78	0.66	0.56	0.48	0.42
Not in PPA							
+Currently breastfeeding[e]	0.98	0.91	0.79	0.67	0.58	0.50	0.44
+Currently breastfeeding[f]	0.99	0.95	0.89	0.82	0.76	0.70	0.66
+Currently breastfeeding[g]	0.99	0.96	0.89	0.83	0.77	0.72	0.68
+Currently not breastfeeding[h]	0.98	0.91	0.78	0.66	0.56	0.48	0.42

Note:

[a] Mothers of those index children who were illiterate considered as educated up to primary level.

[b] Mothers of those index children who were illiterate and has primary level education considered as educated up to secondary level.

[c] All dead children were considered as surviving.

[d] Mothers of those index children who were not using spacing method considered as c urrently using spacing method.

[e] Mothers of those index children who never breastfed considered as currently breastfeeding.

[f] Mothers of those index children who were currently not breastfeeding considered as currently breastfeeding.

[g] Mothers of those index children who never breastfed and were currently not breastfeeding considered as currently breastfeeding.

[h] Mothers of those index children who never breastfed considered as currently not breastfeeding.

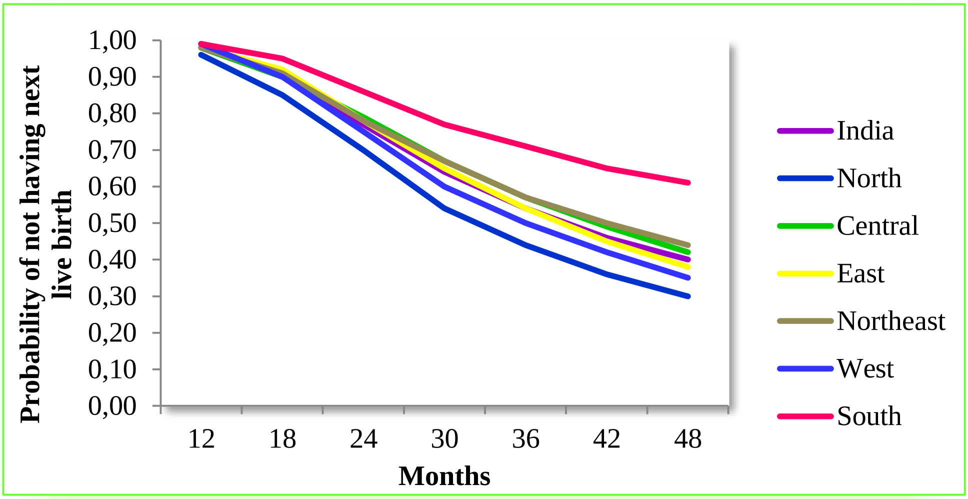

Figure 1. Estimated probabilities of not having next live birth at specific months in India and its regions-2005-06

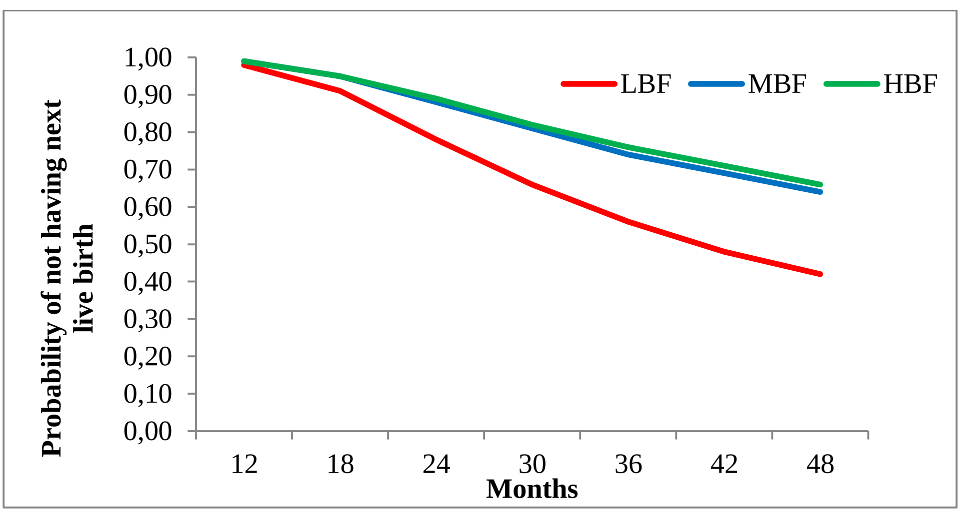

Figure 2. Estimated probabilities of not having next live birth at specific months by those women who were not in PPA by different levels of breastfeeding in India-2005-06

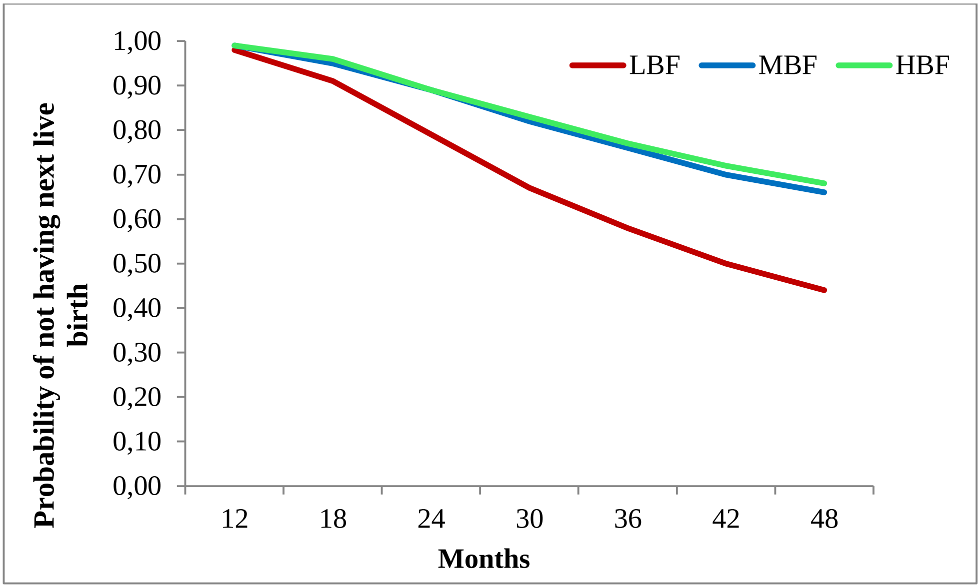

Figure 3. Estimated probabilities of not having next live birth at specific months by those women who were not in PPA and were currently using contraceptives by different levels of breastfeeding in India-2005-06