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Estimating Duration of Post-Partum Amenorrhoea through Breastfeeding Duration

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Introduction

Human fertility is influenced by a number of biological and behavioural factors. Davis and Black (1956) have identified eleven key factors as the proximate determinants of fertility. These factors are categorised as intercourse, conception and gestation related factors. Henry (1961) has pointed about the influence of breastfeeding on fertility or equivalently to the fact that the post-partum amenorrhoea (PPA) depends on the duration of breastfeeding. Among all the proximate determinants of fertility, PPA is the one which directly affects the natural fertility (Bongaarts, 1978).

PPA is the duration between the birth and the resumption of menstruation. During this period, there is very little probability of conception and, therefore, this period is also known as the period of temporary infecundability. It plays an important role in deciding the level of fertility by increasing the inter-live birth interval (Potter et al, 1965). Under natural fertility conditions, the first birth interval (duration between the marriage and the first birth) is on an average shorter than the interval between the first and the second birth because of the absence of the period of post partum amenorrhoea.

Breastfeeding is also an important biological factor that contributes to child survival and child health because it is an inexpensive and appropriate source of nutrients and a key factor in developing a strong emotional relationship between mother and child. During breastfeeding, the nipple-suckling by the child stimulates receptors in the breast nipple that initiate a neural signal to the hypothalamus, a nerve centre in the brain. The hypothalamus signals the pituitary gland to increase the production of the hormone prolactin which inhibits ovulation either by reducing the release of gonadotropic hormones needed for ovulation or by directly affecting the ovaries (Bongaarts and Potter, 1983). The frequency and the intensity of suckling, and the number of months the child is breastfed, are important determinants of the length of PPA (Labbok and Krasovec, 1990; McCann et al, 1981; Simpson-Herbert and Huffman, 1981). In the absence of breastfeeding, the

average duration of PPA may last between one and three months. When breastfeeding is initiated just after the childbirth, the duration of PPA increases with the increase in the duration of breastfeeding (Bongaarts and Potter, 1983; Santow, 1987).

There are many factors which may be responsible for the resumption of menstruation after birth. It is, therefore, difficult to estimate, accurately, the duration of PPA. Data on the duration of PPA also suffer from a number of biases such as recall laps, digit preference, etc. Therefore, a number of models have been developed to estimate the average duration of PPA by exploring the relationship between the average duration of PPA and the mean duration of breastfeeding (Bongaarts and Potter, 1983; Singh and Berman, 1976; Yadava and Islam, 1994). Regression analysis has generally been used to obtain the relationship between the mean duration of breastfeeding and the duration of PPA under the assumption that the duration of PPA is a function of the duration of breastfeeding (Leridon, 1977; Van Ginneken, 1974). In the present study, we propose a new model describing the relationship between the duration of PPA and the mean duration of breastfeeding and compare our results with results obtained from already available models. We conclude that results based on our model are comparatively better than the results based on other models.

Data and Methodology

A number of models have been developed to estimate the average duration of PPA on the basis of the mean duration of breastfeeding. These include:

Bongaarts and Potter (1983) exponential model-I

$$P = 1.753e^{(0.1396L - 0.001872L^2)} \quad (1)$$

Bongaarts & Potter (1983) exponential model-II

$$P = 3.186e^{(0.0937L - 0.00158L^2)} \quad (2)$$

Yadava & Islam (1994) linear regression model

$$P = 3.147 + 0.474L \qquad L \leq 18\,months$$
$$P = 8.431 + 0.182L \qquad L > 18\,months \quad (3)$$

Singh and Barman (1976) quadratic model

$$P = 2.7064 + 0.6379L - 0.0086L^2 \quad (4)$$

where P is the duration of *PPA* and L is the mean duration of breastfeeding.

It may, however, be observed that the mean duration of breastfeeding varies from 3-40 months whereas the average duration of *PPA* ranges from 4-14 months. Thus, the range of the mean duration of breastfeeding is 36 months but the range of the average duration of *PPA* is only 10 months. In order to ensure that the range of the dependent variable and the range of the independent or explanatory variable in the regression analysis remains nearly the same, we have used the natural logarithmic transformation of the mean duration of breastfeeding and estimated the average duration of *PPA* on the basis of the following regression model:

$$P = \alpha + \beta \ln(L) + \varepsilon \quad (5)$$

Equation (5) was fitted using the data available from India's National Family Health Survey 2015-16 which yielded the following relationship between the average duration of *PPA* and the mean duration of breastfeeding:

$$P = 4.18 \ln(L) - 0.58 \quad (6)$$

with a coefficient of determination (R^2) of 0.98. The constant term in equation (6) is only 0.58 while the regression coefficient is 4.18. Hence, for all practical purposes, the average duration of *PPA* may be obtained as four times the natural logarithm of the mean duration of breastfeeding. Thus, the final mathematical relationship between the average duration of *PPA* and the mean duration of breastfeeding may be defined as follows:

$$P = 4 * \ln(L) \quad (7)$$

In order to examine the suitability of the model (7), we have applied equation (7) along with other models to the data available from surveys carried out in The Philippines, Taiwan and India. Data for the Republic of the Philippines come from the fertility survey conducted in the country (RPFS, 1978) under the WFS programme (Reyes, 1981). Data from Taiwan are taken from Jain et al (1979) while data for India are taken from Singh and Barman (1976). We have also used data available for India and its major states available through the National Family Health Survey 2015-16.

Results and Discussion

Tables 1, 2 and 3 show the estimated average duration of *PPA* obtained from the mean duration of breastfeeding on the basis of different models described above respectively for the Republic of the Philippines, Taiwan and India while table 4 presents estimated average duration of *PPA* for India and its major states. Table 5 shows the simple zero order correlation coefficient between observed duration of *PPA* with estimated duration of *PPA* obtained on the basis of different models including the model proposed in this paper.

From table 1, we find that the estimated duration of *PPA* derived on the basis of the models by Bongaarts and Potter; Yadava and Islam; and Singh and Barman corresponding to mean duration of breastfeeding of 3 months is respectively 2.62, 4.21, 4.57 and 4.20 months while the estimate derived from the model proposed in this paper is 4.39 months. When the mean duration of breastfeeding is 18 months, the Bongaarts and Potter model; the Yadava and Islam model; and the Singh and Barman model give the estimate of average duration of *PPA* as 11.8, 11.0, 11.7 and 10.5 months respectively compared to the observed average duration of *PPA* of 10.9 months, whereas according to the proposed model, the average duration of *PPA* is 11.6 months. When the mean duration of breastfeeding is 30 months, the estimated average duration of *PPA* as obtained by the earlier models is 21.4, 14.2, 13.9 and 12.8 months respectively against the observed average duration of PPA of 12.5 months while according to the proposed model, the estimated average duration of *PPA* is 13.6 months. Thus, the proposed model provides a fairly good estimate of the average duration of *PPA* for the Philippines data which is in the close approximation of the estimate of the average duration of *PPA* obtained from other models.

Figure 1
Mean duration of PPA according to different models

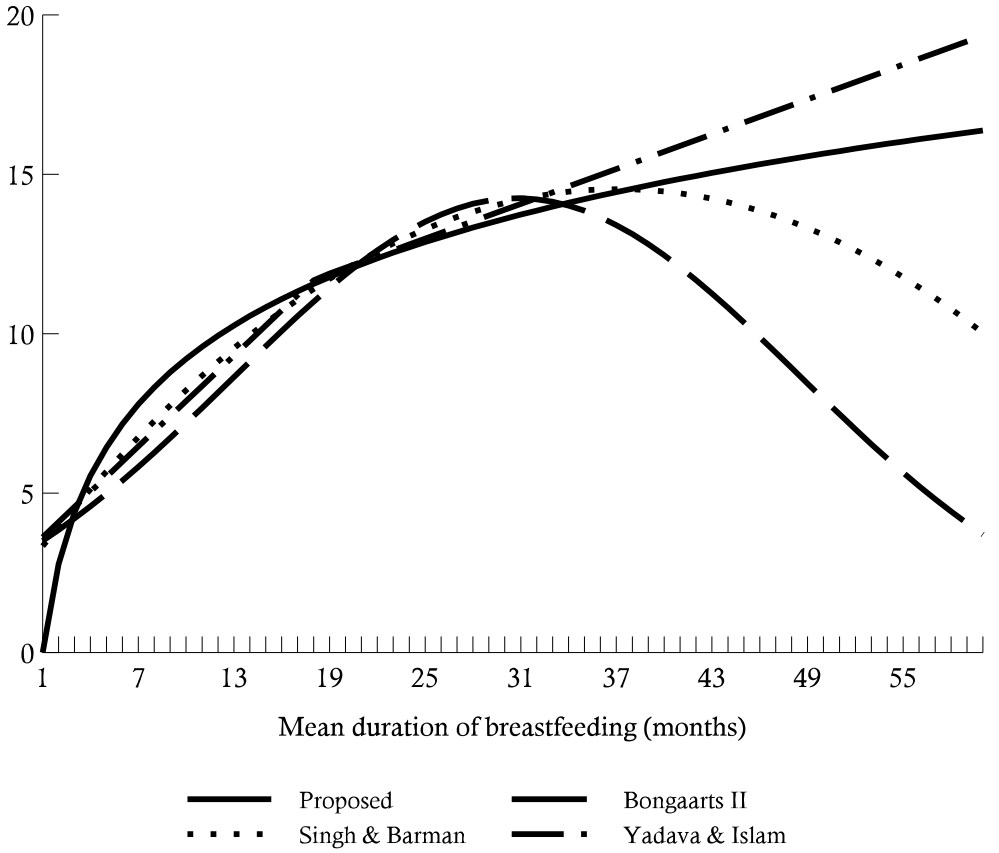

Table 2 provides estimates of the average duration of *PPA* derived from the mean duration of breastfeeding in Taiwan and it can be seen from the table that the estimates of the average duration of breastfeeding obtained from the proposed model are in the close approximation to the estimates obtained from other models. Specifically, estimates derived from the proposed model are very similar to the estimates derives derived from the Yadava and Islam model. Similarly, table 3 shows that for India also, estimates of the average duration of *PPA*, based on the mean duration of breastfeeding by the proposed model, are very similar to estimates obtained from other models.

Table 4 provides estimates of the average duration of *PPA* derived from the proposed model and from other models for rural, urban and combined population of India and Uttar Pradesh, the most populous state of the country, on the basis of the data available from the National Family Health Survey 2015-16. It may be seen from the table that the proposed model provides a good approximation of the average duration of *PPA,* particularly when the mean duration of breastfeeding is not very large. It may be seen from the table that the average duration of *PPA* in India is longer than that in Uttar Pradesh irrespective of the mean duration of breastfeeding. This indicates that there is a spatial heterogeneity in the average

duration of *PPA* in India which has implications for the level of fertility. It may also be seen from the table that the average duration of *PPA* in the rural areas of either India or Uttar Pradesh is almost one month longer than that in the urban areas. It is a matter of further investigation, how the relatively longer average duration of *PPA* contributes to rural-urban differentials in fertility in India and in Uttar Pradesh.

Figure 1 shows how the average duration of *PPA* varies with the mean duration of breastfeeding on the basis of different models including the proposed model. It is expected that with the increase in the mean duration of breastfeeding, the average duration of *PPA* should also increase up to a certain duration of breastfeeding and then further increase in the mean duration of breastfeeding should have a diminishing return in terms of the increase in the average duration of *PPA*. However, according to Bongaarts and Potter; and Singh and Barman models, the average duration of *PPA* first increases with the increase in the mean duration of breastfeeding and then decreases with the further increase in the mean duration of breastfeeding. The decrease in the mean duration of *PPA* after a certain level of the mean duration of breastfeeding is not acceptable as the mean duration of *PPA* cannot decrease. At best, it should remain unchanged or should not be affected by the mean duration of breastfeeding. On the other hand, according to Yadava and Islam model, the average duration of *PPA* increases consistently with the increase in the mean duration of breastfeeding. It is worthwhile to mention here that after a certain duration, breastfeeding influences little the duration of *PPA*. According to the proposed model, however, the average duration of *PPA* increases with the increase in the mean duration of breastfeeding up to a certain extent only. Further increase in the mean duration of breastfeeding has virtually no impact on the average duration of *PPA*. The relationship between the mean duration of breastfeeding and the average duration of *PPA* reflected through the proposed appears to be more realistic.

Lastly, table 5 shows the simple zero order correlation coefficients between observed average duration of *PPA* with the estimated average duration of *PPA* obtained from different models. All the models show very high degree of correlation between the observed and the estimated average duration of *PPA*. The advantage of the model proposed here is that, unlike other models, this model is computationally very simple and the average duration of *PPA* can be obtained just with the help of a simple calculator if the mean duration of breastfeeding is known. It can be used as an alternative to the existing models.

Conclusions

In this paper, we have proposed an alternative model of estimating the mean duration of post partum amenorrhoea (*PPA*) on the basis of the mean duration of breastfeeding. The main advantage of the method proposed by us in this paper is that it is very simple and easy and straightforward to calculate. The method that we have proposed does not require complex mathematical calculations as is the problem with earlier models. Because of its simplicity, the model proposed in this paper can be effectively used in the field conditions by field level functionaries.

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Table 1
Mean duration of breastfeeding, observed and estimated average duration of *PPA* for The Philippines

Mean duration of breastfeeding (Months)	Observed average duration of *PPA* (Months)	Estimated average duration of *PPA* by different models				
		Bongaarts and Potter I	Bongaarts and Potter II	Yadava and Islam	Singh and Barman	Proposed model
3	4.5	2.62	4.21	4.57	4.20	4.39
4-5	4.6	3.16	4.78	5.28	5.00	6.02
6	5.8	3.79	5.40	5.99	5.76	7.17
7-8	6.5	4.50	6.05	6.70	6.49	8.06
9-11	7.2	5.87	7.20	7.89	7.61	9.21
12	8.6	7.15	8.16	8.84	8.43	9.94
13-17	9.8	9.34	9.61	10.26	9.54	10.83
18	10.9	11.79	11.00	11.68	10.49	11.56
19-23	11.3	14.40	12.25	12.25	11.29	12.18
24	11.9	17.00	13.25	12.80	11.94	12.71
25-29	11.9	19.41	13.93	13.35	12.43	13.18
30	12.5	21.42	14.24	13.89	12.77	13.60
31-35	13.4	22.86	14.14	14.44	12.96	13.99

Source: Authors' calculations

Table 2
Mean duration of breastfeeding, observed and estimated average duration of *PPA* for Taiwan

Mean duration of breastfeeding (Months)	Observed average duration of *PPA* (Months)	Estimated PPA by different methods				
		Bongaarts and Potter I	Bongaarts and Potter II	Yadava and Islam	Singh and Barman	Proposed model
1-3	3.8	2.30	3.85	4.10	1.58	2.77
4-6	5.7	3.36	4.98	5.52	5.19	6.44
7-9	6.3	4.75	6.27	6.94	8.26	8.32
10-12	8.5	6.49	7.67	8.36	10.78	9.59
13-18	11.1	9.73	9.85	10.49	13.56	10.96
19-24	14.2	14.84	12.43	12.34	15.36	12.27
25-30	14.6	19.78	14.01	13.44	14.99	13.26
31+	15.2	21.98	14.25	14.07	13.78	13.74

Source: Authors' calculations

Table 3
Mean duration of breastfeeding, observed and estimated average duration of *PPA* for India

Mean duration of breastfeeding (Months)	Observed average duration of *PPA* (Months)	Estimated PPA by different methods				
		Bongaarts and Potter I	Bongaarts and Potter II	Yadava and Islam	Singh and Barman	Proposed model
3	4.44	2.62	4.21	4.57	4.54	4.39
9	7.94	5.29	6.73	7.41	7.75	8.79
15	10.68	9.34	9.61	10.26	10.34	10.83
21	11.51	14.40	12.25	12.25	12.31	12.18
27	13.96	19.41	13.93	13.35	13.66	13.18
33	14.64	22.86	14.14	14.44	14.40	13.99
39	14.37	23.53	12.81	15.53	14.50	14.65

Source: Authors' calculations

Table 4
Mean duration of breastfeeding, observed and estimated duration of *PPA* for rural and urban areas of India and Uttar Pradesh based on the proposed model

Mean duration of breastfeeding	Observed average duration of *PPA*			Average duration of *PPA* obtained from the proposed model
	Total	Urban	Rural	
		India		
1-3	4.67	4.49	4.74	2.77
4-6	5.50	5.30	5.57	6.44
7-9	6.12	5.87	6.20	8.32
10-12	6.95	6.50	7.12	9.59
13-18	7.23	6.70	7.42	10.96
19-24	7.69	6.75	8.01	12.27
25-30	7.78	6.95	8.02	13.26
31+	8.75	7.89	8.97	13.74
		Uttar Pradesh		
1-3	3.14	2.62	3.30	2.77
4-6	4.46	3.73	4.72	6.44
7-9	4.77	4.23	4.93	8.32
10-12	5.83	5.32	6.01	9.59
13-18	6.29	5.57	6.51	10.96
19-24	6.52	5.42	6.88	12.27
25-30	6.45	5.81	6.62	13.26
31+	7.49	6.20	7.75	13.74

Source: Observed values of average duration of *PPA* are from IIPS (2017). Estimated values are calculated by the authors.

Table 5
Simple zero order correlation coefficient between observed and expected duration of *PPA*

Countries	Bongaarts & Potter I	Bongaarts & Potter II	Yadava & Islam	Singh & Barman	Proposed Model
Philippines	0.953**	0.988**	0.997**	0.995**	0.986**
Taiwan	0.961**	0.994**	0.995**	0.938**	0.956**
India	0.958**	0.978**	0.986**	0.994**	0.988**

** Correlation is significant at the 0.01 level.
Source Authors' calculations.