

Nutrition, lactation, and postpartum amenorrhea^{1, 2}

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Chronic protein-calorie malnutrition and prolonged lactation are characteristics of poor societies in developing nations. These societies are also characterized by rapid population growth rates.

Most developing nations are in a state of flux. With increasing westernization and migration to urban centers, both the prevalence and the duration of lactation are rapidly decreasing (1). At the same time, nutrition and health conditions are changing, improving in some and deteriorating in other regions of the world. Lastly, population growth rates continue to be high, the enormous investment that has gone into family planning programs having proven to be largely unsuccessful.

Viewed simply, population growth is determined by both birth and death rates. Birth rate is affected by the biological capacity to conceive (fecundity) and by the extent to which this potential is realized (i.e., age of first union, coital frequency, contraception, etc.).

In many regions of the developing world, population growth rates are such that fecundity is almost maximal; therefore, factors which affect fecundity are key determinants of population changes in these societies.

Menarche and menopause circle the reproductive life of a woman. In developing nations, this roughly corresponds to the ages of 15 and 45 years, respectively, yielding a reproductive life of nearly 30 years. Two periods of infertility may repeatedly occur throughout the reproductive life, pregnancy and postpartum amenorrhea. The latter period is that immediately following birth during which menstruation is absent. Postpartum amenorrhea is the most variable component of the interval between births (2). For instance, means of 2 months

have been reported for some populations, while for others, means as high as 14 months have been observed (3). This variability appears to be almost entirely determined by biological factors, such as the nutritional status of the mother or hormonal mechanisms.

The aim of this paper is to summarize existing but otherwise dispersed findings on the influence of two factors, nutritional status and length of lactation, on the length of postpartum amenorrhea. The hypothesis entertained is that poor nutritional status as well as the presence of lactation, prolong the period of postpartum amenorrhea and consequently reduce fecundity.

Nutrition and postpartum amenorrhea

Several authors have postulated that malnutrition lowers the reproductive capacity of populations (4-6).

Some experimental evidence supports the plausibility of the above hypothesis. Chávez and Martínez (7), working with a small sample of Mexican women, report findings which suggest that one of the effects of supplementing the diet of pregnant and lactating women is to significantly reduce the duration of postpartum amenorrhea in nursing women. In their study, mothers receiving food supplementation (about 300 cal/day) began menstruating 7.5 months after delivery as compared to control mothers, who began 14 months after having given

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birth. Similarly, our preliminary analyses (8, 9) also suggest that caloric supplementation to the mother during pregnancy and lactation significantly decreases the length of postpartum amenorrhea. Our data indicate that mothers supplemented with more than 20,000 cal during their entire pregnancy (about 100 cal/day) had a statistically significant (t value = 2.24, $P < 0.05$) shorter postpartum amenorrhea (12.4 months S.E. = 0.57) than those mothers who consumed less than 20,000 cal during pregnancy (13.9 months S.E. = 0.36). The greater effect observed by Chávez and Martínez (7) may be due to the larger number of calories consumed by the population studied. Data on possible confounding factors such as dietary and suckling patterns in the child are not currently available for either study.

The possibility that nutrition is related to amenorrhea is also given some support by the findings of Lev-Ran (10) who reported cases of secondary amenorrhea in young normal women following strict diets to reduce weight. Again, the prevalence of amenorrhea has been reported to increase during times of severe food shortage and famine (11).

In summary, different lines of evidence suggest that nutrition may be an important determinant of human ovulation. While this proposition seems reasonable, there is at present insufficient scientific data to support it.

Lactation and postpartum amenorrhea

Most of the evidence on the relationship between lactation and postpartum amenorrhea comes from hospital studies. These studies have shown that the duration of lactation is positively associated with the duration of postpartum amenorrhea (12–23). It has also been reported that menstruation is absent in practically all women during the early months of lactation and that as lactation proceeds, the proportion of women menstruating increases (16, 24). This indicates that there is an inhibitory influence of lactation on ovulatory functions which progressively loses power as the duration of lactation increases. Tietze (3) suggests that lactation could delay pregnancy

even after ovulation has been resumed by interfering with the process of implantation. Results from special field surveys conducted in rural villages in India (18), Alaska (21), and Bangladesh (23) have demonstrated that the median length of amenorrhea for women with a surviving breast-fed child was over 10 months. In contrast, women who did not nurse their infants experienced a shorter duration of amenorrhea, with a median length of 2 months.

The length of postpartum amenorrhea is associated not only with the duration of lactation but also with whether or not an infant is receiving supplementary foods (15, 24, 25). It has been postulated that nutritional supplements may discourage lactation through a "substitution" effect which leads to diminished suckling, and thereby shortens the period of postpartum amenorrhea (26).

Interrelationships and confounding factors

Duration of postpartum amenorrhea is also associated with per capita income; mothers from high socioeconomic groups (19, 24, 27) are amenorrheic for shorter periods than mothers from low socioeconomic groups (16, 20, 28). Table 1 presents the results of some selected studies. It shows the probability of lactating women being amenorrheic by the end of a specific number of months after delivery. These data suggest that mothers from low socioeconomic groups present a higher probability of remaining amenorrheic during the first 6 months after delivery than mothers from high socioeconomic groups. However, this comparison must be viewed with caution because of the series of underlying assumptions involved, particularly concerning the definition of lactation status and the methodology used in each study.

Another way of looking at the reported data consists of comparing the slopes between duration of lactation and duration of postpartum amenorrhea in two different socioeconomic groups. Figure 1 shows the regression lines computed from the data of Salber et al. (19) for Boston women lactating for more than a month and from data reported by Jain et al. (29) who studied nursing women in Taiwan. Clearly, for the

TABLE 1
Probability of being amenorrheic, in lactating women by postpartum month

Studies and site	Months postpartum						Observations
	1	2	3	4	5	6	
Chen et al. Bangladesh, 1974 (23)	1.00	0.98	0.96	0.95	0.93	0.92	Prospective study of rural populations. Low socioeconomic status. Full nursing.
Potter et al. India, 1965 (18)	0.94	0.91	0.86	0.83	0.79	0.74	Prospective study of rural population. Low socioeconomic status. Less than half of the infants received only milk by the 6th month after delivery.
Berman et al. Eskimos, 1972 (21)	0.97	0.91	0.85	0.75	0.70	0.65	Prospective study of rural population. Low socioeconomic status. Usually nursing was supplemented when the infant was 6 months old.
Pérez et al. Chile, 1972 (25)	1.00	0.99	0.83	0.71			Prospective study of urban, low-middle socioeconomic class. Full Nursing.
Salber et al. Boston, 1966 (19)	1.00	0.86	0.76	0.71	0.50	0.35	Prospective study of urban, middle, socioeconomic status. Computed for those mothers lactating 6 months or more.

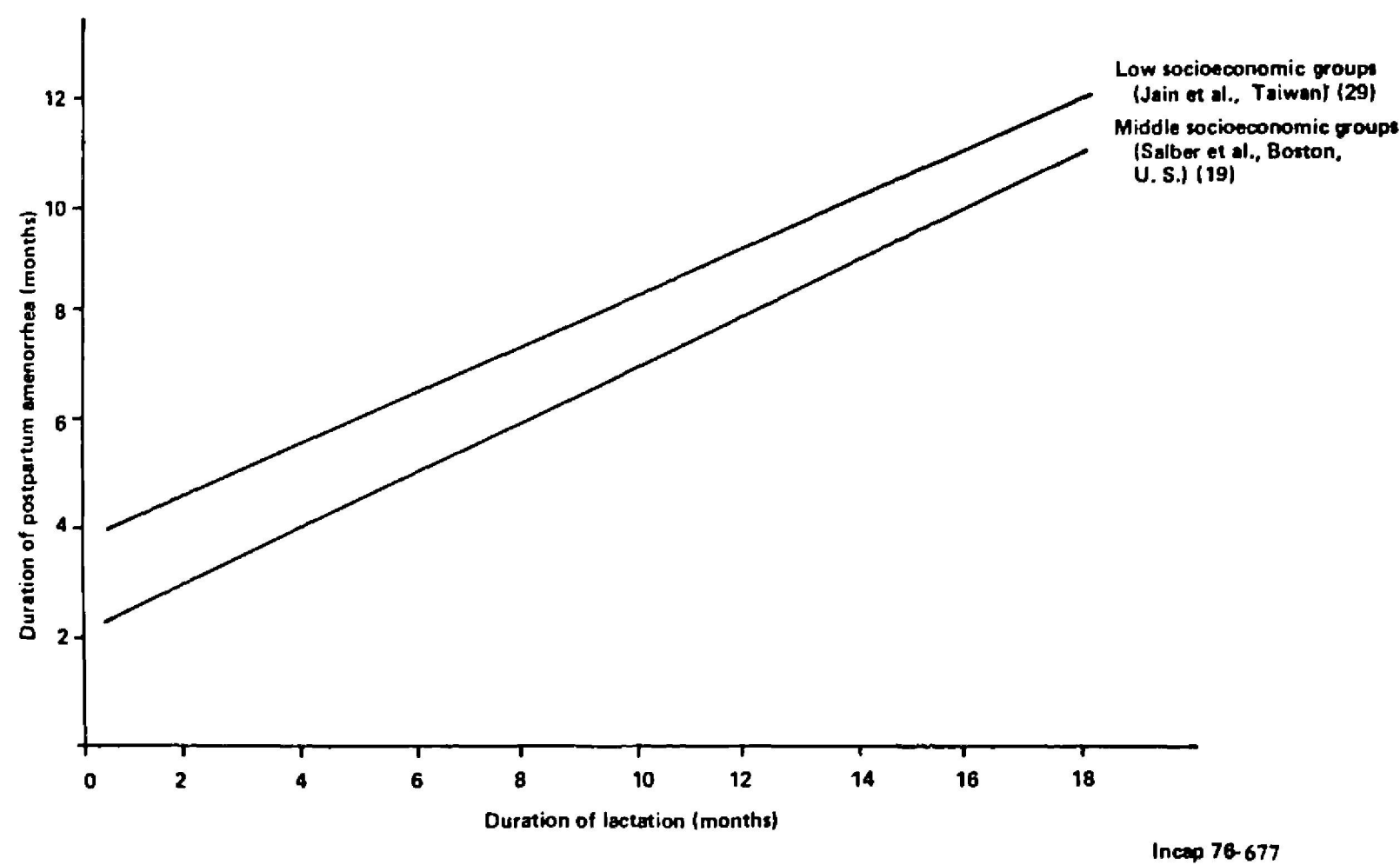


FIG. 1. Relationship between duration of lactation and length of postpartum amenorrhea by two levels of socioeconomic status.

same duration of lactation, mothers from Taiwan (low socioeconomic group) present a longer postpartum amenorrhea than mothers from Boston (middle class). These reports imply that in addition to duration of lactation, factors related to socioeconomic status may affect the duration of postpartum amenorrhea. Nutrition could be one of these factors (19, 23, 30) given that the increased nutritional demands of pregnancy

and lactation are easily coped with in high socioeconomic groups, but not in lower class, malnourished women (31).

Hormonal mechanism: effect of lactation on postpartum amenorrhea

It is commonly assumed that lactation inhibits ovulation. However, very little is known about the mechanisms involved in

this relationship. It has been recently postulated that prolactin, secreted by the anterior pituitary as a response to suckling (32–41), may be the factor related to lactation which inhibits ovulation. There is evidence suggesting that high prolactin levels are associated with amenorrhea and, conversely, that low prolactin levels are associated with ovulation and menstruation (42). Though it has been suggested that the corpus luteum is responsive to gonadotrophic stimulation postpartum (43), *in vitro* studies show that prolactin influences ovulation by inhibiting the secretion of progesterone by the corpus luteum even in the presence of markedly high leutinizing hormone and/or follicle stimulating hormone levels (44). Prolactin therefore may create a state of ovarian insensitivity to gonadotrophic stimulation (45). Another possible mechanism may be that lactation triggers events which reduce the gonadotrophic activity of the anterior pituitary. Though there is conflicting evidence (46), it appears that the secretion of leutinizing hormone and follicle stimulating hormone by the pituitary is suppressed in lactation (47–49). From the preceding discussion it is clear that much work remains to be done before the mechanisms whereby lactation affects ovulation are understood.

Discussion


There is much observational evidence indicating that environmental factors such as health and nutritional status affect the duration of postpartum amenorrhea. These conclusions are mostly derived from comparisons of high and low socioeconomic groups. Consequently, until the relative impact of other factors also varying across socioeconomic status is known, the influence of nutrition and health will remain obscure. Experimental evidence, which would logically circumvent these objections, is unfortunately very scant. The few experiments which have been conducted do suggest that the length of postpartum amenorrhea is reduced in mothers whose diets are supplemented. However, suckling frequency and supplemental feeding to the infant—significant factors in the postulated association between prolactin levels and amenorrhea—were not specifically controlled.

Available evidence on the relationships between lactation and postpartum amenorrhea indicates that the longer the duration of lactation, the longer the period of postpartum amenorrhea. It has been estimated that prolonged lactation extends the period of postpartum amenorrhea about nine months beyond the usual in populations not breast feeding at all. Consequently, the interval between births would be increased by 50% (3). In summary, the data reviewed suggest that poor nutrition and prolonged lactation lengthen the period of postpartum amenorrhea, and consequently, decrease reproductive capacity.

Since poor nutrition and prolonged lactation are characteristics of poor societies in developing nations, it is tempting to infer that fertility would be much higher in these areas were it not for these factors. Public health officials usually recommend that women in poor societies breast-feed their infants as long as possible in order to facilitate better health and nutrition in children (1). As seen earlier, this would lower fertility.

Similarly, public health officials everywhere strive for bettering the nutritional status of mothers. What impact would successful attainment of this objective have on fecundity? Poor nutritional status probably increases the length of postpartum amenorrhea and thus the infertile period. Paradoxically, bettering maternal nutritional status may not result in increased fecundity for the following reasons. Better nutrition seems to be associated with longer periods of lactation (50). Further, better maternal nutrition could reduce infant mortality (51) and should therefore, prolong lactation in cases where death would have occurred. The increase in the length of lactation may prolong postpartum amenorrhea, hence, partially or totally compensating for the shortening effect of nutrition *per se* on postpartum amenorrhea.

While better maternal nutrition would not necessarily result in greater fecundity in poor societies where prolonged lactation is a universal practice, the impact of better nutrition would increase the number of surviving children. It has been speculated that once parents perceive this change, the motivation for using birth control measures is

increased. Further, it has been suggested that family planning has greater acceptance when it is part of a complete package including health and nutrition. 

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