

Factors Influencing Milk Insufficiency and its Long-Term Health Effects: The Bedouin Infant Feeding Study

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Women who breastfeed have frequently reported milk insufficiency as the reason for introducing the bottle, but no one has addressed its potential long-term health effects. This paper described the factors associated with milk insufficiency versus another reason for introducing the bottle and its potential health effects based on an analysis of a prospective cohort study of 1005 Bedouin Arab women who delivered healthy newborns in 1981 and 1982. By two months postpartum, 72% introduced the infant to the bottle with 72% reporting milk insufficiency as the reason for introducing the bottle. The percentage of milk insufficiency declined with increasing age of the infant.

Based on multiple logistic regression analyses, birth season was statistically significantly associated with the odds ratio (OR) of milk insufficiency versus another reason for introducing the bottle during the first two months. Women who delivered in the spring-summer had an increased OR = 1.65 of reported milk insufficiency compared with those who delivered during the rest of the year. Parity was directly related to the OR = 1.04 of milk insufficiency (but just missed significance) during one to two months and was statistically significantly associated with the OR = 1.12 of reported milk insufficiency during 3-18 months.

The rates of stunting after the infant was introduced to the bottle and the duration of breastfeeding did not differ by reason for introducing the bottle. Thus the high frequency of reported milk insufficiency was not associated with adverse health effects.

Women who breastfeed have frequently reported milk insufficiency as the reason for introducing the bottle.¹⁻² For example, in The Nine Country WHO Breast Feeding Study, from 15% to 87% of the mothers, who initially breastfed, were reporting milk insufficiency as the reason for introducing the bottle during the first three months postpartum.³ The percentage of reported milk insufficiency declined with child's age and was directly associated with socioeconomic status.³ In other studies, the range of reported milk insufficiency was from 27% to 63% during the first four months postpartum and the percentage varied among urban-rural residents.⁴⁻⁸ To date, biological and cultural factors potentially associated with the reporting of milk insufficiency have not been addressed. Moreover the potential health effects of milk insufficiency as the reason for introducing the bottle have not been examined, and in only one study,⁷ data were retrospectively

collected to determine the association between milk insufficiency and duration of breastfeeding.

The Bedouin Infant Feeding Study was a prospective cohort study among Bedouin Arab residents of the Negev, Israel. The study was conducted (1981-1984) during a period of transition from a traditional seminomadic lifestyle, where bottle feeding was impractical, to planned urban settlement with greater access to markets, hospitals, and breastmilk substitutes. During the study, selected mother-infant pairs were followed to determine the duration of exclusive and partial breastfeeding and to describe the factors influencing changes in infant feeding practices.

The objectives of this paper are: 1) to examine both biological and cultural factors that might potentially influence the reporting of milk insufficiency compared with another reason for introducing the bottle during infancy; and 2) to examine the potential effects of the reported reason for introducing the bottle on the rates of stunting and the duration of any breastfeeding. The Bedouin Infant Feeding Study was a collaborative effort

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between the National Institute of Child Health and Human Development (Division of Prevention Research) in Bethesda, Maryland and the Center for Health Sciences at the Ben Gurion University (BGU) of the Negev in Beer Sheva, Israel.

METHODS

Three subcohorts of births in 1981 and in 1982 were followed from six to 12 through 18 months (1981 births) or from birth to two through nine months or from birth through the first six months of life (1982 births).⁹ The follow-up subcohorts (N = 1501) were selected from mothers, who delivered newborns weighing >2500g in hospital (average hospital stay = three days).⁹ Approximately 97% of all births were delivered at the Soroka Medical Center Hospital which serves the Negev. Among 1501 mother-infant pairs in the follow-up, the following groups were excluded from the analysis: 1) 62 mothers who exclusively bottle fed; 2) 34 who were missing the age of introduction of the bottle; and 3) 400 mothers who breast and solid fed. Respondents were not asked the reason for introducing solids because pre-study ethnographic research did not reveal specific reasons such as milk insufficiency for introducing semi-solids. The remaining 1005 infants in the analysis were equally distributed by infant's sex; had similar mean birthweights by reason for introducing the bottle; and over 90% were vaginal deliveries (Table 1). Over 80% of the mothers were aged 20-39 years and were multiparae. The families were fairly equally distributed by place of residence, which was characterized by semi-nomadic tent dwellers among the traditional; by tent and hut dwellers among the transitional; and by house dwellers among the established.

Female Arab students at the BGU were trained to administer pretested interview questionnaires by an anthropologist (GLH) with extensive field experience among the Bedouin Arabs of the Negev.¹⁰ The interviews were conducted at the respondent's home at 2, 6, 9, 12, or 18 months dependent upon the subcohort (1981-birth or 1982-birth). At each interview of a subcohort, the questionnaire focused on items relating to specific cultural and developmental issues, while core data were collected across interviews. Core items included the infant feeding practices from birth until the interview; the frequency of breast and bottle feeds during the 24 hours before the interview, and of nursing problems; the intended duration of breastfeeding; as well as the reasons for introduction of milk/formula in bottle and for terminating breastfeeding.

The respondent was asked 'What was the reason for giving your baby milk from a bottle?' The mother

TABLE 1. Characteristics of the milk insufficiency sample (N = 1005)

Characteristic	
Sex (%)	
Male	50.9
Female	49.1
Birthweight in grams (X)	
Milk insufficient (N = 648)	3220
Other (N = 357)	3217
Type of delivery (%)	
Vaginal	90.1
Caesarean	4.0
Other	5.9
Mother's age in years (%)	
15-20	8.3
20-29	50.6
30-39	33.7
40-44	5.5
Unknown	2.0
Parity	
0	12.5
1	10.9
2-16	74.6
Unknown	2.1
Place of residence (%)	
Traditional	31.4
Transitional	28.2
Established	37.0
Unknown	3.4

responded spontaneously and the interviewer identified a category from among approximately a dozen reasons that matched the maternal-reported reason (Appendix A). If no response category was suitable however, the interviewer coded other and wrote down the specific reason.

In addition to the interview as a source of data, demographic data were abstracted from the birth certificate. Obstetric, fetal, and infant health data were abstracted from the maternity and paediatric records at the Soroka Medical Center by trained fourth-year BGU medical students. Weights and lengths of the index child were measured by trained personnel at each interview.⁹ Stunting was defined according to the Waterlow classification as ≤ -2 standard deviation units (SDU) from the gender-specific median height-for-age and ≥ -2 SDU weight-for-height using the CDC/WHO reference population.

Statistical Analyses

In the first phase of the analysis, the rates of milk insufficiency and of other reasons for introducing the

bottle were compared by demographic, obstetric, and neonatal data; by infant feeding practices since birth and duration of breastfeeding the previous child, using the Pearson χ^2 test of independence (χ^2). The analyses were stratified into two time intervals of the first two months and of 3-18 months, respectively, which corresponded with the time period/age distribution of the introduction of the bottle.

In the second phase, all significant variables were placed into a series of multiple logistic regression models to estimate the odds ratio (OR) of milk insufficiency versus another reason for introducing the bottle during the first two months of life. In the first multiple logistic regression model, parity and birth season were analysed using a backward elimination procedure, with a *P* value of 0.15 or more to remove. Parity was treated continuously, while birth season was dichotomized into births during the spring and early summer (i.e. March through July) versus births during the remainder of the year based on the results of the contingency table analysis. The BioMedical Programmes (BMDP) procedure PROC PLR was used to determine the variables remaining in the model.¹¹

The duration of breastfeeding the previous child (treated as a continuous variable) was the variable in the second multiple logistic regression model. This item plus the variables significantly remaining in the first multiple logistic regression model were analysed using the same backward elimination procedure as previously described.

The variables in the third multiple logistic regression model related to the index baby. Specifically whether the baby was breastfed on demand or on a schedule and whether the respondent had any problems nursing were the categorical variables included in this analysis. These variables plus those remaining in the earlier models were entered into a multiple logistic regression analysis with a forward stepping procedure. Thus the strategy was to begin with demographic/contextual factors, remove the insignificant ones, and gradually add factors more proximal to the mother-index infant pair in order to refine the final model.

For the remaining three through 18 months of life, one set of three models was run with the variables that were statistically significantly associated with the percentage of milk insufficiency based on the results of the contingency table analyses. The same sequence of models was repeated for this time interval using the criteria for inclusion of variables in the earlier sequential models.

In the last phase of the analysis, potential long-term effects of reported milk insufficiency versus another reason for introducing the bottle were examined.

Specifically, the rates of stunting after the introduction of the index infant to the bottle and the duration of any breastfeeding were compared by reason for introducing the bottle using the χ^2 . Stunting was prevalent in this cohort from six through 18 months of life.⁹

RESULTS

Approximately 72% of mothers introduced the infant to the bottle by two months postpartum, and 72% of these mothers reported milk insufficiency as the reason for introducing the bottle. The percentage of reported milk insufficiency (72%) remained constant on a weekly basis over this time interval. After the first two months, the rates of reported milk insufficiency declined with increasing age of the infant. Specifically, 50% gave milk insufficiency as the reason for introducing the bottle from three to six months postpartum, while 28% reported milk insufficiency from seven to 18 months. Among the women who reported reasons other than milk insufficiency, 33% reported that the child needed it (milk)/it was time, followed by a similar percentage (11-12%) of reported pregnancy, of maternal illness, of child illness, and of other spontaneous responses. The remaining approximate 20% were scattered across the array of closed responses (Appendix A).

The percentage of reported milk insufficiency varied directly with parity (Table 2). Multiparae reported milk insufficiency as a reason for introducing the bottle more often than primiparae throughout the first 18 months.

The percentage of reported milk insufficiency varied by the month (Table 2). Mothers with newborns in January, March to July, and December had the highest rates of milk insufficiency during the first two months postpartum, but this pattern did not hold over the remaining three through 18 months of life.

Several factors surrounding the current and past breastfeeding experience were related to the percentage of milk insufficiency (Table 2). Nursing on demand rather than on schedule was surprisingly associated with a higher percentage of milk insufficiency and was positively correlated with maternal age and parity ($P < 0.0001$). Mothers who experienced problems with nursing reported more milk insufficiency than those without nursing problems, however <10% of women experienced nursing problems. Finally those who did not breastfeed the previous child and those who had breastfed the previous child for ≤ 6 months had higher rates of milk insufficiency than those who breastfed the previous child for > 6 months.

One indicator of socioeconomic status, namely place of residence was associated with milk insufficiency in

TABLE 2. Percentage of mothers reporting milk insufficiency* as a reason for introducing the bottle by infant's age and by maternal and infant characteristics

Variable**	Milk insufficiency					
	1-2 (N = 728)			3-18 (N = 277)		
Infant's age in months	%	(N)	P value	%	(N)	P value
Parity						
0	53	(62)		34	(59)	
1	76	(66)	<0.001	39	(38)	0.08
2-16	74	(593)		50	(179)	
Birth month						
January	75	(51)		29	(14)	
February	60	(85)		44	(27)	
March	80	(121)		58	(36)	
April	75	(73)		33	(12)	
May	73	(107)	0.06	39	(33)	NS
June†	—	—		—	—	
July	76	(67)		55	(38)	
August	63	(54)		34	(29)	
September	65	(46)		36	(25)	
October	66	(53)		45	(31)	
November	68	(41)		53	(15)	
December	84	(25)		57	(14)	
Nursing on demand‡						
Yes	80	(361)	<0.001	45	(177)	NS
No	71	(94)		37	(40)	
Feeding of last child (in months)						
Not breastfed	77	(125)		63	(16)	
Breastfed ≤6	77	(393)	0.007	45	(117)	NS
Breastfed <6	62	(105)		46	(70)	
Place of residence						
Traditional	72	(196)		49	(94)	
Transitional	71	(224)	NS	52	(83)	0.07
Established	70	(292)		36	(90)	

*The percentage of maternal-reported milk insufficiency is based on the denominator of all mothers who introduced milk formula in the bottle at each age interval.

**The total for each variable does not equal 1005 either because of missing data or the exclusion of subjects because the question was not asked. For example primiparae were not asked about the infant feeding of the last child.

†Few newborns in June were included in the follow-up because their dates of follow-up fell during a war or a religious holiday.

‡Several responses had small numbers in the cells and were excluded. A 'no' means that the respondent fed on a schedule.

later infancy (3-18 months). Residents of the traditional semi-nomadic encampments and residents of temporary 'transitional' shanty towns reported more milk insufficiency than residents of the established urban settlements.

Several variables did not significantly differ by reason for introducing the bottle. In this Moslem society, marital status and infant's gender were not related to

maternal reporting of milk insufficiency. Mean birth-weight, maternal age, how the respondent felt during pregnancy, whether she went to the infant nursery to feed her baby during the birth stay, infant feeding practices at birth, and birth interval since the previous child were not associated with the reported rates of milk insufficiency.

Multiple Logistic Regression Analysis

During the first two months of life, the factors influencing the OR of milk insufficiency versus other reasons for introducing the bottle included: parity and birth season (Table 3). Parity was directly (but not statistically significantly) associated with the OR of milk insufficiency after adjustment for birth season. Infants who were born during the months of March through July had an increased OR of being introduced to the bottle with milk insufficiency as the reported reason. Finally parity was directly related to the OR of milk insufficiency from three through 18 months (Table 3).

TABLE 3. Factors influencing milk insufficiency as a reason for introducing the bottle: multiple logistic regression analysis.

Variable (Comparison)	Odds ratio*	95% CI
	0-2 months	
Birth season (August-February)	1.00	
March-July	1.65	(1.19-2.31)
Parity	1.04	(0.99-1.10)
	3-18 months	
Parity	1.12	(1.04-1.22)

*The adjusted OR is estimated from the multiple logistic regression modelling.

Among the potential long-term effects of milk insufficiency, the rate of stunting after the infants were introduced to the bottle did not statistically significantly differ by reason for introducing the bottle (Table 4). Likewise, the percentage of women who stopped breastfeeding did not differ by reason for introducing the bottle (Table 5).

DISCUSSION

Among Bedouin Arab women with healthy newborns who were breast and bottle fed during the first 18 months of life, 72% introduced the infant to the bottle by two months of age. Also 72% of women reported milk insufficiency as the reason for introducing the bottle on a weekly basis during this time interval. The percentage of milk insufficiency was near the upper

TABLE 4. Percentage of infants who were classified as stunted by infants' age at the time of introduction of and by reason for introducing milk in the bottle.

Age by reason	Stunting*, [†] %
≤2 Months	
Milk insufficiency (N = 504)	16
Other reasons (N = 199)	
3-18 Months	
Milk insufficiency (N = 124)	20
Other reasons (N = 147)	20

*Stunting was determined from anthropometrics taken at 2, 6, 9, 12 and 18 months. At each time interval, the percentage of stunting was based on infants who had already been introduced to the bottle and who were previously normal length for age.

†None of the differences in the percentage of stunting by reason and by age were statistically significant based on the χ^2 test for independence.

TABLE 5. The percentage who stopped breastfeeding by reason for introducing the bottle.

Reasons for introducing the bottle	Percentage who stopped breastfeeding by infant's age at stopping (months)		
	≤2	3-18	Still breastfeeding*
Milk insufficiency (N = 646)	16	37	48
Other reasons (N = 356)	22	40	37

*Those who were still breastfeeding were based on data from the last follow-up which ranged in ages from 6 to 18 months.

None of the differences in the percentage who stopped breastfeeding by infant's age were statistically significant based on the χ^2 test for independence.

range of reported rates of milk insufficiency during early infancy.^{3,5-8} Earlier studies frequently reported the rate of milk insufficiency among women who breastfed and introduced either the bottle or semi-solids. Given a different population base for (the denominator used in the estimate of) the rates of milk insufficiency, the percentage of milk insufficiency might be lower in earlier studies compared with the current one. After two months, the rate of milk insufficiency declined with increasing age of the infant, which was concordant with other studies.³

Based on the results of the multiple logistic regression analyses, birth season was significantly related to the OR of milk insufficiency versus another reason for introducing the bottle during the first two months. The parity-milk insufficiency relation just missed statistical significance in early infancy and was statistically significant in later infancy. Compared with primiparae,

multiparae had an increased OR of reported milk insufficiency. This finding was concordant with the results of two^{6,7} but differs with one study.¹²

In this study, the parity-milk insufficiency relation arose from the larger cultural context of social change from a semi-nomadic to a sedentary lifestyle. During the study period, Bedouin Arab women were undergoing social change, and help during the traditional 40-day postpartum rest period was either reduced or eliminated.¹⁰ At the same time, recent urban settlement led to closer proximity to kin, increased visiting, and more maternal work during the 40 days. Thus the new mother had more household chores and visits from kin but less social support.

For multiparae, their short birth intervals (\bar{X} = 18 months) might lead to undernutrition; however maternal nutritional status was not assessed in this study. The overall situation was a mixture of reduced help, increased work from visitors during the 40-day rest period, and increased work caring for other children. Under these circumstances, the multiparae needed a break between breastfeeds and milk insufficiency was the reason used to introduce the bottle which created the opportunity for such a break. Thus women might have reported or perceived milk insufficiency when it actually did not occur. On the other hand, the potential for the production of less breast milk might also be a reality as described in a case study of several multiparae in Istanbul.⁶

Women who delivered during spring and summer compared with women who delivered during the remainder of the year had an increased OR of reported milk insufficiency. This season was the time of hot dry weather, when water availability might be reduced. Such weather conditions might set the stage for the new infant to receive diluted breast milk¹³ and increased the chances of being introduced to the bottle with concomitant reduction in breast-milk production.

While parity and birth season were independently associated with an increased OR of milk insufficiency, the long-term effects of milk insufficiency on stunting and on the duration of breastfeeding did not appear. The latter finding was discordant with the results of one,⁷ but not another study.⁵ Moreover, among mothers who reported introducing the bottle, the frequency of breast and bottle feeds in the 24 hours before the interview did not differ by reason for introducing the bottle. Thus, it was not surprising to find that the duration of breastfeeding ultimately did not differ by reason as well.

In summary, 72% of mothers reported milk insufficiency as the reason for introducing the bottle during the first two months postpartum. The percentage of

reported milk insufficiency declined with child's age. Although we examined an array of biocultural parameters potentially associated with the OR ratio of milk insufficiency, only two variables remained in the analysis. Infants born during the spring and summer time had an increased OR of milk insufficiency in the first two months, while multiparae had an increased OR of reported milk insufficiency during months three through 18. Although milk insufficiency was frequently reported in this population, the long-term effects on stunting and the duration of any breastfeeding were not evident.

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APPENDIX

Possible reasons for introducing milk/formula in the bottle

- 1 --- I did not have sufficient milk/Mother's milk was insufficient
- 2 --- Mother became pregnant or R wanted to become pregnant
- 3 --- Other Mothers also bottle fed
- 4 --- The child needs a milk/it's about time/the child grew/needs to be weaned
- 5 --- Mother became ill or was hospitalized
- 6 --- Child became ill
- 7 --- Baby cried (after a breastfeed)
- 8 --- Other, specify _____
- *9 --- Infant was not satisfied
- 10 --- R does not remember
- 11 --- The hospital staff told me to do so
- 12 --- The clinic told me to do so
- 13 --- The baby was not gaining enough weight
- 14 --- Mother had nipple or breast problems
- 15 --- Mother wanted to wean the baby
- *16 --- Baby refused to breast feed
- *17 --- Mother works outside the home

Note the order of closed responses was changed over the course of the study but this did not change the rate of reported milk insufficiency.

Note all items were not administered at each interview because they were not relevant for the age of the child or mother's condition. Still others* were added as the study progressed with all 17 used for the interviews in 1982.