

A latent variable regression method using the skew-normal distribution for modeling the determinants of breastfeeding

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Abstract: To identify the rates of breastfeeding in Iran by characteristics of the child, Mother, Family and Socio-economic status and to evaluate the determinant of breastfeeding based on a national health survey. **Methods:** The study sample of this survey consisted of urban and rural dwellers in the age group under one year old. Cluster sampling was conducted, with each cluster comprising eight households. Information was obtained about all persons within each household. The unit to record data file contains detailed information on each person in the sample. In total, 1017 children (596 from urban areas and 421 from rural areas) under one year old were studied. Predominant and any breastfeeding were considered as standard definitions for outcomes of study. A latent variable regression model using the skew normal distribution as an underlying continuous variable for binary response was employed for identifying significant determinant of breastfeeding. **Results:** Overall, 88.6% of children breastfed predominantly at two weeks but this rate decreases dramatically to 40% at 6 months. The rate of any breastfeeding approximately remains constant through the first year of life and it is higher than 90% in this period of time. Multiple regression model for evaluating determinants of any breastfeeding revealed that infant age, sex, maternal age and the last two births interval are significant determinant factors of any breastfeeding. **Conclusion:** This study shows that considerable progress had been made toward increasing the rate of breastfeeding in Iran. There is a sex preference in predominant breastfeeding toward male sex in Iranian population and first born infants had lower chance of any breastfeeding.

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1. Introduction

The human milk is the Preferred feeding for all infants, including premature and sick newborns, with rare exception (1). The benefits of breastfeeding for both child and mother in terms of nutrition, immunological protection, anti-infective, biochemical, anti-allergic and contraceptive effects, and emotional satisfaction have been widely documented (2-10). In Iranian traditional medicine, Breastfeeding has a special importance which that, Ibn Sina, a Persian/Iranian physician, in his famous book, the canon of medicine, dedicated one of its chapters to the care of the newborn infant and breastfeeding (11). Breastfeeding plays an important role in child growth (12,13) and has a preventive effect against obesity (14-17), also many studies had shown a similar preventive effect for many diseases later in life (18-23).

In Iran there has been a lack of national data on breastfeeding in recent years. The last national survey on breastfeeding returns to 1989 (24), but on that

survey just breastfeeding in general concept was considered whereas in present study predominant breastfeeding will be presented as well. In this paper, we use unpublished unit record data from the 2000 NHS to estimate the proportion of children breastfed at 1 month, at 3 months at 6 months and at 12 months in 2000, nationally and according to some maternal and infant factors. We also present estimates of breastfeeding rates according to a Socio-Economic Index in rural and urban areas.

2. Methods Population

The population sample of this survey consisted of urban and rural dwellers in the age group under one year old. The country's population, according to statistics provided by the health system, was 63 042 188 in 1999, of whom 64.2% lived in urban areas and 35.8% in rural areas. The total number of households was 12 685 113²⁵.

Sample

Cluster sampling was conducted, with each cluster comprising eight households. The Choice of cluster size was based on the daily performance capacity of the data collection group. The statistical framework was based on the household lists available from every health department in the provinces. The ratio of sample size to the total number of households was taken as 1:1000 (13 478 households through 1681 clusters). Information was obtained about all persons within each household. The unit to record data file contains detailed information on each person in the sample. In total, 1017 children (596 from urban areas and 421 from rural areas) under one year old were studied.

Definitions of breastfeeding

The initial question about breastfeeding was whether the child currently breastfed. Subsequent questions were designed to determine if foods other than human milk had been introduced into the diet. These foods included infant formula, cow's milk, other milk substitutes and solid food. No questions were asked about consumption of fruit juices or other liquids. The prevalence of children who currently breastfed predominantly and to any extent were derived from the answers to the above questions. Breastfeeding was classified as 'predominantly' if the child did not consume infant formula, solid food and semi solid food on a regular basis. A child who was regularly consuming large amounts of liquids, and also receiving other foods on an irregular basis, would therefore have been classified as being predominantly breastfed.

Measurements

Information about the time and age like maternal age and time interval between this pregnancy and the last previous live birth was based on self reported answers. There wasn't information on household income but economic index is surrogate for it. Economic Index was defined as a square meter of living place divided by family size. Sample children were classified by their economy index status into four classes: 1) low (economic index \leq Quartile 1), 2) lower-Middle (Quartile 1 < economic index < Quartile 2), 3) upper-Middle (Quartile 2 < economic index < Quartile 3), 4) high (economic index > Quartile 3). In order to study the effect of living place on breastfeeding and to increase the precision of estimates, we used the division of the Iran country by 11 climates which was introduced recently in a study on nutrition status in Iran (6). In this study provinces is combined based on their geographical similarities to use as different climates.

Statistical methods

All calculations were performed by using R software. Sampling uncertainty was expressed through 95% confidence intervals (CIs). In order to compare between the reference group and the other levels within each stratum the student t test and Dunnett multiple comparison test was used as appropriate. P values <0.05 were considered statistically significant. For identifying the determinants of any breastfeeding, We conducted a separate univariate analysis for each of the variables which were related to the child, mother or family characteristics. Then all of the variables with P value less than 0.10 in univariate analysis was entered into the multiple regression model. A latent variable regression model using the skew normal distribution as an underlying continuous variable for binary response was employed for identifying significant determinant of breastfeeding. This model with skewness parameter (λ) has more flexibility for fitting the model and goodness of fit criterias for the model such as AIC showed a better fit for this model compared to the probit model.

3. Results

Overall, 88.6% of children breastfed predominantly at two weeks but as Figure 1 depicts this rate decreases dramatically to 40% at 6 month.

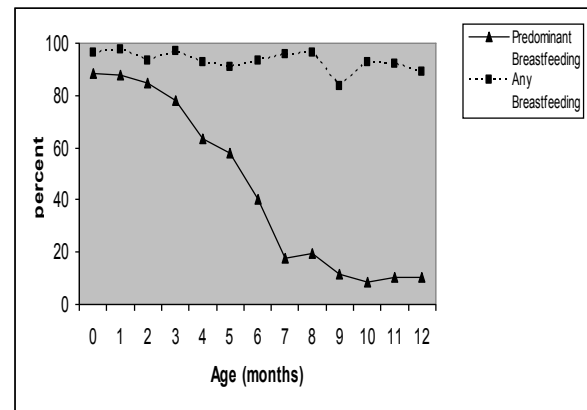


Figure 1: Rate of Predominant and anybreastfeeding in first year of life in Iranian infants

The low rate of predominant breastfeeding after 6 months reflects the regular addition of solids for most infants after 6 months of age. By the age of 12 months, only 10.3% (CI 3.4-17.2%) of infants are receiving predominant breastfeeding. According to figure1 rate of any breastfeeding approximately remains constant through the first year of life. The statistical analyses revealed significant differences relating to gender, birth order, residential, maternal age, maternal occupation and family size. Male children are more likely to be breastfed

predominantly at different time points (Table 1) whereas there is no such difference for any

breastfeeding (Table2) also Non first born children have more chance to be breastfed predominantly.

Table1. Proportion of Children Who Breastfed predominantly (percent \pm Half 95% CI), by Socio demographic Characteristics

Characteristics	Breastfed at 2w	Breastfed at 1 mo	Breastfed at 3 mo	Breastfed at 6 mo	Breastfed at 12 mo
Iran national	88.6 \pm 6.8	87.9 \pm 6.7	78 \pm 8.7	40 \pm 11.3	10.3 \pm 6.9
Gender					
Male	93.5 \pm 8.3 *	93 \pm 7.9 *	81.1 \pm 10.9 *	41.5 \pm 15.7	8.9 \pm 8.6
Female (ref)	85.4 \pm 11.3	83.3 \pm 10.9	73.7 \pm 14.7	38.2 \pm 17.2	12.1 \pm 10.8
Birth order					
First-born	89.7 \pm 12.2	85.7 \pm 11.8	80.6 \pm 13.6	38.1 \pm 22.7	6.9 \pm 9.8
Not first-born (ref)	92 \pm 7.8	86.7 \pm 8.9	78.8 \pm 11.5	40.4 \pm 13.8	12.5 \pm 9.7
residential					
urban	84.8 \pm 11.1 *	83.3 \pm 10.9 *	80.8 \pm 11.1 *	40 \pm 14.9	11.1 \pm 9.5
rural (ref)	98.0 \pm 9.1	93 \pm 7.9	74.4 \pm 14.3	40 \pm 18.6	9.1 \pm 6
Maternal age					
\leq 20	92.3 \pm 16.8	94.4 \pm 11.7	76.2 \pm 19.9	54.5 \pm 35.1	5 \pm 2.1
21-30	90.5 \pm 1	92.2 \pm 7.6	82.6 \pm 11.4	32.5 \pm 15.2	10.6 \pm 9.2
>30 (ref)	82 \pm 11.4	72.7 \pm 20.2	70.8 \pm 19.6	45.8 \pm 21.5	15 \pm 17.4
Maternal education					
Uneducated	97 \pm 7.8 *	90.5 \pm 13.7	81.1 \pm 24.9	37.2 \pm 33.9	7.7 \pm 16.8
Educated (ref)	86.5 \pm 8	87.1 \pm 8	82.9 \pm 9.1	42.4 \pm 12.2	9.4 \pm 7.3
Maternal occupation					
Employed	89.5 \pm 43.3	88.9 \pm 25.6	60 \pm 36.9 *	50 \pm 8.2 *	0 \pm 0 *
Unemployed (ref)	91.3 \pm 6.3	87.8 \pm 7.2	81 \pm 8.8	39.4 \pm 11.7	10.7 \pm 7.2
Interval					
\leq 24	92 \pm 15.2	91.9 \pm 9.2	80 \pm 13.9	34.8 \pm 21.1	3.7 \pm 7.6
>24 (ref)	94.5 \pm 6.2	84.6 \pm 10.1	79.2 \pm 11.3	42 \pm 14.2	14 \pm 10
Family size					
<5	94.6 \pm 11.8 *	90.9 \pm 8.8 *	86 \pm 10 *	30.3 \pm 16.5	13 \pm 10.1
5-7	93.8 \pm 8.9	85.3 \pm 12.5	65.5 \pm 18.4	51.6 \pm 18.6	4.5 \pm 9.5
>7 (ref)	88.2 \pm 17.1	84.6 \pm 22.7	75 \pm 28.7	36.4 \pm 33.9	10 \pm 22.6

*Significantly different from the reference level (ref) with $P < 0.05$

Mothers of urban children were less likely to initiate breastfeeding than mothers of rural children (98% vs 84.8% for predominant breastfeeding, 99% vs 94.2% for any breastfeeding). In addition, employed mothers were less likely to initiate or maintain breastfeeding than unemployed mothers for example, at 3,6 and 12 months the rate of predominant breastfeeding for those children whose mothers are employed were 21%, 10.6% and 10.7% lower than other children (Tables 1 and 2). Older mothers had consistently lower rates of any breastfeeding rates. For example, compared with children whose mothers were older than 30 years old, those whose mothers were less than 20 years old were 5.4% and 6.4% lower for two weeks and maintaining to one month, respectively (Table 2). In addition children of families with lower family size were more likely to be breastfed. For example children of families with less than five members had rates that were 6.4%, 6.3% and 11% higher for predominant breastfeeding compared to children whose families had more than 7 members at 2 weeks one month and two months, respectively (Tables 1 and 2). Study of rate of breastfeeding in climates revealed that the predominant breastfeeding rate in rural urbanben areas of Sistan-balouchestan and southern area of Khorasan and east of Kerman (climate 5) are significantly lower than Tehran and boushehr, Hormozgan and Khuzestan provinces (climate 7). ($P=0.01$, Table 3). According to table 3, there is a lower rate of breastfeeding in socioeconomically least disadvantaged families, however this association is not statistically significant ($P=0.21$). Table 4 shows the results of multiple regression model for evaluating determinants of any breastfeeding. As expected, child age by nature has a significant effect on breastfeeding and as child grows the rate of breastfeeding decreases. Infant sex also has a significant effect on breastfeeding and female infants had a significantly lower rate of breastfeeding ($P=0.002$). High maternal age is a significant risk factor for breastfeeding and infants of mothers with age higher than 25 are at more risk to not be breastfed compared to younger mothers ($P=0.009$). Infants who had more interval with previous birth had more rate of breastfeeding ($P < 0.001$).

Table 2. Proportion of Children Who Breastfed to any extent (percent \pm Half 95% CI), by Sociodemographic Characteristics

Characteristics	Breastfed at 2w	Breastfed at 1 mo	Breastfed at 3 mo	Breastfed at 6 mo	Breastfed at 12 mo
Iran national	97.5 \pm 3.9	96.2 \pm 6.5	96.1 \pm 7.7	93 \pm 5.8	90.3 \pm 6
Gender					
Male	97.9 \pm 4.3	96 \pm 3.9	95.1 \pm 3.8	90.2 \pm 9.7	87.9 \pm 8.6
Female (ref)	95.1 \pm 6.9	95.8 \pm 5.9	94.7 \pm 7.4	88.2 \pm 11.2	87.1 \pm 4.8
Birth order					
First-born	94.7 \pm 12.2	92.7 \pm 11.8 *	90.6 \pm 12.6 *	88.1 \pm 17.7 *	87.9 \pm 10.8
Not first-born (ref)	98.3 \pm 10.8	97.7 \pm 8.9	97.1 \pm 9.5	94.4 \pm 6.7	92.5 \pm 9.7
residential					
urban	94.2 \pm 6.6 *	95.8 \pm 5.9	96.2 \pm 5.4	88.9 \pm 9.5	85.1 \pm 6.3 *
rural (ref)	99.1 \pm 7	98 \pm 7.3	97.4 \pm 5.2	93.2 \pm 12.1	90.1 \pm 5.4
Maternal age					
\leq 20	99.4 \pm 16.8 *	99.1 \pm 8.9 *	96.1 \pm 7.12	94.7 \pm 22.1	91.3 \pm 13 *
21-30	98.8 \pm 1	98.2 \pm 2.2	95.7 \pm 6.1	91.5 \pm 8.3	90 \pm 14.4
>30 (ref)	94 \pm 11.4	92.7 \pm 11.2	91.8 \pm 12.6	90.6 \pm 11.5	87.5 \pm 15.4
Maternal education					
Uneducated	98 \pm 17.3	96.5 \pm 13.7	96.3 \pm 14.9	94.2 \pm 21.9	93 \pm 16.7
Educated (ref)	95.9 \pm 8	94.1 \pm 8.3	92.8 \pm 9.1	91.4 \pm 11.8	89.4 \pm 13.3
Maternal occupation					
Employed	89.5 \pm 21.3 *	87.9 \pm 18.6 *	85.1 \pm 20.9 *	83.4 \pm 18.2 *	80 \pm 17.4 *
Unemployed (ref)	97.5 \pm 3.5	97.1 \pm 3.4	96.1 \pm 8.5	93.4 \pm 10.7	92.1 \pm 8.2
Interval					
\leq 24	98.2 \pm 14.2	95.3 \pm 5.5	94.1 \pm 12.9	90.8 \pm 18.1	86.7 \pm 7.6
>24 (ref)	99.5 \pm 9.2	97.6 \pm 11.1	96.6 \pm 9.3	94 \pm 7.2	92 \pm 10.1
Family size					
$<$ 5	99.8 \pm 14.7 *	99.5 \pm 8.3 *	97.4 \pm 11 *	95.3 \pm 12.5 *	94 \pm 8 *
5-7	97.2 \pm 8.9	97 \pm 6	95.5 \pm 9.4	92.6 \pm 18.6	90.2 \pm 9.5
>7 (ref)	94.1 \pm 12	93.1 \pm 17.7	91.9 \pm 18.7	87.2 \pm 21.9	85.5 \pm 16.6

Table3. Proportion of Children Who Breastfed predominantly and to any extent by climates and socioeconomic index in urban and rural areas

characteristics	predominant breastfeeding		Any breastfeeding	
	urban	rural	urban	rural
climate				
climate(1)	50 \pm 17.7	56.3 \pm 18.2	94.1 \pm 8.3	93.8 \pm 8.9
climate(2)	47.9 \pm 11.9	38.6 \pm 15.0	91.5 \pm 6.6	93.2 \pm 7.8
climate(3)	60 \pm 36.9	36.8 \pm 23.9	100.0 \pm 0.0	94.7 \pm 11.1
climate(4)	45.6 \pm 12.1	47.7 \pm 12.5	91.2 \pm 6.9	93.8 \pm 6.0
climate(5)	18.8 \pm 21.5	27.3 \pm 16.0	93.8 \pm 13.3	87.9 \pm 11.8
climate(6)	46.7 \pm 15.2	33.3 \pm 19.0	93.3 \pm 7.6	96.3 \pm 7.6
climate(7)	59.6 \pm 14.6	64.2 \pm 13.3	95.7 \pm 6.0	98.1 \pm 3.8
climate(8)	52.0 \pm 8.0	57.1 \pm 29.7	93.4 \pm 4.0	100 \pm 0.0
climate(9)	51.2 \pm 15.6	36.8 \pm 23.9	93.0 \pm 7.9	89.5 \pm 15.2
climate(10)	56.4 \pm 13.5	47.2 \pm 13.9	98.2 \pm 3.6	94.3 \pm 6.4
climate(11)	41.8 \pm 13.5	54.8 \pm 12.7	89.1 \pm 8.5	93.5 \pm 6.3
Socioeconomic Index				
Quartile 1 (most disadvantaged)	41.8 \pm 8.9	46.6 \pm 7.3	89.3 \pm 5.6	92.3 \pm 3.9
Quartile 2	54.0 \pm 8.8	45.6 \pm 11.2	93.7 \pm 4.3	92.4 \pm 6.0
Quartile 3	48.8 \pm 7.5	48.1 \pm 11.1	95.3 \pm 3.2	97.5 \pm 3.5
Quartile 4 (least disadvantaged)	52.3 \pm 7.5	50.0 \pm 11.3	93.8 \pm 3.6	96.2 \pm 4.4
total	49.5 \pm 4.0	47.3 \pm 4.8	93.3 \pm 2.0	94.1 \pm 2.3

Table 4: Results of the latent variable regression method using the skew-normal distribution for determinants of any breastfeeding

Variable		β (SE)	95 % CI	P value
Infant age, months		-0.117 (0.031)	-0.178, -0.056	<0.001
Infant sex	Male	Reference		
	Female	-0.523 (0.167)	-0.850, -0.196	0.002
Maternal age, years	<25	Reference		
	≥ 25	-0.641 (0.247)	-1.125, -0.157	0.009
The last two births interval, months	<24	Reference		
	≥ 24	0.597 (0.163)	0.278 – 0.916	<0.001
Skewness parameter (λ)		0.072 (0.041)	—	—

Discussion

This analysis shows that considerable progress had been made toward increasing the rate of breastfeeding in Iran. According to the result 97.5% of children are breastfed at two weeks, of whom 88.6% are predominantly breastfed. In New Zealand rate of exclusive breastfeeding at fifth week is 61 percent(10), while the rate of predominant breastfeeding is 87.9 percent at one month in this study. In Egypt rate of predominant breastfeeding for infants lower than 4 months is 21.1% which is much lower than present study(11) (Table1).

There are reports for breastfeeding in some provinces of Iran. The rate of exclusive breastfeeding at 6 months in Zahedan was 44.7% that is similar to the rate of predominant breastfeeding in this study²⁶. Rate of any breastfeeding for infants less than 2 years in Tabriz is 85.2% (27). In a study by Hajian in Babol revealed that 87% of urban and 89% of rural 12-month infants had taken advantage of breast-feeding that is close to the result of any breastfeeding at 12 months 90.3% in Iran(28). At early months of the life the rate of predominant breastfeeding is close to any breastfeeding but approximately after 6 months the rate of predominant breastfeeding differs from any breastfeeding by amount of 53%. This difference could have several reasons, for many mothers, this is the time at which they return to work or school and need additional support to continue breastfeeding predominantly. Lack of support for lactation in the workplace has been cited as a major barrier to maintaining breastfeeding(29,30). There is a sex preference in predominant breastfeeding toward male sex in Iranian population although previous studies in some parts of Iran didn't show such a difference(31,32). First born infants had lower chance of any breastfeeding (table 2), which shows that previous feeding is an effective factor for

pattern of feeding in subsequent infants. This confirms the result of another study in Iran, that Women who stopped breastfeeding before their babies were 6 months of age, were first-time mothers(32).

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