

The relationship between the type of nutrition and anthropometric indices of infants during the first year of birth

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Abstract

Background: Considering the importance of proper infant nutrition, especially in the first two years of life, and also the effect of cultural issues on the type of infant's nutrition, this study aimed to investigate the type of nutrition and anthropometric indices of infants during the first year of birth in Bushehr, Iran.

Methods: This cross-sectional study carried out on 546 delivered mothers. The data of mothers and their children were collected through Integrated Health System (SIB). Five centers of comprehensive health care centers were randomly selected. Required information included maternal demographic characteristics and anthropometric indices of infants at birth, 6 and 12 months. The collected data were analyzed using SPSS 19 with appropriate statistical tests at a significance level of $p < 0.05$.

Results: The frequency of exclusive breastfeeding, formula feeding and also both feeding methods (combined) were 56.8%, 25.1%, and 18.1%, respectively. The results showed that the 6-month weight gain compared to birth time was not different among the three groups. The increase in height and head circumference in the first six months in the formula feeding group was less than the exclusive breastfeeding group and the combined group ($P < 0.05$). In the second six months, weight gain and height in the formula feeding group were less than the other two groups ($P < 0.01$).

Conclusion: This study showed that the prevalence of exclusive breastfeeding in Bushehr is desirable. The growth trend in breastfed infants is either similar or better than formula-fed infants. Using formula with breast milk compared to formula alone has better growth outcomes.

Key Words: Breastfeeding, Exclusive breastfeeding, Formula feeding.

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1- INTRODUCTION

The type of nutrition in children is directly related to health consequences (1). Nutrition in infancy and early childhood can increase the risk of lifelong obesity and chronic diseases such as hypertension, type 2 diabetes, non-alcoholic fatty liver disease, and cardiovascular disease (2, 3). Breastfeeding and formula are the two main types of infant nutrition in the first year of life that have important effects on the nutritional status of the baby. Breast milk is known to infants as the golden standard of nutrition and the provider of natural and healthy growth and development (4).

The World Health Organization (WHO) recommends exclusive breastfeeding for the first 6 months of life and also emphasizes that it should be continued for the first 2 years of life with complementary foods (5). According to the WHO in 2017, only 40% of infants in the world have exclusive breastfeeding in the first 6 months of life, and efforts should be made to increase this percentage to 50% by 2025 (6). Despite the importance of breastfeeding, according to the report of the WHO for breastfeeding, especially in developing countries, it is less than the target set by the WHO (7, 8). Given the importance of proper infant nutrition, especially in the first two years of life, as well as the impact of cultural issues on the type of infant nutrition, it is important to examine the status of infant and child nutrition in different communities and also to examine the consequences related to nutrition (9). One of the most important consequences of the type of infant and child nutrition can be seen in the growth indices of the child. Determining anthropometric indices (height, weight, head circumference, chest and arm circumference) is one of the most common and simplest methods to assess the growth and health of children in a community (10). Measuring growth rate is a dynamic

process and a useful indicator for evaluating nutritional effects and monitoring growth process. Growth patterns are assessed by comparing growth indices at a particular age with the reference or measurement charts; and comparing growth indices over a period of time is considered as growth rate (11, 12). The differences between the content and characteristics of artificial milk and breast milk may affect the developmental process of the infant (13, 14).

Different studies report different results on the relationship between infant and early childhood nutrition on anthropometric indices. Studies have shown that the increase in weight and height of the infant in the early postpartum period is directly affected by the infant's nutritional status (15-17). Differences between the content and characteristics of artificial milk and breast milk may affect the growth process of the infant (13, 14). The results of Malekzadeh et al.'s study showed that the Z score of head circumference at 6 months of age was higher in breastfed infants than in formula-fed infants (18). In another study, the growth of head circumference, height and weight at six months in the breastfed group was higher than the artificial milk group, but at one year there was no significant difference between the two groups regarding growth indices (19).

The results of a study conducted in 2019 by Anidi et al. showed that formula-fed infants had faster growth than breastfed infants, and this difference was attributed to greater growth of lean body mass (20). Lonnerdal et al. found that breastfed infants weighed more at two to six months and had a larger head circumference at five and six months compared to the formula-fed group (21). In a systematic review conducted by Giugliani in 2019, the results showed that the growth trend of breastfed infants is different from that of formula-fed infants, because formula-fed infants gain more weight and body mass in the

first three to six months of life (22). A study by Patel et al. in 2018 measured anthropometric indices of infants according to the type of feeding and showed that the formula-fed infants weighed more than the breastfed infants and those fed by both types of nutrition, but there was no difference between the groups regarding other anthropometric indices including body mass index, height and arm circumference (23).

Considering the importance of proper infant nutrition, especially in the first two years of life, and also the effect of cultural subjects on the type of infant's nutrition, it is important to study the nutrition type of the infants in different communities and its consequences. This study aimed to investigate the relationship between the type of nutrition and anthropometric indices of infants during the first year of birth.

2- MATERIALS AND METHODS

2-1. Design and setting

This descriptive-analytical cross-sectional study was carried out on 546 mothers and their children living in Bushehr city of Iran. Five centers of urban comprehensive health care centers in Bushehr were randomly selected for the purpose of study; they included Nabi Akram, Sahib Al-Zaman, Kheybar, Hazrat Zeinab and Haftê Tir. With a total type I error of 0.05, a power of 85% and effect size of 0.20, a sample size of 93 subjects was calculated for the exclusive breast feeding, formula feeding and combined feeding, respectively, by the use of G power 3.9.1.2 software. By considering the expected percentage of exclusive breast feeding i.e. 50% and the 20% drop-out rate, a sample size of 447 subjects was calculated. Finally, all eligible mothers from the five mentioned centers, who had delivery during 2017-2018 in Bushehr, Iran, were included in the study. The data of all mothers and their infants, from the

first prenatal visit to the end of first year of their infants' birth were registered in SIB.

2-2. Inclusion and Exclusion criteria

The inclusion criteria consisted of the mother's age being between 18 to 40 years, having singleton pregnancy and healthy baby, the specific method of breastfeeding up to one year being recorded in the file and the baby having been born after 37 weeks of pregnancy. Smoking or tobacco use by the mother, and the presence of abnormalities and/or diseases in the infant were the exclusion criteria.

2-3. Data Collection

The data of mothers and their children were collected through the Integrated Health System, locally known as SIB (An abbreviation for the Persian equivalent of 'integrated health system'), established in 2016 to register all health care services in health centers. The demographic characteristics of the mother, weight, height and body mass index of the mother before pregnancy, regular prenatal care, hemoglobin and fasting blood sugar in the first and second trimesters, delivery method, gender of the baby, gestational age at birth, presence or absence of pregnancy disorders such as diabetes and hypertension, type of feeding from birth to at least 6 months (breastfeeding, formula feeding or both of them), and anthropometric characteristics of the infant, including weight, height and head circumference at birth, six months and one year old were recorded in a form prepared by the researcher.

2-4. Statistical analysis

The collected data were analyzed by SPSS software version 19.0, by the use of the appropriate statistical tests. Frequency, median, mode, mean and standard deviation were used to describe the data. Kruskal-Wallis test as a non-parametric method was used to analyze the

quantitative variables (due to abnormal distribution of variables in at least one group) among the three groups. Mann-Whitney test was used for pairwise comparison. Chi-square test was used to compare nominal variables among the three groups. A P-value less than 0.05 was considered significant.

3- RESULTS

In this study, 546 health records of the mothers and their infants were reviewed. The mean age of the mothers was 30.72 ± 5.32 years. The mean gestational age at delivery was 39.04 ± 1.06 weeks. The percentages of exclusive breastfeeding, formula feeding and combined feeding were 57 (n=310), 25 (n=137) and 18 (n=99), respectively. A comparison of the frequency distribution of demographic characteristics and some maternal complications during pregnancy among the three groups are shown in **Table 1**.

Table 2 shows that the three groups had no statistically significant difference regarding the maternal age, gestational age at birth, weight, height and body mass index at the first prenatal visit, number of pregnancies and deliveries, hemoglobin and fasting blood sugar in the first and second trimesters, weight, height and head circumference at birth. According to **Table 3**, the changes in weight, height and head circumference at six months compared to birth and also one year compared to six months showed an increase in weight and height from six months to one year and also an increase in height and head circumference from birth to six months were found among the three groups. A two-by-two comparison showed that the mean rank of weight gain from six months to one year in the breastfed group was significantly higher than that in the formula-fed group ($P < 0.001$, $Z = -5.609$). Also, the mean rank weight gain in the combined feeding group was significantly higher than that in the formula-fed group ($P < 0.001$, $Z = -4.581$). There was no

significant difference between the exclusive breastfeeding group and the combined feeding group regarding weight gain during the second six months of life ($P = 0.001$, $Z = -0.462$). The mean rank of height increase from birth to six months in the formula-fed group was significantly lower than that in the breastfed group ($P = 0.040$, $Z = -2.052$), and the combined feeding group ($P = 0.028$, $Z = -2.193$). There was no significant difference between the exclusive breastfeeding group and the combined feeding group ($P = 0.884$, $Z = 0.146$).

Regarding the growth in height during the second six months of life, the two-by-two comparison showed that in the formula-fed group, the mean rank of height increase was significantly lower than the exclusive breastfeeding group ($P = 0.001$, $Z = -3.297$), and combined feeding group ($P = 0.010$, $Z = -2.591$). There was no significant difference between the exclusive breastfeeding group and the combined feeding group ($P = 0.754$, $Z = -0.314$). Also, in favor of head circumference growth, the two-by-two comparison showed that the mean rank of head circumference increase in the first six months of birth in the formula-fed group was significantly lower than the exclusive breastfeeding group ($P = 0.004$, $Z = -2.918$). There was no statistically significant difference between the exclusive breastfeeding group ($P = 0.298$, $Z = -1.040$), and the formula-fed group ($P = 0.202$, $Z = -1.276$).

4- DISCUSSION

Due to the importance of nutrition in the first year of birth and its effect on neonatal growth, the present study aimed to determine the amount of exclusive breastfeeding and the relationship between nutrition and anthropometric parameters of the infant during the first year of birth. In this study, three groups were examined and compared.

Table-1: Comparison of the frequency distribution of demographic variables and important disorders during pregnancy among the three groups (n=546)

Variables		Formula group		Breast milk group		Combined group		Total		X ²	P-value
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent		
Education level	Under diploma	17	13.5	51	18.1	11	12.0	79	14.5	4.468	0.346
	Diploma	41	32.5	78	27.7	23	25.0	142	26.0		
	Collegiate	68	54.0	153	54.3	58	63.0	279	51.1		
Occupation	Housekeeper	94	74.6	233	82.9	68	74.7	395	79.3	5.098	0.078
	Employed	32	25.4	48	17.1	23	25.3	103	20.7		
Delivery type	Vaginal	54	40.3	147	47.4	40	40.4	241	44.4	2.698	0.259
	Cesarean	80	59.7	163	52.6	59	59.6	302	55.6		
Gender of the neonate	Female	56	41.2	143	47.0	42	42.4	241	44.7	1.563	0.458
	Male	80	58.8	161	53.0	57	57.6	298	55.3		
Disorders In urinalysis in the first trimester	Yes	99	77.3	227	76.9	73	77.7	399	77.2	0.023	0.988
	No	29	22.7	68	23.1	21	22.3	118	22.8		
Disorders in urinalysis in the second trimester	Yes	83	72.2	220	80.9	65	77.4	368	78.1	3.621	0.164
	No	32	27.8	52	19.1	19	22.6	103	21.9		
Anemia in the first trimester of pregnancy	No	111	86.7	245	82.8	82	86.3	438	84.4	1.384	0.501
	Yes	17	13.3	51	17.2	13	13.7	81	15.6		
Anemia in the second trimester of pregnancy	No	95	83.3	212	76.8	66	75.9	373	78.2	2.353	0.308
	Yes	19	16.7	64	23.2	21	24.1	104	21.8		

Reported percent's are valid percent

Table-2: Comparison of maternal-related quantitative variables and anthropometry at birth in the three groups (n=546)

Variable	Formula group (n=137)			Breast milk group (n=310)			Combined group (n=99)			X ²	P-value
	Mean	SD	Mean rank	Mean	SD	Rank mean	Mean	SD	Rank mean		
Mother's age	30.53	5.19	260.99	30.70	5.91	266.40	31.32	4.86	286.28	2.002	0.368
Mother's height at the first prenatal visit	162.20	28.97	271.61	159.83	9.54	265.02	160.71	5.87	282.85	0.740	0.691
Mother's weight at the first prenatal visit	66.10	12.19	264.56	67.81	13.94	279.09	66.44	12.32	269.41	0.813	0.666
Mother's BMI at the first prenatal visit	25.98	4.62	235.44	26.58	5.48	245.38	25.82	5.48	227.68	0.888	0.641
Number of pregnancy	2.08	1.21	282.57	1.95	1.18	261.62	1.92	1.24	256.22	3.355	0.187
Number of delivery	1.87	.99	289.37	1.64	0.77	254.07	1.65	1.00	245.53	4.886	0.087
Number of live birth	1.89	1.00	289.65	1.65	0.78	254.30	1.65	1.00	244.32	2.276	0.106
Gestational age at delivery	39.09	1.07	281.19	38.94	1.03	258.91	39.02	1.07	269.61	2.179	0.336
Weight at birth	3340.08	389.51	248.82	3227.77	409.07	247.00	3286.57	414.24	252.19	3.309	0.126
Height at birth	50.34	2.12	259.55	49.60	1.92	249.55	50.16	2.31	257.63	4.997	0.084
Head circumference at birth	34.73	1.15	282.70	34.37	1.60	287.97	34.77	2.00	277.37	4.930	0.085
Maternal fasting sugar in the first trimester	83.07	14.24	262.32	83.63	8.72	263.32	83.43	11.24	271.27	1.330	0.514
Maternal fasting sugar in the second trimester	78.87	11.45	237.01	79.53	10.85	246.93	78.83	11.18	237.56	0.440	0.803

Table-3: Comparison of changes in weight, height and head circumference in the first two to six months of life in the three groups (n=546)

Anthropometric changes	Formula group (n=137)			Breast milk group (n=310)			Combined group (n=99)			X ²	P-value
	Mean	SD	Mean Rank	Mean	SD	Mean Rank	Mean	SD	Mean Rank		
Weight at 6 months minus weight at birth (gr)	4267.33	1069.19	233.51	4146.13	1277.62	220.66	4303.33	1018.45	235.23	0.890	0.641
One-year weight minus six-month weight (gr)	2052.04	4883.64	213.43	2147.26	1109.87	300.89	1999.20	1151.45	291.61	41.625	<0.001
Six-month height minus height at birth (cm)	17.92	2.53	247.77	18.48	2.77	280.85	18.49	2.68	286.04	7.050	0.029
One-year height minus six-month height (cm)	8.21	3.04	226.21	8.99	1.93	276.60	8.88	1.79	271.04	13.999	0.001
Six-month head circumference minus head circumference at birth (cm)	8.45	1.33	247.10	8.99	1.80	292.80	8.46	2.15	266.02	8.510	0.014
One-year head circumference minus 6-month head circumference (cm)	2.76	2.74	236.07	3.08	.81	267.38	2.60	4.03	251.95	4.451	0.108

One group of infants was exclusively breastfeeding for the first six months, one group was formula feeding, and the other group had both of them. The results showed that more than half of the mothers had exclusively used breastfeeding. Height gain in the first and second six months of life was less in formula-fed infants than in breast-fed infants and formula-fed infants. The increase in head circumference in the first six months of life was also greater in infants who had exclusively breastfeeding than in the formula group. Weight gain in the second six months of life in the formula group was less than the exclusive breastfeeding group and the combined feeding group.

About 57% of mothers had exclusive breastfeeding during the first six months. Other studies have reported the rate of exclusive breastfeeding as 49% in Sanandaj (24), 54% in Mashhad (25) and in 44% Chaharmahal and Bakhtiari (26). In a meta-analysis study in 2019, the rate of exclusive breastfeeding in the first 6 months of birth in Iran was reported as 53% (27), which is almost similar to the present study.

This rate is acceptable according to the target percentage recommended by the WHO until 2025. Exclusive breastfeeding rate in the first six months of life was reported 31.4 % in Saudi Arabia (28), 25.4% in Madrid (29), 43.1% in Malaysia (30), 47% in Nigeria (31), and 26.2% in Indonesia, (32). Factors including culture, religion, and social issues such as the media and advertising influence exclusive breastfeeding and its duration (32). Although the rate of exclusive breastfeeding in Bushehr is acceptable, but considering the health and economic benefits of breastfeeding, and considering the declining trend of exclusive breastfeeding in most parts of Asia (7), planning to increase exclusive breastfeeding can help improve the health of children and reduce costs, especially in

societies and countries with lower economic levels.

The results of the present study revealed that weight gain in the first six months of life was not different among the three groups. The increase in height and head circumference in the first six months was less in the formula-fed group than in the exclusive breastfeeding group and the combined feeding group. Most studies have shown that weight gain at six months of age is more common in formula-fed infants than in those who are exclusively breastfed (18, 22, 33). However, some studies have not reported these results. In 2017, a study in Lahore showed that breastfed infants gained more weight at four months than formula-fed infants (34).

A study by Lonnerdal et al. found that there was no difference in height or weight in the three formula-fed groups with different compounds added, but the breast-fed group from two to six months of age weighed significantly more than all the formula groups (21). The results of most previous studies are different from those of the present study regarding weight gain in the first six months in formula-fed and exclusively breast-fed infants. Researchers have attributed the increase in weight gain in the breastfeeding group to the bioactive components in breast milk, noting that these bioactive components are either absent in breast milk or in very small amounts affecting the growth process (35). On the other hand, more weight gain in the formula group has been linked to higher protein or energy intake (36).

Differences between the mentioned studies, including the differences between the results of the present study and previous studies can be due to the mother's body mass, which is associated with lean body mass of the baby or related to differences in breastfeeding pattern (35). Although in the present study, maternal body mass was not different at the first prenatal visit, postpartum differences as

well as differences in formula composition may be another reason for differences in results. Also, the role of maternal and environmental determinants should not be ignored. The study of maternal and environmental determinants affecting breast milk composition in future studies can help achieve more accurate results (37). Issues such as socioeconomic status and maternal nutrition, or maternal habits, as well as child-related issues such as gastroenteritis and the number of cases can affect growth outcomes, which have not been addressed in most studies.

Regarding the increase in height and head circumference in the first six months, the study of Vafaei et al. in 2017 in Neishabour also showed that the mean height at six months was higher in breast-fed infants than formula-fed infants, which is consistent with the results of the present study (38). Head circumference at three and six months of age was significantly higher in breastfed infants than in the formula-fed group (19). Research has shown that brain tissue is rapidly synthesizing during the last trimester of pregnancy and infancy, and that mental development and brain development require Docosahexaenoic Acid (DHA) and Arachidonic Acid (AA). Due to defective enzymatic activity, the synthesis of AA and DHA from their constituent fatty acids in fetuses and infants is negligible. Therefore, the needs of AA and DHA must be met by the diet of mothers in the prenatal period or postpartum lactation (39). From the sixth week of breastfeeding to the sixth month, the amount of fat and unsaturated fatty acids in breast milk increases, so breastfeeding during this period is very important for feeding the baby (40). According to the results, it is possible that changes in the composition of breast milk at different ages of infancy are responsible for growth adjustments, while the formula has a fixed composition.

In the present study, in the second six months of life, weight gain was higher in the exclusive breastfeeding group and the combined feeding group than in the formula-fed group. Height growth was higher in the exclusive breastfeeding group and the combined feeding group than in the formula-fed group, but there was no difference in the three groups regarding head growth. A study by Hosseini et al. in 2014 showed that breastfed infants had a higher mean weight than other infants up to 12 months of age (41). These results were consistent with the present study. The mean weight of the infants in the breastfeeding group and the formula-fed group at 9 and 12 months of age was not significantly different. The results of this study also showed that at 9 and 12 months of age, no significant difference was observed between the two groups in the mean head circumference (19).

The results achieved by Hosseini et al. are different from those of the present study in regard to the weight changes in the second six months of life, but are similar to our results regarding the head circumference changes. In another study conducted systematically in California, the results showed that there was no significant difference in the mean head circumference up to one year of age between breastfed infants and formula-fed infants (42), which was consistent with the results of the present study. The differences in the results of studies on weight growth during the second six months in formula-fed or breast-fed infants may be related to the time of starting complementary feeding, and the amount of breast-feeding or formula-fed after the start of complementary feeding. With the onset of complementary foods and their effects, changes in the growth process occur. The onset time, quality and quantity of complementary nutrition affect the growth process by changing the amount of energy received, as well as the appetite and the

choice of tastes and other mechanisms (43).

The share of breast milk or formula in the food can also be a factor for growth. A study in western Kenya on children aged 9 to 18 months revealed that height growth was directly related to the duration of breastfeeding in breastfed infants (44). The principle of feeding and adhering to the correct method of complementary feeding in the mothers who breastfeed their infants, compared to the mothers of formula-fed infants, can be the reason for gaining more weight in the second six months of life in breastfed infants, also the rich feeding may protect them from nutritional problems in the future (45, 46). Another point that should not be overlooked is that weight gain can be a function of the child's height increase and it is always expected that in a healthy child, weight will increase in the same proportion with height (47). The lack of difference in head circumferences among the three groups can also be attributed to the slight increase in head circumference after the first six months of life (48).

4-1. Suggestions and limitations

This study is the first study in Bushehr dealing with the relationship between the nutrition type of the infants and their growth indices, but it has some limitations. First, the study was retrospective and based on the records, so some of the items needed for data analysis and better conclusions were not recorded. Longitudinal studies are recommended to achieve more accurate results. The second limitation was the impossibility of knowing the type of formula used that may affect the results. The third limitation was the lack of access to information about the share of breast milk and formula in the combined feeding group, due to which it was not possible to infer that the feeding model was closer to breast milk or formula. Other foodstuffs that may have been used in Bushehr culture in a group

that does not have exclusive breastfeeding such as water, tea, local medicines, etc. could not be examined, which may also affect the results. Another important limitation was that the neonatal anthropometric indices as well as prenatal disorders were based on the records in the system, which may not have been affected by the inconsistencies in the accuracy of measuring instruments in different centers.

5- CONCLUSION

This study showed that the prevalence of exclusive breastfeeding in Bushehr is about 57%, which is desirable compared to the target stated by the WHO. This percentage is almost in the same and good condition compared to the whole country of Iran, where the percentage of exclusive breastfeeding is 53%. In general, the present study showed that the growth trend in breastfed infants is either similar or better than formula-fed infants. Use of formula with breast milk compared to formula alone has better growth outcomes. It is recommended to examine the methods of persuading mothers to choose exclusive breastfeeding and plan to implement these methods.

6- ETHICAL CONSIDERATIONS

Human rights were respected in accordance with the Helsinki Declaration 1975, as revised in 1983. The study was approved by the ethics committee of forensic medicine of Bushehr (IR.BPUMS.REC.1398.143).

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8- CONFLICT OF INTEREST

None.

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