Association of Maternal Diet Quality Indices and Dietary Patterns during Lactation and the Growth of Exclusive Breastfed Infant

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Abstract—Maternal dietary intake during lactation might affect the growth rate of an exclusive breastfed infant. The present study was conducted to evaluate the effect of maternal dietary patterns and quality during lactation on the growth of the exclusive breastfed infant. Methods: 484 healthy lactating mothers with their infant were enrolled in this study. Only exclusive breastfed infants were included in this study which was conducted in Iran. Dietary intake of lactating mothers was assessed using a validated and reliable semi-quantitative food frequency questionnaire. Diet quality indices such as alternative Healthy eating index (HEI), Dietary energy density (DED), and adherence to Mediterranean dietary pattern score, Nordic and dietary approaches to stop hypertension (DASH) eating pattern were created. Anthropometric features of infant (weight, height, and head circumference) were recorded at birth, two and four months. Results: Weight, length, weight for height and head circumference of infants at two months and four months age were mostly in the normal range among those that mothers adhered more to the HEI in lactation period (normal weight: 61%; normal height: 59%). The prevalence of stunting at four months of age among those whose mothers adhered more to the HEI was 31% lower than those with the least adherence to HEI. Mothers in the top tertiles of HEI score had the lowest frequency of having underweight infants (18% vs. 33%; P=0.03). Odds ratio of being overweight or obese at four months age was the lowest among those infants whose mothers adhered more to the HEI (OR: 0.67 vs 0.91; Ptrend=0.03). However, there was not any significant association between adherence of mothers to Mediterranean diet as well as DASH diet and Nordic eating pattern and the growth of infants (none of weight, height or head circumference). Infant weight, length, weight for height and head circumference at two months and four months did not show significant differences among different tertile categories of mothers' DED. **Conclusions:** Higher diet quality indices and more adherence of lactating mother to HEI (as an indicator of diet quality) may be associated with better growth indices of the breastfed infant. However, it seems that DED of the lactating mother does not affect the growth of the breastfed infant. Adherence to the different dietary patterns such as Mediterranean, DASH or Nordic among mothers had no different effect on the growth indices of the infants. However, higher diet quality indices and more adherence of lactating mother to HEI may be associated with better growth indices of the breastfed infant. Breastfeeding is a complete way that is not affected much by the dietary patterns of the mother. However, better diet quality might be associated with better growth.

Keywords—Breastfeeding, growth, infant, maternal diet.

I. INTRODUCTION

DIETARY intakes among breastfeeding women can have significant effect on the health of mothers and the growth of infants. The World Health Organization currently recommends that infants should be exclusively breastfed for the first six months of life [1].

The quality of the whole diet, rather than the analysis of specific food groups, is now a major topic of interest among epidemiologists. HEI is one of the best index for assessing the diet quality [2]. Previous reports showed that more adherence to this index was associated with lower risk of cardiovascular diseases and different chronic diseases [2]. Furthermore, those who adhered more to HEI had higher intake of vitamins and minerals [2]. According to our knowledge there is rare information about diet quality indices of mothers during lactation and the trend of growth among exclusive breastfeeding children. Dietary patterns of lactating mothers are also important. At the same time, infant growth, defined by infant weight, height and head circumference is influenced by maternal dietary practices during lactation [3]. As the fatty acid intake of mothers can affect the fat content of breast milk, it is important to know the influence of adherence to the HEI with several components of different fats by the mothers and the growth rate of the children [2]. Hence, the present study was undertaken to assess the influence of maternal diet quality and dietary pattern during lactation on infant growth.

II. MATERIAL AND METHODS

In this study, 484 healthy lactating mother-infant pairs were recruited. Only the exclusive breast fed children were included. Dietary intake data of mothers were collected from lactating mothers through a valid and reliable 168-item food frequency questionnaire [4]. HEI was calculated. According to methods described by Kennedy et al. [5], 10 components were considered. For the first five components (grain, vegetables, fruits, milk, and meat) and total dietary diversity, the frequency of consumption was scored as 10 in highest consumption and 0 in lowest consumption. In the other

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components (total fat, saturated fatty acids, cholesterol and sodium), the highest frequency of consumption scored as 0 and the lowest frequency of consumption scored as 10. Moderate frequency of consumption rated between 0 and 10. The total HEI score was calculated by summing the scores of all 10 components.

A component of HEI is dietary diversity score (DDS). In this scoring method, five main food groups were divided in to several subgroups. The subgroups of each main food group were considered as follow: 1) grains: refined bread, biscuits, macaroni, wholegrain bread, corn flakes, rice and refined flour; 2) vegetables: vegetables, potato, tomato, other starchy vegetables, legumes, yellow vegetables and green vegetables; 3) fruits: fruit and fruit juice, berries and citrus; 4) meat: red meat, poultry, fish and eggs; 5) dairy products: milk, yoghurt and cheese. According to a study done by Kant et al., each person received the score of each subgroup if his/her frequency of consumption was at least once a day [6]. The maximum score for each main food group was considered 2. The score of each food group was calculated through the following formula: (the sum of consumption frequency of each subgroup/number of subgroups) ×2. Therefore, the maximum score of each subgroup was 2 and the maximum score of dietary diversity was 10 (5 main food groups×2).

Adherence to Mediterranean diet and DASH and also Nordic eating pattern was evaluated. Mediterranean and Nordic score was done based on Trichopoulou et al. method [7]. DASH eating pattern was scored based on the method of Fung et al. [8]. Anthropometric features such as infant weight, height and head circumference at birth, 2 and 4 months were recorded. The Statistical Package for Social Science software version 16 (SPSS Inc., Chicago, IL, USA) was used for all statistical analyses. All the indices were categorized to tertiles or quartiles. Significant differences in general characteristics across quartile or tertile categories of indices were investigated using ANOVA. If there was a significant main effect, the Bonferroni test was used to detect pairwise differences. The chi-squared test was used to detect significant differences in the distribution of participants across quartile categories of indices with regard to qualitative variables. To compare general characteristics across quartiles, analysis of variance and χ^2 tests were used for continuous and categorical variables, respectively. We used logistic regression models to examine associations between HEI, weight, height, head circumference and weight-for-age. A second model was further adjusted for other potential confounders including cigarette smoking, physical activity, socioeconomic status, supplement use. International Physical Activity Questionnaire (IPAQ) was used to assess the physical activity.

III. RESULTS

Mean maternal age was 31.0±4.3 years. Also, 40% of the families were low income and 88% percent of women worked as housekeepers. The husbands of the 40 % of mothers were self-employed. 36% of mothers had university educations. 72% of mothers did not get any supplements. Infant weight at birth, two month and four months of age, within four categories of mothers' dietary index of quality (HEI) are shown in Table I. The weights of children at 2 and 4 months of life were higher among those whose mothers adhered more to the HEI. However, there was not significant difference between those in the fourth quartile compared to the first ones. This difference was in a marginal significant level.

Table II shows the dietary intakes of the mothers based on the tertiles of HEI. The results show that those in the top tertiles of HEI had higher intake of vitamins and minerals and lower amounts of total fat. Those adhered more to the HEI had higher intake of vitamins and minerals such as vitamin B1, riboflavin, vitamin C and calcium as well as zinc. Percentage of normal weight among infants at 2 and 4 months of life in different quartile categories of HEI based on mothers' diet is shown in Table III. Those in the top quartiles of adherence to HEI had the highest percentage of having the normal weight child at 2 and 4 months of life. Percentage of normal height at 2 and 4 months of life among infants in different quartile categories of HEI based on mothers' diet is shown in Table IV. Those mothers in the top quartile of adherence to the HEI had higher rate of having a normal height infant.

Table V shows the odds ratio of being stunted or underweight among children at 4 months of life based on the adherence to the HEI by their mothers. According to the results, those with higher adherence to the HEI had the lower odds ratio for underweight or stunting.

No significant differences were observed for infant weight, height, weight for height, head circumference, at 2 and at 4 months in relation to quartiles of DED. The results regarding analysis of the growth indices in different quartiles of adherence to the Mediterranean diet and DASH eating pattern and Nordic diet by mothers showed no significant difference between the adherence to different dietary patterns and infant growth.

The percentage of underweight across different dietary patterns is shown in Table V. There was not significant difference in the percentage of underweight infant in different categories of HEI.

IV. DISCUSSION

The results of this study suggest that adherence to a diet with higher quality may be indicated by better growth indices in breast fed child. Diet quality was evaluated by HEI. However, there was no association between quartiles of maternal DED during lactation and infant weight, length, weight-for-length and head circumference growth at 2 and 4 months of age. Adherence to a specific dietary pattern such as Mediterranean diet or Nordic diet or DASH eating pattern was not associated with any growth indices of the breast fed child.

The association between diet quality as indicated by the healthy eating pattern and growth indices might be related to the higher amounts of vitamins and minerals and also good kind of fat intake by the more adherence to the HEI [9]. As the previous studies showed that adherence to HEI is associated with lower risk of cardiovascular diseases and higher quality, it is important to know if this is a suitable way for lactating women or not [10]. Furthermore, based on the previous

literature, adherence to HEI might be associated with the lower levels of inflammation which might be related to better growth rate of the infant [11].

TABLE I
INFANT WEIGHT AT BIRTH, TWO MONTH AND FOUR MONTHS OF AGE, WITHIN FOUR CATEGORIES OF HEI OF THE MOTHERS' DIET

Variables	Quartiles of healthy eating score based on mothers' diet during lactation				
	1	2	3	4	P
Weight (birth)	3102.73±423.14[a]	3143.31±497.00	3169.11±489.69	3124.90±450.50	0.405
Weight (2 months)	5143.52±335.47	5128.33±371.90	5139±335.36	5294±333.31	0.076
Weight (4 months)	6502.62±326.27	6501.39±321.50	6534.69±398.04	6690.306±85.01	0.081

[a]All values are expressed as mean±SD and were adjusted for age, supplement use, breastfeeding frequency and duration of each breastfeeding session, week of pregnancy in which the birth occurred and physical activity.

TABLE II
DIETARY INTAKES OF THE MOTHERS BASED ON THE TERTILES OF HEI OF THE MOTHERS' DIET

Variables	Tertiles of HEI			
	1	2	3	P
Energy	1775.10 ± 582.89	2109.86 ± 614.14	2189.40 ± 794.02	0.001
Carbohydrate	216.49 ± 89.35	305.62 ± 96.11	319.31± 100.70	0.01
Protein	65.74 ± 21.71	59.23 ± 25.47	55.01 ± 32.38	0.01
Fat	64.25 ± 32.28	50.80 ± 34.01	49.03 ± 43.90	0.01
Cholesterol	250.02 ± 103.90	242.15 ± 101.90	226.16 ± 100.22	0.01
Vitamin A	1367 ± 605.32	1397.40 ± 619.95	1490.61 ± 710.76	0.01
Beta carotene	690.43 ± 61.22	699.97 ± 68.86	720.31 ± 94.46	0.01
Thiamine	1.35 ± 0.36	1.44 ± 0.35	1.50 ± 0.53	0.01
Riboflavin	1.93± 0.25	2.16 ± 0.32	2.27 ± 1.04	0.01
Niacin	11.83 ± 5.46	15.23 ± 5.56	15.39 ± 6.08	0.01
Vitamin C	179.18 ± 19.18	206.06 ± 20.32	218.37 ± 29.05	0.01
Calcium	1025.43 ± 133.06	1234.45 ± 193.15	1322.29 ± 643.51	0.01
Iron	8.99 ± 3.18	11.70 ± 3.24	12.24 ± 4.18	0.01
Zinc	6.80 ± 2.31	7.84 ± 2.58	8.02 ± 3.36	0.01

TABLE III
PERCENTAGE OF NORMAL WEIGHT AT 2 AND 4 MONTHS IN DIFFERENT QUARTILE CATEGORIES OF HEI BASED ON MOTHERS' DIET

Variables	Quartiles of Healthy eating score based on mothers 'diet during lactation				
	1	2	3	4	P
Normal weight (2 months)	391	45	56	61	0.035
Normal Weight (4 months)	34	49	5	65	0.016

TABLE IV
PERCENTAGE OF NORMAL HEIGHT AT 2 AND 4 MONTHS OF LIFE AMONG INFANTS IN DIFFERENT QUARTILE CATEGORIES OF HEI BASED ON MOTHERS' DIET

Variables	Quartiles of Healthy eating score based on mothers 'diet during lactation				
	1	2	3	4	P
Normal weight (2 months)	40[b]	48	53	59	0.045
Normal Weight (4 months)	41	50	59	67	0.036

Percentage[b]

The lack of association between infant growth indices and DED in the present study may be related to several factors. Energy dense foods are many processed foods that are high in refined grains, saturated fat and added sugar [12]. A low-energy-density diet is associated with more intake of fruits and vegetables, more intake of vitamins and minerals [13]-[16]. Conversely, the high-energy-density eating pattern is associated with increased energy intake, greater intake of refined grains, more saturated fat, more sugar and poor quality diet, characterized by low nutrient density [12], [17]. So, lactating mothers with low energy density dietary patterns seem to have adequate intake of vitamins and minerals to meet their needs during breastfeeding.

TABLE V
ODDS RATIO[c] OF UNDERWEIGHT AND STUNTING IN DIFFERENT QUARTILE CATEGORIES OF HEI BASED ON THE MOTHERS' DIET DURING LACTATION

Variables	Quartiles of Healthy eating score based on mothers 'diet during lactation				
	1	2	3	4	P
Underweight	0.881	0.80	0.71	0.64	0.035
Stunting	0.83	0.76	0.69	0.62	0.036

Odds Ratio[c]

No association between different dietary patterns of mother and the growth of the infant shows the fact that breast feeding is a natural way that might not be very different in different dietary patterns of the mothers.

The short duration of our study limits our ability to observe how dietary patterns over longer periods of lactation may influence infant growth and our results afterwards. In addition, we did not assess the quality and the quantity of the milk produced. Milk adequacy was defined based on only two factors, including the frequency of breastfeeding per day and duration of breastfeeding in each session. There is a need for further investigation taking into account the quantity of milk produced.

TABLE VI
THE STATUS OF THE INFANT'S WEIGHT GROWTH IN ADHERENCE TO DIFFERENT DIETARY PATTERN

Variables	DASH				Mediterranean				Nordic			
	1	2	3	p	1	2	3	p	1	2	3	p
At 2rd month	27.3	45.5	27.3	1.00	18.2	36.4	45.5	0.47	9.1	45.5	45.5	0.31
Underweight (z<-2)	25	50	25	0/98	25	25	25	25				
At 4th month Underweight (z<-2)									0	100	0	0.24

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