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The Relationship between Dietary Diversity at Third Trimester of Pregnancy and Newborns' Anthropometric Indices at Birth

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ABSTRACT

Background: Due to the importance of nutrition during pregnancy and its role in future generations' health, the study tried to determine dietary diversity and its relationship with newborns' anthropometric indices at birth. **Methods:** In this cross-sectional study, 400 pregnant women (28-40 weeks of pregnancy) whom were referred to the health centers in Zahedan were studied in 2016. To assess the usual dietary intake, food frequency questionnaire and the 24-hour recall were used. Dietary diversity was calculated based on the score 8 of food groups using food pyramid of Food and Agriculture Department, and Kant method. Newborns' anthropometric indices were measured by the standard and analyzed by using descriptive statistics and analytical tests. **Results:** The mean (± Standard deviation) of the total score of dietary diversity was 2.60 ± 0.73 and the highest diversity was seen in the dairy group (0.45 ± 0.19) and the lowest diversity of food was observed in grains group (0.20 ± 0.10). There was a significant difference between various groups of birth weight at the score of dietary diversity and it was significantly increased by rising family's incomes. The linear regression analysis has shown that the variables including; weight at the beginning of pregnancy, a variety of dairy products, vegetables and total dietary diversity could be considered for predicting birth weight. **Conclusion:** The study has shown that there was a significant correlation between the score of dietary diversity and newborns' anthropometric indices at birth.

Keywords: *Birth weight; Dietary diversity; Pregnancy*

Introduction

Pregnancy is one of the most important periods of women's life, which may affect most of their needs. The maternal nutrition during pregnancy and parental nutrition even before the fecundation can affect the mother and child's health (Mora and Nestel, 2000). There are many maternal and fetal complications due to inappropriate nutrition during pregnancy, which can be noted as intrauterine growth retardation, abortion, premature delivery, fetal malformations and especially low birth weight (Delvarianzadeh *et al.*, 2007). Some studies have shown that those

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newborns who are small for gestational age (Haghighatdoost *et al.*) are more susceptible to chronic diseases in their adulthood, which must comply with food deprivation conditions at fetal life (Moore *et al.*, 2004).

The quality and quantity of nutrition are very important during the pregnancy. Healthy diets include the most diverse foods, and balance in eating food provides maternal and fetal health, and reduces the number of low birth weight (LBW) newborns (Zhang et al). Therefore, dietary guidelines emphasized on the importance of dietary diversity (Ramlal *et al.*, 2015) and micronutrient intake (Mora and Nestel, 2000).

Dietary diversity represents various food consumptions among different groups of food guide pyramid as well as each dietary group. Therefore, the principle of diversity must not only be observed in 5 groups of food guide pyramid but also diverse and different food items should be used within each group constituting that group (Haines *et al.*, 1999). There are numerous effects on getting a varied diet; including adequacy of the consumer diet, reducing the risk of shortages or getting too much nutrients. A varied diet can be defined for each group of consumption based on the groups of food guide pyramid and proposed recommendations (Coulston, 1999).

Considering the great importance of nutrition during pregnancy as well as having little information about the direct impact of dietary diversity at third trimester of pregnancy on newborns' anthropometric parameters and other previous studies, the effect of supplements and micronutrients intake on newborns' anthropometric indices were examined in specific cases. Therefore, this study aimed to determine the relationship between maternal dietary diversity at third trimester of pregnancy and newborn's anthropometric indices at birth.

Materials and Methods

Study Design: It is a descriptive-analytical cross-sectional study which was conducted on 400 pregnant women, with a gestational age of 25-40 weeks, who were referred to gynecological clinic of Tamin- Ejtemaee Hospital in Zahedan, in 2016. The sample size was determined based on the sample size formula and similar studies conducted in other parts of Iran(Mohammadshahi *et al.*, 2013). The gestational age was characterized based on the first day of the last menstrual period (LMP) and ultrasound. The inclusion criteria were singleton pregnancy, absence of chronic diseases such as diabetes, hypertension, heart and respiratory and kidney diseases, thyroid disorders, autoimmune diseases, preeclampsia, placental abruption, premature rupture of membranes, hepatitis, special medication and diet and non-using of tobacco, alcohol, Hookah and using iron and folic acid supplementation during pregnancy. An informed consent was obtained from the participants. Demographic variables including age, occupation and education were taken by a questionnaire.

Dietary Assessment: The usual dietary intake of Participants was evaluated by using food frequency questionnaire (FFQ) and the 24-hour recall questionnaire for two days. The FFQ includes 61 list of foods with the standard consumer unit which its reliability and validity have shown in numerous national and international studies(Ahluwalia and Lammi-Keefe, 1991, Sharafi *et al.*, 2016). The participants were asked to mention the frequency of all food consumption over their last 3 months of pregnancy based on daily (e.g. bread), weekly (e.g. meat) or monthly (e.g. fish) programs. To complete the 24- hour recall questionnaire, the participants were asked to name all foods and beverages they had consumed during the past 24 hours. Household dishes and bushels were used to help the subjects to accurately recall what they had eaten. They were converted to grams using the household scales. Each food and drink was; then after, coded according to the listed protocol. The total energy and other nutrients were designed for Iranian foods using the Nutritionist IV (N4) program.

The Kant (Kant *et al.*, 1995) method was used to determine the dietary diversity score, which was calculated based on the number of groups and subgroups of foods. According to the frequency questionnaire, foods were divided into 8 main groups; including bread and grains, meat, dairy, vegetables, fruits, fats, snacks and drinks; thus, each of these main groups had their own subgroups. Being a consumer of each of food groups, half of a serving must be consumed in a day. Score 1 was assigned to each group of food and calculated as the number of sub-groups relating to each person in a day, which must be divided by the number of subgroups. A total point of the 8 groups is equal to the total score of dietary diversity.

Measurements: Infant's anthropometric indices at birth were recorded by boat scale with an accuracy of 10^{-2} kg and his tallness was calculated using the scaled board. The information about birth weight and gestational age were obtained from medical charts. Small for gestational age (SGA) and large for gestational age (LGA) were considered as a birth weight less than the 10^{th} and more than 90^{th} percentile growth, respectively (He *et al.*, 2014).

Ethical considerations: At the beginning of the project, the informed consent was obtained from all the participants. They would all allowed not to participate in the project if there is any reluctance. In this study, there was no intervention and all the information was reserved by the researcher.

Data Analysis: To analyze the data, SPSS 18 statistical software and descriptive and inferential statistical methods, and independent *t-tests* were used and, logistic regression was utilized to evaluate the factors influencing LBW.

Results

The results of the study showed that the average age of the women was 29.69 ± 2.94 year. In terms of demographic characteristics, 33.8% (n = 135) were under diploma and 83.5% (n = 334) were housewives. It must be noted, 97% & 78% of women were taken iron and multivitamin pills; respectively, during pregnancy. The average maternal weight was 62.88 ± 11.30 kg. In terms of body mass index (BMI) classification, 7.5% (n = 30) of the women were under weight and 3.5% (n = 14) were obese; thus, the highest percentage of the women (55.5%, n = 222) had a normal BMI.

On the basis of energy and protein intake, the participants were divided to two groups; adequate and inadequate nutrition intake groups. 73.5%, 5% and 9% of the participants had inadequate nutrition intake in terms of energy (less than 2500 Kcal), carbohydrate (less than 135 grams per day) and protein (less than 60 grams per day) intake, respectively **(Table 1).**

The rate of SGA, appropriate for gestational age (AGA) and LGA were estimated as 17.5% (n = 70), 73.75% (n = 295) and 8.7% (n = 35), respectively, between newborns. Based on the findings and Chi-square *test*, the frequency of protein intake is significantly different between the women at third trimester of pregnancy and infants of different weight at birth ($P = 0.01$) **(Table 1).**

Table 2 is shown the average score of maternal dietary diversity intake among different groups of birth weight. The average score of total dietary diversity is 2.6 ± 0.7. The result of ANOVA *test* was shown that there is no significant difference among the scores only in the fat and drink diversity intake at third trimester of pregnancy and birth weight. However, there are significant difference among various groups of birth weight on the score of different groups of grains ($P < 0.001$), meat ($P < 0.02$), dairy ($P < 0.03$), fruits ($P < 0.001$), vegetables ($P < 0.05$), sundries ($P < 0.004$) and the total score of dietary diversity ($P < 0.001$).

Table 3 is shown the distribution of total score of maternal dietary diversity intake among different groups of birth weight. The dietary diversity score less than 3 was 70%, and the Chi-square *test* result was shown that there is a significant relationship between the birth weight and level score of maternal dietary diversity intake ($P = 0.001$).

Multiple logistic regression models were used as a backward elimination method to determine the most important nutritional factors during pregnancy. The results showed that pre-pregnancy weight, diary diversities, vegetable and total diversity can be effective in predicting the birth

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weight. The Lemeshow *test* was used to determine the best model of the most important nutritional factors during pregnancy, which was related to the infant's low-weight **(Table 4)**.

Birth weight = 2.14 + (-0.37 × dairy variety) + (0.48 × vegetable variety) + (0.18 × total variety) + (0.008 × weight at the beginning of pregnancy)

Table 1. Distribution of macronutrients intake at third trimester of pregnancy on the basis of birth weight

Energy and macronutrients	Birth weight SGA N (%)	AGA N (%)	LGA N (%)	Total	P-value[a]
Energy (Kcal)					
< 2500	31 (10.5)	255 (86.7)	8 (2.8)	294 (73.5)	0.74
≥ 2500	14 (13.2)	90 (84.9)	2 (1.9)	106 (26.5)	
Carbohydrate (g)					
< 135	1 (20)	4 (80)	0 (0)	5 (1.27)	0.06
135 - 175	1 (11.1)	6 (66.5)	2 (22.2)	9(2.2)	
≥ 175	44 (11.3)	334 (86.5)	8 (2.2	386(96.6)	
Protein (g)					
< 60	10 (27.7)	22 (61.1)	4 (16.2)	36 (9)	0.01
≥ 60	36 (9.8)	322 (88.4)	6 (0.8)	364 (91)	

SGA: Small for gestational age, AGA: Appropriate for gestational age, LAG: Large for gestational age, [a]: Chi-square *test*

Table 2. Mean and standard deviation of dietary diversity score of different groups of food intake at last trimester of pregnancy based on the birth weight

Food groups	SGA (N = 70)	AGA (N = 295)	LGA (N = 35)	Total score (N = 400)	P-value[a]
Grains	0.20 ± 0. 08	0.20 ± 0. 10	0.27 ± 0. 13	0.20 ± 0. 1	0.001
Meat	0.18 ± 0. 12	0.22 ± 0. 11	0.25 ± 0. 12	0.21 ± 0. 1	0.022
Dairy	0.40 ± 0. 18	0.46 ± 0. 20	0.48 ± 0. 12	0.45 ± 0. 1	0.032
Fat	0.21± 0. 10	0.24 ± 0. 14	0.27 ± 0.14	0.24 ± 0. 1	0.14
Fruit	0.34 ± 0. 20	0.44 ± 0. 21	0.44 ± 0. 22	0.43 ± 0. 2	0.001
Vegetable	0.23 ± 0. 15	0.34 ± 0. 17	0.42 ± 0. 14	0.30 ± 0. 1	0.001
Sundries	0.22 ± 0. 17	0.29 ± 0. 18	0.32 ± 0. 18	0.28 ± 0. 1	0.004
Drink	0.38 ± 0. 16	0.44 ± 0. 19	0.40 ± 0. 11	0.42 ± 0. 1	0.4
Total Diversity	2.1 ± 0. 52	2.60 ± 0. 75	2.80 ± 0. 66	2.60 ± 0. 7	0.001

SGA: Small for gestational age, AGA: Appropriate for gestational age, LAG: Large for gestational age, [a]: One-Way ANOVA *test*

Table 3. Distribution of the level score of maternal dietary diversity at last trimester of pregnancy based on the birth weight

Score of maternal dietary diversity	Birth weight SGA N (%)	AGA N (%)	LGA N (%)	Total	P-value[a]
< 3	44 (15.7)	230 (82.1)	6 (2.1)	280 (70)	0.001
≥ 3	2 (1.7)	114 (95)	4 (3.3)	120 (30)	

SGA: Small for gestational age, AGA: Appropriate for gestational age, LAG: Large for gestational age, [a]: Chi-square *test*

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Table 4. Estimating regression coefficients of nutritional factors (multivariate analysis) in relation to the birth weight based on the multiple logistic regressions

Variables	Beta	Standard error	t	P-value
Constant coefficient	2.14	0.14	15.30	0.001
Grains variety	0.039	0.22	1.78	0.07
Dairy variety	-0.370	0.13	-2.26	0.008
Vegetable variety	0.48	0.15	3.23	0.001
Total variety	0.18	0.05	3.48	0.001
Weight at the start of pregnancy	0.008	0.002	4.32	0.001

Discussion

Protecting mothers' health and delivering a healthy baby are the ultimate goals of prenatal care. Maternal dietary intake is one of the most important points in these cases, since the embryonic growth has been intertwined with maternal nutrition and the embryo's energy and structural needs are only meet through the maternal nourishing blood through the placenta. The average of dietary diversity was 2.60 ± 0.73 and the majority of population did not have an adequate dietary diversity. Dairy had the maximum (0.45 ± 0.19) and grains had the minimum dietary diversity score (0.20 ± 0.10) among the groups, which might be due to our private dietary habits and limited number of wholegrain products of cereals in Iran society compared to the developed countries, such as breakfast cereals, enriched pasta and wholegrain biscuits (Mirmiram *et al.*, 2003).

The studies on different ages of Iranian populations show that the maximum dietary diversity score (DDS) was belonged to the fruits (diversity score of fruits was about 1.48 ± 0.6 for those who were over 18 years old and lived in 13th district of Tehran (Mirmiram *et al.*, 2003) and diversity score of fruits was 1.26 ± 0.68 amongst teenage girls of Tehran (Davallo *et al.*, 2015) that are in conflict with the results of the study. The probable reasons of this conflict can be generalized as both dry and tropical climate of the South-East and the low agriculture level of the province.

There was a significant relationship between the family income and the variety of all groups of foods, so that, by having a better financial power, the family can provide all various groups of foods. In this regard, numerous studies have shown that there is a direct and strong relationship between the dietary diversity and the family economic status. For instance, it can be referred to Hoddionott, who found that there is a direct relationship between dietary diversity and family socio–economic level (Hoddinott and Skoufias, 2004).

There is a significant difference between different groups of birth weight on the total score of dietary diversity and the groups of foods. Therefore, the percentage of SGA infants is higher for those mothers who have low score in grains, meat, dairy, fruits, vegetables and total diversity intake at last trimester of pregnancy. Lu stated that an adequate birth weight is always associated with an adequate dietary intake during pregnancy, which is rich in fruits and vegetables (Lu *et al.*, 2016). Olsen also indicated that there is a significant relationship between the milk intake (during pregnancy) and a decrease in the risk of SGA babies' birth and an increase in the risk of LGA (Olsen *et al.*, 2007). Besides, Poon Anna had conducted a cohort study on 1502 pregnant women at their last trimester of pregnancy. She stated that there is no relationship between birth weight and the maternal dietary (Poon *et al.*, 2013). There is a significant relationship between the maternal nutritional status at last trimester of pregnancy and the birth weight since the fetus receives the maximum nutrients in this period. It is one of the most important indicators reflecting the nutritional status and maternal health care during pregnancy and nutritional status and infant's health. Numerous studies have, so far,

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examined the relationship between maternal dietary and embryonic growth (Coelho *et al.*, 2015, Colón-Ramos *et al.*, 2015, Okubo *et al.*, 2012, Thompson *et al.*, 2010, Wolff and Wolff, 1995). The results of the studies have shown that the overall quality of the diet during pregnancy, or varied dietary intake patterns is positively associated with an increase in the birth weight (LGA) and reducing the risk of SGA birth (Okubo *et al.*, 2012, Thompson *et al.*, 2010, Wolff and Wolff, 1995). On the other hand, the low maternal nutritional status is along with a reduction in weight and surface of the placenta, which may affect the ability to transfer nutrients from the mother to the evolving fetus.

Despite promoting nutrition during pregnancy, there is an equivocal relationship between the maternal dietary and pregnancy outcomes, some of these contradictions are due to differences in the size of birth, the population, regional dietary patterns, geography, different cultures and genetics, etc. Embryonic growth is largely determined by non-food factors such as genetics, placenta, maternal age, weight, height, immune response to pregnancy, blood pressure, infections, chronic diseases, prenatal care and smoking (Knudsen *et al.*, 2008, World Health Organization, 2006), so that, in this study, they were controlled as much as possible.

Conclusions

The study has shown that there was a significant correlation between the score of dietary diversity and infant anthropometric indices at birth. According to the results, nutritional training should be educated in nutritional policies to those women who are in gestational age in order to raise their awareness. And special attention should be paid on the effects of adequate dietary diversity, groups and their food items to improve the nutritional culture and maternal nutritional literacy and achieving the best results for infants' anthropometric indices at birth. However, there are some limitations; including the small sample size and lack of accountability of a larger number of women to food frequency questionnaire, which must be considered in future studies.

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Authors' contribution

Javadi M designed and supervised the study. Dashipour A helped intellectually in finalizing the study design. Jamalzehi A performed most of the analyses, wrote the preliminary manuscript and was actively involved in the field work. All authors read and approved the article.

Conflict of interest

There are no conflicts of interest to declare.

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