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Original Article

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Association Between Infants Anthropometric Outcomes With Maternal AHEI-P and DII Scores

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Conflict of Interest
The authors declare that they have no competing interests.

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ABSTRACT

The present study sought to examine the association between an infant's anthropometric outcomes with maternal Dietary Inflammatory Index (DII) and Alternate Healthy Eating Index for Pregnancy (AHEI-P) scores during the third trimester of pregnancy. This prospective cohort study was applying 130 pregnant women, at the pregnancy training center in west Tehran, Iran (November 2020 to July 2021). The maternal dietary intake, and body mass index (BMI), and social economic level were evaluated. The data about birth weight, birth height, head circumference, and, gestational age at birth were extracted from each child's health records. The ultimate sample included 122 (93.8%) pairs of women/newborn children. The participants, mean age was 28.13 ± 4.66 years with gestational age between 28 to 40 weeks and the mean of BMI was 24.62 ± 3.51. Our outcomes, after adjustment for confounding factors, suggested that those newborn infants in the highest quartile of maternal DII score had a significantly lower weight ($p < 0.001$) and height ($p = 0.05$), in comparison to those in the lowest quartile, but not head circumference ($p = 0.18$). Moreover, after adjustment for confounding factors, results suggested that those newborn infants in the First quartile of maternal AHEI-P score had a significantly lower weight ($p = 0.018$) and, in comparison to those in the higher quartile. It appears that newborn infants with lower maternal DII and higher AHEI-P scores may have a better anthropometric outcome. Further longitudinal and in-depth qualitative and quantitative studies, with a longer-term follow-up, is warranted to support the integrity of our outcomes.

Keywords: Infants; Anthropometry; Healthy Eating Index; Dietary Inflammatory Index; Pregnancy

INTRODUCTION

Nutritional quantity and quality during pregnancy have a crucial role on current and future health of both mother and child [1]. Women with poor diet during pregnancy have disposed to irreversible health issues such as gestational diabetes mellitus, pre-eclampsia [1,2]. In addition, low quality of maternal diet can cause abnormal fetal growth [2,3]. Previous research has documented that maternal diet quality may strongly affect newborn growth [4-6]. Several

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nutritional scores have been considered to evaluate the maternal diet quality during pregnancy for instance alternate maternal dietary diversity, dietary patterns index, Alternate Healthy Eating Index for Pregnancy (AHEI-P), and Dietary Inflammatory Index (DII).

Former studies have suggested that a diet with higher score for AHEI-P is beneficial diet whose effects on children health and optimal anthropometric indices [7,8]. Dietary components in AHEI-P is coincident with nutritional guidelines during pregnancy [9] and rich of nutrients that associated with fetal growth [10-12]. However, another research with pregnant women did not show a statistically significant association between AHEI-P and newborn anthropometrics [13]. On the other hand unhealthy diet with an increased level intake of trans fat, refined carbohydrate and animal protein correlated with increased level of inflammatory markers [14]. DII as another dietary score has been designed and validated to define the inflammatory potential of the whole diet [15]. A former study indicated that higher dietary inflammatory score associated with higher risk of abortion. Another research has shown that high inflammatory index of diet have an association with small for gestational age (SGA) infant birth [16]. In addition, some studies were confirm the positive relation between high DII and low neonate birth weight [16,17]. However, Moore et al. [18] reported that in the pre-pregnancy obese women show positive association between higher DII score and high newborn birth weight. This study documented that increased in DII score associated with increase in neonate body fat [18].

It is the first time that the simultaneous role of AHEI-P and DII score on neonate anthropometry in the third trimester of pregnancy was investigated. In addition, the association between DII and neonate height and head circumference was not assessed yet. Therefore, this study was conducted to examine the association between AHEI-P, DII and neonatal anthropometric among Iranian pregnant women in the third trimester.

MATERIALS AND METHODS

Participants

Current prospective cohort study was applying 130 pregnant women, at the pregnancy training center in west Tehran, Iran (November 2020 to July 2021). The study was confirmed by the local ethics committee of Islamic Azad University, Science and Research Branch, Tehran (Ethic ID: IR.IAU.SRB.REC.1400.112) and was carried out based on the Declaration of Helsinki. All authors have agreed to submit the manuscript to Clinical Nutrition Research. In order to evaluate the sample size employing Gpower software version 3.9.1.7 [19] based on multiple linear regression and settings of the alpha value of 5% and power of 80%, it was calculated as 118 people, which, taking into account the loss of 10%, the total sample size is equal to 130 individuals were considered. The pregnant women were selected according to the following inclusion criteria; being Iranian and a resident of Tehran, have been over 16 years old with the gestational age was over 28 weeks with singleton pregnancy, free from any acute or chronic disease such as severe anemia, infertility, abortion, preeclampsia, hypertension, diabetes, hypothyroidism, hyperthyroidism, use of auxiliary methods for pregnancy such as in vitro fertilization, uterine anomalies and fetal anomalies, and finally not taking, drug treatments or unusual supplements during pregnancy. Participants were excluded if preterm delivery (an infant was born under 37 weeks of pregnancy), fetal death and the questionnaires were not completed and/or did not respond to more than 53 food items available in the feed frequency questionnaire. All participants signed an informed consent form prior to taking part in the research.

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Variable assessments

The maternal demographic parameters, including gestational age (week), maternal age (years), maternal body mass index (BMI), maternal education, pregnancy supplementation smoking during pregnancy, alcohol consumption during pregnancy, were gathered via a general questionnaire. The data about birth weight, birth height, head circumference and, gestational age at birth were extracted from each child's health records. The socioeconomic levels were evaluated using the Social Economic Survey (SES) questionnaire, and consists of five indexes, namely, income, occupation, education, wealth, and place of living. Based this score, the participants were classified into three levels of SES, namely low (< 12); middle (≥ 12 to < 16); high (≤ 16) [20].

Dietary intake was evaluated with the use of a valid and reliable [21], 147-item, semi-quantitative food frequency questionnaire (FFQ), to determine the usual dietary intake during the year preceding the assessment. Household measures were used to convert all the portion sizes of consumed foods to grams [22]. Nutrient analysis of diets was performed using Nutritionist IV software, with its database modified for Iranian foods.

The Alternative Healthy Eating Index (AHEI) is an a priori dietary index that is according to the Healthy Eating Index, which was established by the US Department of Agriculture. The AHEI is a measure of diet quality that focuses on foods and macronutrients, including evaluation of unsaturated fats, related with reduced chronic disease risk [23]. To make the AHEI suitable for apply in a pregnant women, Poon and colleagues [24] modified the score to create the AHEI-P, by excluding the alcohol component and including components for nutrients important for pregnancy (i.e., calcium, folate, and iron). The AHEI-P has been applied to assess the association between maternal diet in the third trimester and birth weight and early infant growth [23]. This index has 0–10 points awarded for optimal intake of 6 food groups (vegetables; whole fruit; whole grains; sugar-sweetened beverages; nuts and legumes; red/processed meats) and seven nutrient-based categories (*trans* fat; long-chain fats; polyunsaturated fatty acids; sodium; calcium; folate; and iron) [24].

Also, The DII score was calculated for each participants applying the method suggested by Shivappa et al. [25]. The process of calculating the DII score is that, first, the intake of each of the 45 food parameters (here, 32 food parameters from the FFQ can be obtained) is subtracted from the corresponding global average intake. A larger score indicates a pro-inflammatory regimen and a smaller score indicates an anti-inflammatory regimen. Dietary parameters for DII calculation in this study are: energy intake, carbohydrate, protein, fat, fiber, cholesterol, saturated fat, polyunsaturated fatty acid, monounsaturated fatty acid, omega-3, omega-6, niacin, thiamine, riboflavin, vitamin B12, iron, magnesium, selenium, zinc, vitamin A, vitamin C, vitamin D, vitamin E, folic acid, beta-carotene, garlic, ginger, onion, turmeric, saffron, and pepper.

Statistical analysis

Kolmogorov-Smirnov tests were employed to assess the distribution of the data. The characteristics of participants were assessed using the Independent t-test for quantitative and χ^2 test for qualitative variables. The analysis of variance (ANOVA) test was used to analyze the relationship between infant's anthropometric measurements (weight, height and head circumference) at birth with different quadrants of DII and AHEI-P. Statistical significance was accepted, a priori, at p value ≤ 0.05. All statistical analyses were performed applying SPSS version 24 (IBM Corp., Armonk, NY, USA).

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RESULTS

The ultimate sample included 122 (93.8%) pairs of women/newborn children. We excluded individuals (n = 8) based on our criteria, i.e., preterm delivery (n = 3) and not completing the questionnaire (n = 5). The participants, aged from 18 to 35 years (means ± standard deviation [SD], 28.13 ± 4.66 years) in the third trimester of pregnancy with 28 to 40 weeks gestational age and that of BMI was from 17.89 to 36.22 kg/m^2 (means ± SD, 24.62 ± 3.51) (data not shown in table).

The background characteristics of participants by quartiles of maternal DII score are reported in **Table 1**. Our results indicated that there were not significant differences between quartiles of maternal DII for gestational age (p = 0.33), maternal age (p = 0.91), maternal BMI (p = 0.10), iron (p = 0.52), B3 (p = 0.24), B9 (p = 0.10), maternal education (p = 0.54), the economic situation (p = 0.94), pregnancy supplementation (p > 0.05), smoking during pregnancy (p = 0.78), and alcohol consumption during pregnancy (p = 0.55). Although, maternal nutrients intake was significantly different among quartiles of maternal DII score including protein (p < 0.001), carbohydrate (p < 0.001), total fat (p < 0.001), dietary fiber (p < 0.001), cholesterol (p < 0.001), magnesium (p < 0.001), zinc (p < 0.001), selenium (p = 0.09), B2 (p < 0.001), B6 (p<0.001), B12 (p < 0.001), vitamin C (p < 0.001), vitamin E (p < 0.001), vitamin D (p < 0.001), and vitamin A (p < 0.001).

The background characteristics of participants by quartiles of maternal AHEI-P score are reported in **Table 2**. Our outcomes that there were not significant differences between quartiles of maternal AHEI-P for gestational age (p = 0.28), maternal age (p = 0.89), maternal BMI (p = 0.66), protein intake (p = 0.18), cholesterol (p = 0.22), zinc (p = 0.21), selenium (p = 0.22), B2 (p = 0.31), B3 (p = 0.11), B12 (p = 0.93), vitamin C (p = 0.93), vitamin E (p = 0.92), and vitamin D (p = 0.71), maternal education (p = 0.16), the economic situation (p = 0.43), pregnancy supplementation (p > 0.05), smoking during pregnancy (p = 0.28), and alcohol consumption during pregnancy (p = 0.56). However, maternal nutrients intake was significantly different among quartiles of maternal AHEI-P including carbohydrate (p = 0.02), total fat (p = 0.005), dietary fiber (p < 0.001), iron (p < 0.001), magnesium (p = 0.03), B6 (p < 0.001), B9 (p < 0.001), and vitamin A (p < 0.001).

The association between infants' anthropometric outcomes and maternal DII score during the third trimester of pregnancy are reported in **Table 3**. Our outcomes, after adjustment for confounding factors, suggested that those newborn infants in the highest quartile of maternal DII score had a significantly lower weight (p < 0.001) and height (p = 0.05), in comparison to those in the lowest quartile, but not head circumference (p = 0.18).

The association between infants' anthropometric outcomes and maternal AHEI-P score during the third trimester of pregnancy are shown in **Table 4**. Our outcomes, after adjustment for confounding factors, suggested that those newborn infants in the Fourth quartile of maternal AHEI-P score had a significantly higher weight (p = 0.018) and, in comparison to those in the lower quartile, but not head circumference (p = 0.476) or height (p = 0.189).

DISCUSSION

The aim of the present prospective cohort study was to test the association between AHEI-P, DII and neonatal anthropometric measurements among pregnant women in the third

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Table 1. Background characteristics of participants by quartiles of maternal DII score

Characteristic	Q1 (n = 30) (−9.21 to −4.51)	Q2 (n = 30) (−4.50 to −2.42)	Q3 (n = 31) (−2.41 to −0.30)	Q4 (n = 31) (−0.29 to 9.03)	p value*
Gestational age (wk)	33.63 ± 3.01	34.26 ± 3.01	32.74 ± 3.14	34. 0 ± 3.16	0.33
Maternal age (yr)	28.40 ± 6.24	27.90 ± 4.38	28.22 ± 4.99	27.83 ± 5.14	0.91
Maternal BMI (kg/m^2)	22.99 ± 4.60	24.96 ± 3.17	24.34 ± 3.69	25.4 ± 4.29	0.10
Energy and nutrients intake					
Energy (kcal/day)	1,624.5 ± 229.5	2,072.5 ± 212.5	2,506 ± 218	3,156.5 ± 408.5	< 0.001
Carbohydrate (g/day)	207.12 ± 29.26	269.42 ± 27.62	332.04 ± 28.88	410.34 ± 53.10	< 0.001
Protein (g/day)	81.22 ± 11.47	93.26 ± 9.56	106.50 ± 9.26	126.26 ± 16.34	< 0.001
Total fat (g/day)	52.34 ± 7.40	69.08 ± 7.08	83.53 ± 7.27	112.23 ± 14.52	< 0.001
Dietary fiber (g/day)	13.39 ± 3.79	13.86 ± 3.39	13.04 ± 2.12	13.64 ± 3.12	< 0.001
Cholesterol (mg/day)	14.8 ± 2.22	17.56 ± 3.34	21.5 ± 3.68	25.74 ± 9.96	< 0.001
Iron (mg/day)	6.36 ± 0.95	6.72 ± 1.29	6.47 ± 0.96	6.40 ± 0.80	0.52
Magnesium (mg/day)	172.46 ± 24.74	176.07 ± 23.09	166.57 ± 13.56	184.85 ± 31.29	< 0.001
Zinc (mg/day)	4.73 ± 0.55	5.68 ± 0.10	5.03 ± 0.40	5.51 ± 0.60	< 0.001
Selenium (mg/day)	44.43 ± 7.85	49.01 ± 9.53	49.64 ± 12.70	49.05 ± 5.59	0.09
B2 (mg/day)	0.86 ± 0.13	0.91 ± 0.22	0.95 ± 0.12	1.13 ± 0.18	< 0.001
B3 (mg/day)	9.98 ± 1.71	10.55 ± 2.05	9.78 ± 1.34	10.47 ± 1.8	0.24
B6 (mg/day)	0.79 ± 0.11	0.91 ± 0.09	0.89 ± 0.01	1.06± 0.15	< 0.001
B9 (mcg/day)	203.62 ± 57.30	225.63 ± 60.28	232.95 ± 5.57	225.63 ± 46.37	0.10
B12 (mcg/day)	1.30 ± 0.54	1.47 ± 0.87	1.62 ± 0.49	2.13 ± 0.75	< 0.001
Vitamin C (mg/day)	39.33 ± 25.49	43.49 ± 16.28	45.43 ± 15.53	59.69 ± 23.13	< 0.001
Vitamin E (mg/day)	1.44 ± 4.77	5.50 ± 1.82	6.12 ± 2.20	1.89 ± 2.29	< 0.001
Vitamin D (mg/day)	2.28 ± 1.27	2.53 ± 1.09	2.07 ± 1.07	3.77 ± 1.59	< 0.001
Vitamin A (mg/day)	208.99 ± 63.38	265.54 ± 62.76	287.95 ± 62.44	432.91 ± 145.85	< 0.001
Maternal education					0.54
Less than diploma (%)	-	3.3	3.2	12.9	
Diploma (%)	40	30	22.6	87.1	
College graduate (%)	60	66.7	74.2	22.6	
The economic situation					0.94
Low (%)	20	6.7	22.6	25.8	
Middle (%)	63.3	63.3	41.9	48.4	
High (%)	16.7	30	35.5	25.8	
Pregnancy supplementation					
Folic acid (in third trimester), yes (%)	53.3	66.7	58.1	64.5	0.65
Calcium, yes (%)	93.3	93.3	83.9	90.3	0.55
Iron, yes (%)	90	96.7	90.3	96.8	0.54
Multivitamin, yes (%)	90	93.3	93.5	90.3	0.93
Omega 3, yes (%)	73.3	56.7	58.1	71	0.39
Smoking during pregnancy (%)	3.3	3.3	-	25.8	0.78
Alcohol consumption during pregnancy (%)	3.3	3.3	-	-	0.55

Quantitative variables are expressed as mean ± SD and qualitative variables are expressed as percentage (%).
DII, Dietary Inflammatory Index; BMI, body mass index; SD, standard deviation; ANOVA, analysis of variance.
*p values for trend from ANOVA test.

trimester. Our results indicated that the maternal DII score in the third trimester has a significant association with lower neonatal weight and height, however we observed no significant relationship with neonatal head circumference. Moreover, our outcomes showed a significant association between maternal AHEI-P score and infant birth weight. However, there was no significant relationship between different quartiles of AHEI-P score with height and head circumference of infants.

The present study suggested that there is significant correlation between maternal DII score in the third trimester and neonatal weight and height. While maternal AHEI-P score during pregnancy has been previously studied in relation to birth weight [16-18], to the best of our knowledge this is the first study to investigate the effect of maternal DII score during pregnancy on neonatal height and neonatal head circumference. For example, Qin et al. [17]

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Table 2. Background characteristics of participants by quartiles of maternal AHEI-P score

Characteristic	Q1 (n = 30) (15.66 to 20.98)	Q2 (n = 30) (20.98 to 23.78)	Q3 (n = 31) (23.78 to 27.47)	Q4 (n = 30) (27.47 to 43.94)	p value*
Gestational age (wk)	33.46 ± 3.48	33.99 ± 3.25	32.93 ± 2.68	34.43 ± 2.90	0.28
Maternal age (yr)	28.46 ± 5.05	28.26 ± 4.84	28.35 ± 4.60	27.60 ± 4.32	0.89
Maternal BMI (kg/m^2)	1.89 ± 2.29	1.89 ± 2.29	1.89 ± 2.29	1.89 ± 2.29	0.66
Energy and Nutrients intake					
Energy (kcal/day)	1,624.5 ± 248.5	2,132.5 ± 280.5	3,016.5 ± 399.5	2,497.50 ± 198.50	0.06
Carbohydrate (g/day)	208.12 ± 29.91	272.38 ± 29.48	409.31 ± 54.41	335.21 ± 28.10	0.02
Protein (g/day)	83.22 ± 12.01	94.16 ± 9.89	120 ± 16.04	108.51 ± 10.01	0.18
Total fat (g/day)	54.71 ± 5.40	68.23 ± 7.48	113.29 ± 12.38	84.58 ± 6.23	0.01
Dietary fiber (g/day)	11.82 ± 2.77	12.38 ± 2.10	13.36 ± 2.27	16.03 ± 3.47	< 0.001
Cholesterol (mg/day)	17.07 ± 2.13	16.91 ± 2.01	24.05 ± 3.97	17.14 ± 3.31	0.22
Iron (mg/day)	5.80 ± 0.91	6.47 ± 0.86	6.53 ± 0.87	7.14 ± 0.97	< 0.001
Magnesium (mg/day)	172.82 ± 44.30	248.40 ± 55.09	225.26 ± 40.52	264.66 ± 48.21	0.03
Zinc (mg/day)	5.01 ± 0.73	4.95 ± 0.60	5.08 ± 0.53	5.25 ± 0.63	0.26
Selenium (mg/day)	45.39 ± 6.61	49.37 ± 13.82	47.78 ± 7.79	5.09 ± 7.61	0.22
B2 (mg/day)	0.91 ± 0.22	0.97 ± 0.16	0.99 ± 0.17	0.99 ± 0.21	0.31
B3 (mg/day)	10.64 ± 1.11	9.97 ± 1.43	9.85 ± 1.78	10.83 ± 1.99	0.11
B6 (mg/day)	0.82 ± 0.11	0.86 ± 0.09	0.93 ± 0.12	1.03 ± 0.16	< 0.001
B9 (mcg/day)	178.82 ± 44.30	248.40 ± 55.09	225.26 ± 40.52	264.66 ± 48.21	< 0.001
B12 (mcg/day)	1.59 ± 0.91	1.59 ± 0.55	1.66 ± 0.69	1.69 ± 0.79	0.93
Vitamin C (mg/day)	32.50 ± 16.37	43.0 ± 20.13	49.77 ± 18.89	62.42 ± 20.33	< 0.001
Vitamin E (mg/day)	55.27 ± 2.27	5.58 ± 1.47	6.07 ± 1.92	5.69 ± 2.01	0.71
Vitamin D (mg/day)	2.76 ± 2.03	2.71 ± 1.11	2.93 ± 1.36	2.92 ± 1.72	0.92
Vitamin A (mg/day)	231.36 ± 83.61	273.81 ± 75.78	328.87 ± 115.81	362.34 ± 157.29	< 0.001
Maternal education					0.16
Less than diploma (%)	3.3	3.3	-	-	
Diploma (%)	20	40	16.1	38.7	
College graduate (%)	76.7	56.7	83.9	61.3	
The economic situation					0.43
Low (%)	16.7	16.7	12.9	29	
Middle (%)	66.7	53.3	51.6	45.2	
High (%)	16.7	30	35.5	25.8	
Pregnancy supplementation					
Folic acid (in third trimester), yes (%)	53.3	73.3	48.4	67.7	0.22
Calcium, yes (%)	90	93.3	93.5	83.9	0.54
Iron, yes (%)	86.7	96.7	96.8	93.5	0.34
Omega 3, yes (%)	53.3	70	61.3	74.2	0.32
Smoking during pregnancy, yes (%)	-	6.7	-	3.2	0.28
Alcohol consumption during pregnancy, yes (%)	-	3.3	-	3.2	0.56

Quantitative variables are expressed as mean ± SD or qualitative variables are expressed as percentage (%).
AHEI-P, Alternate Healthy Eating Index for Pregnancy; BMI, body mass index; SD, standard deviation; ANOVA, analysis of variance.
*p values for trend from ANOVA test.

Table 3. The association between infant's anthropometric outcomes and maternal DII score during the third trimester of pregnancy

Variable	Q1 (n = 30) (−9.21 to −4.51)	Q2 (n = 30) (−4.50 to −2.42)	Q3 (n = 31) (−2.41 to −0.30)	Q4 (n = 31) (−0.29 to 9.03)	p value*
Head circumference (cm)	34.51 ± 1.36	34.48 ± 1.28	35.16 ± 1.42	34.77 ± 1.3	0.183
Weight (g)	3,329.33 ± 238.48	3,208.16 ± 263.62	3,265 ± 414.07	3,057.41 ± 367.26	< 0.001
Height (cm)	50.36 ± 1.97	50.8 ± 2.12	50 ± 1.87	49.4 ± 51.7	0.050

ANOVA test for the relationship between infant's anthropometric measurements and DII. Variables are expressed as mean ± SD.
DII, Dietary Inflammatory Index; ANOVA, analysis of variance; SD, standard deviation.
*p values for trend adjusted for carbohydrate, protein, total fat, dietary fiber, cholesterol, iron, magnesium, zinc, selenium, B2, B3, B6, B9, B12, vitamin C, vitamin E, vitamin D, and vitamin A.

found that maternal DII score in late pregnant women was positively correlated with maternal serum interleukin-6 (IL-6). The elevated maternal serum IL-6 was negatively correlated with birth weight. They suggested that the IL-6 may be a mediator in the association between maternal DII score and birth weight of newborn [17]. In other study Sen et al. [16] indicated that pro-inflammatory maternal diet during second trimester of pregnancy may be associated

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Table 4. The association between infant's anthropometric outcomes maternal AHEI-P score during the third trimester of pregnancy

Variable	Q1 (n = 30) (−9.21 to −4.51)	Q2 (n = 30) (−4.50 to −2.42)	Q3 (n = 31) (−2.41 to −0.30)	Q4 (n = 30) (−0.29 to 9.03)	p value*
Head circumference (cm)	34.61 ± 1.30	34.53 ± 1.47	34.74 ± 1.47	35.04 ± 1.15	0.476
Weight (gram)	3,133.16 ± 289.4	3,173.83 ± 312.29	3,180.87 ± 384.19	3,298.06 ± 351.71	0.018
Height (cm)	50.56 ± 1.83	50.23 ± 2.4	49.51 ± 1.98	50.29 ± 1.48	0.189

ANOVA test for the relationship between infant's anthropometric measurements and AHEI-P. Variables are expressed as mean ± SD.
AHEI-P, Alternate Healthy Eating Index for Pregnancy; ANOVA, analysis of variance; SD, standard deviation.
*p values for trend adjusted for carbohydrate, protein, total fat, dietary fiber, cholesterol, iron, magnesium, zinc, selenium, B2, B3, B6, B9, B12, vitamin C, vitamin E, vitamin D, and vitamin A.

with impaired fetal growth including low birth weight. While Moore et al. [18] indicated that among pre-pregnancy obese women, each 1-unit increase in maternal DII score during pregnancy was associated with increased newborn birth weight. However, they no report the same findings from neonates of lean or overweight women [18].

Moreover, our results demonstrated a significant association between maternal AHEI-P score and infant birth weight. Although, the result of our study did not show significant correlation between maternal AHEI-P score with neonatal height and head circumference. A previous investigation confirmed our finding [7] while some others did not [8,13]. Rodríguez-Bernal et al. [7] suggested that high quality diet assessed by maternal AHEI-P score in the first trimester of pregnancy is positively associated with neonatal weight and length but these relation did not find between the quintile of the maternal AHEI-P score and birth head circumference. Also, Chia et al. [13] suggested that there was not significant association with birth weight in the different quartile of maternal AHEI-P score in Singapore. Furthermore, Rifas-Shiman et al. [8] reported that each 5-unit increase in AHEI-P score in first trimester was associated with slight reduce in SGA newborn birth. These discrepancies results might arise from different timing of dietary assessment or methods for collecting data, study population, statistical methods and considering potential confounders.

The maternal DII and AHEI-P scores might affect neonatal anthropometry via multiple mechanisms including interact between multiple nutrients and these may not be elucidated by a single nutrition factor [18]. However, in these study women in the lowest quartile of maternal DII and highest quartile of AHEI-P scores were more likely to be intake whole grains, fish, green vegetables, fruits, olive oil compared with those in the lowest quartile. This good quality diet high in vitamin C and E are associated with decreased levels of pro-inflammatory biomarker, mainly C-reactive protein, IL-6 and tumor necrosis factor-alpha. Reduced levels of these inflammatory biomarkers had a positive correlation with birth weight and other neonatal anthropometric measurements [17]. However, the higher levels of pro-inflammatory cytokines IL-6 and TNF-α is associated with higher maternal blood pressure [26]. The rise in blood pressure in the third trimester may be lead to failing placental function and there is increased risk of the birth of the baby with small for gestational age [27]. Diet patterns with higher AHEI-P score and lower dietary DII scores unlike western dietary pattern have a lower intake of the red meet, refined carbohydrates, saturated fatty acids and ultra-processed food [28]. These factors in the western dietary pattern can change the gut microbiota for example increase in harmful bacteria including *Firmicutes*, *Proteobacteria*, *Eggerthella* and decrease the beneficial bacteria such as *Lactobacillus* and *Entrococcus* and this dysbiosis lead to inflammation [29,30]. The higher proportion of genera *Parabacteroides* and *Eggerthella* in gut microbiota were associated with smaller male neonatal head circumference or weight. In addition, the higher proportion of genus Streptococcus in gut microbiota was association with smaller female neonatal height [31]. On the other hand, the findings suggested that there was an association between newborn height and weight and maternal serum short-chain fatty acids (SCFAs) levels, and partly maternal serum SCFAs is the result of the gut microbial fermentation. Because healthy eating patterns with low DII scores is reach of fiber can influence microbial metabolites such as short chain fatty acids. The role of the short chain fatty acid on newborn anthropometrics was defined through their effect on hormones same leptin or incretins [32].

Our study has some strengths and limitations. To our knowledge, it was for the first time that association between maternal DII score during pregnancy on neonatal height and head circumference and simultaneously with maternal AHEI-P score was investigated. Our analysis is not without limitations. First the sample size in this study was relatively small, second, we did not measure inflammatory biomarkers in participant's blood. Also, the assessment of dietary intake was done through self-reported questionnaires, which might conduct to misclassification. Furthermore, the effect of other confounding factors such as clinical parameters and genetic background on pregnancy outcomes was not evaluate in this study. The relationship between maternal DII and AHEI-P scores during pregnancy with newborn anthropometry, as well as, its possible mechanism remains controversial, therefore, further high-quality prospective cohort or/and longitudinal studies are necessary.

CONCLUSION

The hypothesis of this study was that evaluate the association between maternal DII and AHEI-P scores during the third trimester of pregnancy influences newborn anthropometric measurement. These findings suggest that women with maternal lower DII and higher AHEI-P scores have better newborn birth weight although this association only remain significant for maternal DII score for neonatal height. In this study, there was no relationship between maternal DII and AHEI-P scores with head circumference. Thus, a lower pro-inflammatory diet and high-quality diet during pregnancy may improve fetal growth and avert substantial healthcare burdens related with adverse birth outcomes. More longitudinal and/or cohort study, with larger sample sizes and with evaluate clinical parameters and long term follow up needed to confirm the veracity of our findings.

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