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Maternal diet and breastfeeding duration of infants after NICU hospitalization in Greece: A cohort study

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Abstract

Objectives: To investigate the role of maternal diet, personal characteristics and willingness to breast-feed on breastfeeding duration of hospitalized neonates as well as to evaluate the mothers' dietetic intake based on the national recommendations.

Methods: A sample of 161 pregnant women from Athens, Greece was followed up during pregnancy, labor and the first 40 weeks of lactation. The participants attended breastfeeding classes and were interviewed regarding their nutritional habits, personal characteristics and breastfeeding intention. A multivariable logistic regression, adjusted for maternal age, smoking, weeks of gestation, body mass index, mode of delivery was conducted in order to estimate the adjusted odds ratios of breastfeeding for at least 6 months for consuming additional serves of fruit or vegetables from the recommended by the national guidelines.

Results: The adjusted odds ratios for breastfeeding at 6 months was 2.15 (P=0.05) for women consumed ≥3.5 servings of fruits/day. Moreover, the participants reported low conformity with the national dietetic guidelines.

Conclusions: Mothers who consumed the recommended by the NDG fruit servings/day breastfed their hospitalized newborns for a longer period. Despite the fact that our participants were highly motivated and willing to breastfeed, we argue that this relationship is highly unlikely to be biological.

Introduction: The World Health Organization (WHO) recommends exclusive breastfeeding for at least the first 6 months of life, and introduction of nutritionally-adequate and safe complementary (solid) foods at 6 months together with continued breastfeeding up to 2 years of age or beyond.[1] Breastfeeding is also promoted by various organizations, including the Academy of Breastfeeding and the American Academy of Pediatrics, as the most advantageous form of nourishment for infants. [2-3] Neonates, who are admitted to the Neonates Intensive Care Unit (NICU), may are in greater need of the beneficial and protective properties of human milk.[4] Decreased rates of necrotizing enterocolitis (NEC) and retinopathy of prematurity (ROP), fewer re-hospitalizations in the first year of life and improved gut microbiota composition of term and preterm infants, are among the benefits of human milk administration to this vulnerable population.[5-9] However, breastfeeding hospitalized neonates could be challenging and often short lasting, with increased drop-off rates after the first month of lactation.[4, 10-12] Various factors are associated with breastfeeding duration before and after NICU discharge.[4, 13] Supporting feeding methods, maternal experiences and personal characteristics, including body weight, social economic status, education and smoking habits, are correlated with the duration of lactation until the 6th month of life.[4, 14] Maternal nutrition is integrated with successful breastfeeding.[15] Human milk production requires adequate nutrient reserves, which are formatting since the early stages of pregnancy, in order to include all the necessary for the newborn, elements.[15] The National Institute of Preventive Medicine, Environmental and Occupational Health of Greece in collaboration with the Greek ministry of Health, have published specific dietetic guidelines (National Dietetic Guidelines, NDG) for adult, pregnant and lactating women in Greece, in order to enhance the health of this population.[16] The aforementioned guidelines highlight the significance of a balanced and qualitative nutrition during pregnancy and lactation for both women and infants.[16] Moreover, they recommend a specific number of servings from every food group ensuring an adequate nutritional status during these critical periods of life.[16] In addition to the essential role of maternal nutrition for optimal breast milk production, evidences from published surveys indicate that a higher intake of fruit/vegetables during lactation, is also associated with increased breastfeeding duration in healthy neonates.[15, 17-19] The reported relationship was attributed from both studies to the connection of breastfeeding intention and health-enhancing behaviors of the mother, rather to biological or physiological causal factors.[18-19] Moreover, they suggested that all breastfeeding studies measure maternal infant feeding intention as an important determinant.[18] To date and to the best of our knowledge, the relationship between maternal nutrition, breastfeeding

intention and breastfeeding duration of neonates admitted in NICU has not been evaluated yet. Therefore, the objective of our study was to: (i) investigate the role of maternal diet on breastfeeding duration of neonates admitted in NICU considering at the same time, mothers' personal characteristics, desire and willingness to breast-feed and (ii) evaluate the participants' dietetic intake based on the Greek NDG.

Methods: Design of Study: This is a prospective observational study conducted between September 20th, 2013 to January 1st, 2016 in "Elena Venizelou" Maternity Hospital of Athens, which is certified as a Baby Friendly Hospital since 2011. One hundred sixty one (161) pregnant women willing to breastfeed their infants (Figure 1) were recruited in the study and they were followed up until the day of labor and the first 40 weeks of lactation. The volunteers were assessed three times in this study; the first during the 4th-8th weeks of pregnancy, the second immediately after labor, when the mothers were in hospital, and finally, 40 weeks post-partum. The aim of the study was to record the nutritional and health habits of the women, compare them with the National Nutritional Guidelines for women in adulthood, pregnancy and lactation and illustrate the role of nutrition in breastfeeding duration of neonates admitted in NICU. The research protocol was approved by the Scientific and Ethical Committee of the same hospital and Harokopeion University Special Assembly according to the guidelines laid down in the Declaration of Helsinki for anonymous surveys. A schematic overview of the design of the study is presented in Figure 1.

Participants: There were five inclusion criteria: (i) the participants were healthy pregnant women between the 4st and 8th week of pregnancy, who attended preparatory for parenthood-painless childbirth consults during September 20th, 2013 to July 1st, 2014 (ii) planned to breastfeed their infants, (iii) joined parenthood prenatal breastfeeding classes before recruitment, (iv) their infant stayed in NICU for more than one day, (v) breastfed exclusively or partially at discharge from the hospital and (vi) were voluntarily offered to participate to the study. The exclusion criteria were: (i) Infants died during the first 72 h of life, (ii) with major congenital disorders or gastrointestinal malformations, (iii) with major neurological problems, (iv) diagnosed with bronchopulmonary dysplasia (BPD),

(v) intra-uterus growth restriction (IUGR) (vi) mother followed a special diet (vegetarian, low fat, low sugar or sodium) and (vii) mother failed to initiate breastfeeding.

The infants were admitted in NICU of the hospital immediately after labor. The mothers were encouraged to have a direct skin to skin contact and breastfeed their children as soon as was it possible. Enteral nutrition (tube and syringe either cup feeding) as well as breastfeeding began from the first minute of life and raw and/ or donor human milk was administrated to the neonates. Preterm infants' daily nutritional requirements were covered mainly by their mother's own raw milk at a proportion of 70% and by donor banked milk at an analogy of 30%, due to the inadequacy of most preterm mothers to provide sufficient daily milk supply, mainly during the first week of life. Volunteers were recruited by the hospital's neonatologists, midwifes and dieticians, who had a face-to-face interview with them. Subsequently, each potential volunteer was specifically asked if she would be willing to take part anonymously in the study. After ensuring that participants understood the information, only those who voluntarily accepted were enrolled.

Breastfeeding Workshops and Lactation Consults: All the participants were planning to breastfeed their children and received breastfeeding education and individual counseling by neonatologists and midwifes. Breastfeeding education was consisted of two cycle courses, one before labor and one postpartum. The courses did not include any form of nutritional counseling. The participants also received educational booklets and they were asked about their breastfeeding intention.

Interviews and Dietary Assessment: At the beginning of the study, participants' age, nationality, educational level (primary school, high school, technological studies and university graduation), parity, mode of conceiving and medical history were recorded from the official database of the hospital. Moreover, they had an in person interview from a registered dietician regarding their 6 months pre-conception dietary consumption, smoking habits, as well as for their nutrient supplementation. A validated for the Greek population semi quantitative Food Frequency Questionnaire (FFQ) was used, in which basic foods were classified into specific food groups.[20-21] After that, the daily or weekly frequency of food consumption was estimated. Participants were also asked if they followed a special diet (low calorie, low fat, low carbohydrates, low sodium diets or any type of vegetarian diets). The same dietary assessment was also performed one day after labor and 40 weeks post-partum. However, it was focused on

the previous time intervals of pregnancy and lactation. Additional information regarding the type and the duration of infants' feeding method were recorded. Duration was measured as the number of months the mother continued to breast-feed or pump breast milk (defined as any amount of breast-feeding or expressed milk). Breastfeeding outcomes were characterized by maternal reported breastfeeding intention and infants' feeding patterns were classified according to WHO's definitions: "exclusive breastfeeding" and "predominant breastfeeding. Neonates' birth weight, medical history, weeks of gestation and mode of delivery was immediately recorded after labor. The mothers' intake in fruits, vegetables, dairy products, cereals, meat, eggs, fish, legumes, dietary fats and alcohol as recorded by the FFQ was compared with the recommended portions of the NDG for adult, pregnant and lactating women.

Maternal anthropometric measurements (body weight in kilograms and height in meters) were also conducted by a registered dietician with a unique well calibrated scale and stadiometer. Participants' body weight was assessed at the beginning of the study, before and after labor and finally, 40 days post-partum, while a height measurement was conducted only in the beginning of the study. Body mass index (BMI) was calculated by dividing weight in kilograms by the square of height in meters.

Statistical Analysis: Continuous data were expressed as medians and ranges (non-Gaussian distribution, Wilk test) and dichotomous variables as counts and proportions. Comparisons between participants' daily dietary consumption and the recommended by National Nutritional Guide (NNG) food portions were performed with Wilcoxon test. The Friedman test was used to detect differences in women's dietary intake across the study. A post hoc analysis with Bonferroni corrections was conducted for the same time periods. A multivariable logistic regression, adjusted for maternal age, smoking, weeks of gestation, BMI, mode of delivery was conducted in order to estimate the adjusted odds ratios of breastfeeding for at least 6 months for consuming additional serves of fruit or vegetables from the recommended by the NGG. Statistically significant threshold was set at 5%. Statistical analysis was performed using the SPSS software for Windows (version 16.0; SPSS, Inc, an IBM Company, Chicago, IL).

Results: Figure 1 shows all the phases of the cohort study from recruitment to the latest assessment, when women were on lactation period. Of the 214 mothers included at the start of the study, 161 (75.2 %) were interviewed at the beginning of the study. Twenty four (24) were excluded due to the fact that they followed a special diet or they did not succeed to breastfeeding. Finally, only 137 (64%) were included in the follow-up period.

The participants were residents of Athens and had a similar socioeconomic status. Median maternal age was 25.8 years (range: 13.8), median gestational age and neonatal birth weight were 34.2 weeks (range: 11.4) and 2.17 kg (range: 2.9), respectively. Most women were Greek (93.2%), while 26.7% of them were university graduates. Finally, the 91.3% of the sample gave birth via emergency cesarean section, and only 2.5% smoked during pregnancy. Median weight gain during pregnancy was 14 kg (range: 25). Diabetes mellitus was present in 4.3% of the pregnancies. The 9.5% (13) of all neonates were born full term, the 78.1% (107) were moderate to late preterm, while 17 neonates (12.4%) were classified as very premature.[21] Median length of stay in NICU was 22.0 (15.0–31.5) days. Full- term infants were admitted in NICU mainly on account of severe perinatal asphyxia. Median breastfeeding duration was 6.0 months (range: 13), while 81% of the infants were exclusively breastfeeding at discharge.

The mothers' daily intake of dairy products and red meat before pregnancy and during lactation was greater than the suggested in the NNG while, for all the other food groups, their consumption was lower. The same trend was observed during pregnancy, excluding the mother's daily intake in fruits, which was equal to the recommended by the NNG (Table 1). Moreover, their dietetic consumption postpartum in fruits, vegetables, cereals, dairy products, red meat, fish and alcohol significantly changed during the study, from beginning of the study to the lactation period (Table 1). A post hoc analyses showed that the participants' intake in fruits, vegetables, fish, dairy products and cereals significantly increased comparing the preconception and lactation period with pregnancy ($P<0.001$, $P=0.001$, $P<0.001$, $P=0.014$, $P<0.001$ respectively). On the other hand, daily red meat consumption and alcohol intake decreased significantly during the same period ($P<0.001$).

The duration of breastfeeding is shown according to maternal fruit intake, vegetable intake, and total fruit and vegetable consumption in Table 2. Women who consumed the recommended by the NDG servings of fruits (3.5 or more servings per day) had 2.35 times higher odds to breastfeed their infants over a 6 month period ($P= 0.024$).

The effect of eating vegetables and fruits-vegetables combined, was not significant (P=0.581, P= 0.131, respectively). After an adjustment for basic confounders (age, BMI, education, mode of delivery, smoking), the consumption of 3.5 or more fruit servings per day remained statistically significantly associated with breastfeeding duration over 6 months.

Discussion: The present study showed that fruits consumption close to the national recommendations was associated with increased breastfeeding duration of infants hospitalized in the NICU. This relationship remained significant even after an adjustment for selected factors related with lactation's duration. Furthermore, in our study, the participants demonstrated low compliance with the NDG. During adulthood, they consumed higher amounts of red meat and dairy products than the recommended. The opposite results were observed regarding cereals, fruits, vegetables, poultry and eggs, legumes, fish and fats intake. Similar results were recorded among lactating women. In pregnancy, their consumption in fruits and dairy products was significantly closer to the recommendations. Our survey is in agreement with the study of Arvaniti et al, which reported decreased intake of vegetables and cereals and at the same time increased dietetic consumption of red meat and dairy products in adult women living in Athens.[22]

We believe this is the first study investigating the association of maternal diet and breastfeeding duration of hospitalized neonates. However, a previous study has already investigated the same relationship in healthy neonates.[18] Amir et al. concluded that a higher maternal intake of fruits and vegetables is associated with longer breastfeeding duration, despite the absence of a biological causal explanation.[18] This study underlined the role of breastfeeding intention and mothers behavioral aspects as possible confounding factors and determinants of this relationship.[18] In our research, we tried to diminish the influence of these factors by excluding the women did not intend or failed to initiate breastfeeding and, at the same time, by training and supporting them during pregnancy and lactation. In addition to that, the special characteristics and needs of our sample may be determinative of mothers' breastfeeding intention. As it is previously mentioned, breastfeeding hospitalized neonates could be challenging.[4, 23] Lack of systematic breastfeeding and personal contact with the neonate, conflict about parents' role in NICU, less frequent mammary stimulation leading to reduced lactogenesis and the transition from artificial

pumping to breastfeeding, could be proved difficult for the mothers.[24-27] In our study, the participants were informed about the difficulties that they could probably face during the lactation period. However, they were willing participate to our workshops and after labor, they tried to breastfeed as much it was possible. They developed their own milk stocks, they attended the organized by the hospital seminars regularly and eventually, they managed to breastfeed their children for at least 3 months. Other studies on premature neonates, report increased drop off rates after the first 4 weeks of lactation.[26] Based on that, our participants have shown to be considerably motivated and indented to breastfeed their infants.

Participants smoking habits, BMI, age, mode of delivery and education were also included in our model as possible confounding factors. Previous studies have shown that smokers tend to be less willing to breastfeed their children and, at the same time, they report shorter lactation durations.[28-30] However, other studies have presented controversial results.[31] Moreover, a higher BMI has been associated with reduced breastfeeding duration.[32] Maternal education has also a crucial role on breastfeeding duration.[19, 23] In a study of 556 healthy neonates, a positive association was found with mother's educational level and age.[33] Finally, a recent study of Hobbs et al concluded that planned c-sections are associated with reduced breastfeeding success in the first 4 postpartum months.[34] In our multivariable logistic regression model, we included all the aforementioned variables, as possible confounding factors, but the effect of maternal dietetic intake in fruits regarding breastfeeding duration, remained significant.

In our study, we do not support a biological causal relationship between mothers' dietetic intake and breastfeeding's duration. Despite the fact that we did our best to recruit women with increased breastfeeding intention, other factors, such as maternal depression levels, professional occupation, workload and social differences may be strong determinants of breastfeeding duration in newborns admitted in NICU. Postpartum depression is indeed associated with lower breastfeeding initiation rates and shorter breastfeeding duration, and the stress of having a neonate hospitalized in the NICU increases a mother's risk for important depressive symptoms.[35-36] Unfortunately we do not have information on these variables in our data set. Another limitation of our study is the absence of a validated for our sample breastfeeding intention questionnaire. We believe that the already existing questionnaires may not be reliable to quantify the breastfeeding

intention of mothers with unique breastfeeding priorities, goals and difficulties, such as the lactating mothers with hospitalized neonates.

The evidences indicating a biological relationship between maternal diet and breastfeeding duration are insufficient. Based on that, suggesting lactating mothers to increase their dietetic consumption in fruits just in order to maintain breastfeeding, may not be accurate. However, the deviation observed in our survey from the NDG should carry clear a message to researchers from related scientific fields to consider the adult, pregnant and lactating women as major target of the population based programs promoting nutrition and healthy behaviors.

Conclusions: In our study, mothers who consumed the recommended by the NDG fruit servings/day breastfed their hospitalized newborns for a longer period. Despite the fact that our participants were highly motivated and willing to breastfeed, we argue that this relationship is very unlikely to be biological. Other factors, such as maternal depression levels and infants' medical history, may have strong influence on lactation's duration. The understanding of the psychological factors contribution to lactations duration of hospitalized neonates should be a major target of the future studies.

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Figure 1. The design of the study (96 DPI)

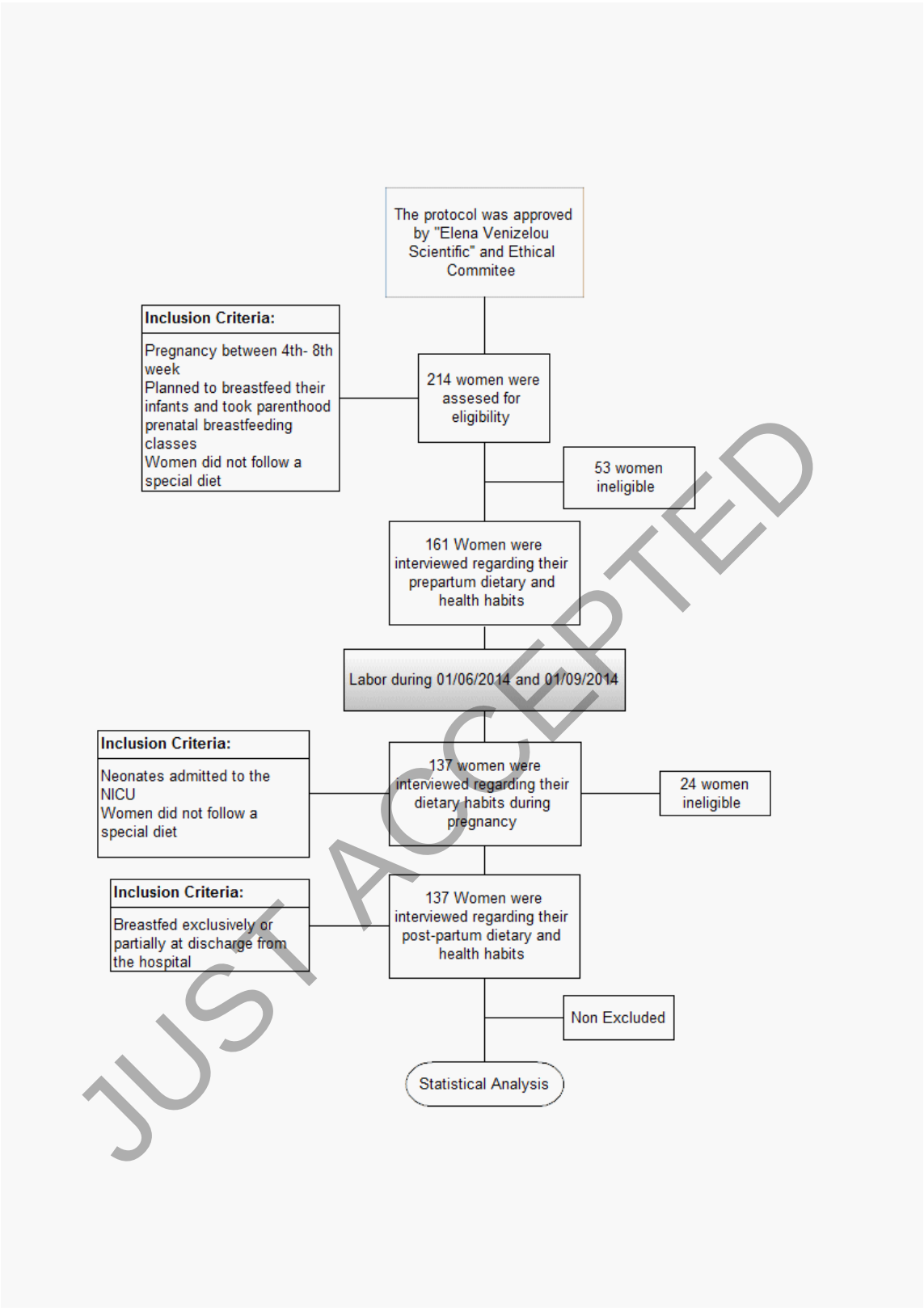

Table 1. Nonparametric comparisons of participants' dietary consumption before, during pregnancy and in lactation with the recommended by the National Dietetic Guidelines (NDG) food portions for the same life stages- Comparisons between the mothers' dietetic intake for the preconception period, pregnancy and lactation

Nonparametric comparisons of participants' dietary consumption before, during pregnancy and in lactation with the recommended by the National Dietetic Guidelines (NDG) food portions for the same life stages

Foods	NDG Portions 1	Median 1	P Value	NDG Portions 2	Median 2	P Value	NDG Portions 3	Median 3	P Value
Vegetables	4.0 (p/d)	1.61	<0.001	4.0(p/d)	2.27	<0.001	4.0(p/d)	1.88	<0.001
Fruits	3.0 (p/d)	2.23	<0.001	3.3(p/d)	2.95	0.65	3.5(p/d)	2.62	<0.001
Cereals	6.0(p/d)	2.15	<0.001	6.3(p/d)	2.60	<0.001	6.5(p/d)	2.02	<0.001
Dairy Products	2.0(p/d)	2.37	<0.001	3.0(p/d)	3.06	0.180	3.0(p/d)	3.06	<0.001
Red Meat	≤1.0(p/w)	1.57	<0.001	≤2.5(p/w)	1.57	<0.001	≤2.5(p/w)	3.00	<0.001
Poultry	1.5(p/w)	0.43	<0.001	2.5(p/w)	0.43	<0.001	2.5(p/w)	0.42	<0.001
Eggs	≤4.0(p/w)	0.43	<0.001	≤4.5(p/w)	0.43	<0.001	≤4.5(p/w)	0.42	<0.001
Fish	2.5(p/w)	0.14	<0.001	2.5(p/w)	0.43	<0.001	2.5(p/w)	0.14	<0.001
Legumes	≥3.0(p/w)	0.14	<0.001	≥3.0(p/w)	0.14	<0.001	≥3.0(p/w)	0.14	<0.001
Dietary Fat	4.5(p/d)	1.06	<0.001	4.5(p/d)	1	<0.001	4.5(p/d)	1.06	<0.001
Alcohol	1.0(p/d)	0.12	<0.001	0(p/d)	0	<0.001	1.0(p/d)	0	<0.001

1: preconception period, 2: pregnancy, 3: lactation period, (p/d) portions/day, (p/w) portions/week

Comparisons between the mothers' dietetic intake for the preconception period, pregnancy and lactation

Food Group	Chi-Square Test	P Value
Vegetables	28.18	<0.001
Fruits	22.28	<0.001
Cereals	20.78	<0.001
Dairy Products	52.31	<0.001
Red Meat	37.87	<0.001
Poultry	0.29	0.900
Eggs	6.79	0.074
Fish	17.16	0.013
Legumes	3.40	0.941
Dietary Fat	0.14	0.570
Alcohol	38.80	0.04

Table 2. Effect of fruit and vegetable consumption on breastfeeding at 40 weeks

	Unadjusted		Adjusted	
	OR (95%CI)	p-value	OR (95%CI)	p-value
Maternal fruit intake (serves/day)				
<3.5	1	0.024	1	0.05
>=3.5	2.35 (1.11-4.95)		2.15 (1-4.63)	
Maternal vegetable intake (serves/day)				
<4	1	0.581	1	0.775
>=4	1.45 (0.39-5.42)		1.23 (0.29-5.13)	
Maternal fruit/vegetable intake (serves/day)				
<7.5	1	0.131	1	0.175
>=7.5	2.13 (0.80-5.70)		2.03	