ORIGINAL ARTICLE

Nutritional profile of diabetic women at two months postpartum

Profil nutritionnel des femmes diabétiques à deux mois postpartum

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Abstract

Background: The mother's diet may have an impact on the quantity and/or quality of the milk produced. The aim of our study was to evaluate the nutritional profile of a group of diabetic women consulting at two months postpartum.
Methods: We conducted a descriptive observational cross-sectional study in women with type 1 and type 2 diabetes followed at the National Institute of Nutrition and Food Technology of Tunis. Each patient underwent an anamnesis, a clinical examination, and completed a food questionnaire.
Results: Fifty-two patients were included in the study. The mean age of patients was 35.4±0.4 years, with extremes ranging from 23 to 44 years. The majority (80%) had type 2 diabetes, while 20% had type 1 diabetes, diagnosed before pregnancy. We noted exclusive and partial breastfeeding rates of 44% and 33%, respectively. Women who exclusively breastfed their babies had a lower caloric intake compared to women who did not breastfeed or partially breastfed their babies(p<0.001).
Nearly half of the women had a hypercarbohydrate and hyperprotein diet, regardless of breastfeeding modality. Half of the non-breastfeeding women had a hyperlipidic diet, whereas only 25% of the breastfeeding women had an excessive lipid intake. Most patients had an insufficient intake of magnesium, potassium, vitamin B9, dietary fiber, and water.
Conclusion: These findings highlight the importance of nutritional education for all breastfeeding diabetic women.

Key words: Breastfeeding; Food Intake; Postpartum; Diabetes Mellitus

Résumé

Introduction: Le régime alimentaire de la mère pourrait avoir un impact sur la quantité et/ou la qualité du lait maternel. L'objectif de notre étude était d'évaluer le profil nutritionnel d'un groupe de femmes diabétiques à deux mois du post-partum.
Méthodes: Nous avons mené une étude transversale descriptive observationnelle monocentrique auprès des patientes suivies pour diabète de type 1 et de type 2 à l'Institut National de Nutrition et de Technologie Alimentaire de Tunis. Chaque patiente a bénéficié d'un interrogatoire, d'un examen clinique et d'un questionnaire alimentaire.
Résultats: Nous avons inclus 52 patientes d'âge moyen 35,4±0,4 ans avec des extrêmes allant de 23 à 44 ans. La majorité (80%) avait un diabète de type 2 tandis que 20% avaient un diabète de type 1. Nous avons noté un taux d'allaitement maternel exclusif et partiel de 44% et 33%, respectivement. Les femmes qui allaitaient leurs bébés exclusivement au sein, avaient un apport énergétique plus hypocalorique que les femmes qui n'allaitaient pas ou qui allaitaient partiellement leurs bébés (p<0,001).
Près de la moitié des femmes avait une alimentation hyperglucidique et hyperprotidique indépendamment des modalités de l'allaitement maternel. La moitié des femmes non allaitantes avait une alimentation hyperlipidique alors que seulement 25% des femmes allaitantes avaient un apport lipidique excessif. La majorité des patientes avait un apport alimentaire insuffisant en magnésium, potassium, vitamine B9, fibres alimentaires et en eau.
Conclusion: Ces résultats soulignent l'importance de l'éducation nutritionnelle pour les femmes diabétiques allaitantes.

Mots clés: Allaitement ; Apport Alimentaire ; Postpartum ; Diabète

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Introduction

In Tunisia, according to the 2018 Multiple Indicator Cluster Survey (MICS), 92.2% of most recent live births in the last two years were breastfed, and 31.6% were breastfed within the first hour after birth. However, only 13.5% of infants were exclusively breastfed for the first six months of life (1). Breastfeeding is recommended by the World Health Organization (WHO) to protect the health of pregnant women and their children. Breast milk represents the best source of nourishment for the development of infants. Indeed, breastfeeding provides newborns with vital nutrition and antibodies that help strengthen their immune system. Several studies have additionally highlighted the benefits of breastfeeding on women's health, such as improved insulin sensitivity, a better lipid profile, and more significant weight loss (2,3). Similarly, several studies have suggested that breastfeeding had metabolic benefits for women with gestational diabetes or pregestational diabetes (4). Thus, exclusive breastfeeding is recommended for the first six months, and continued breastfeeding is recommended throughout the first year and beyond (5).

The nutritional focus during breastfeeding tends to be on the newborn, often neglecting the mother's diet. However, breastfeeding is a period of high energy and critical nutrient demands. Therefore, it is a stage where women are particularly vulnerable from a nutritional perspective. For women who exclusively breastfeed during the first six months after birth, the additional energy requirement during lactation has been estimated at 500 kcal per day, and an additional intake of 19 g of protein per day is recommended (6). In the literature, some authors have suggested that the composition of breast milk was partly related to mother's diet (7). However, most studies on women with diabetes focus on the pregnancy period. We didn't find recent data on the nutritional profile of diabetic Tunisian women during the postpartum period. Therefore, we conducted this study to assess the nutritional profile of a group of Tunisian diabetic women at two months postpartum.

Methods

Study Design and Setting

We conducted a descriptive, observational cross-sectional study in the Department of Nutritional Diseases "D" at the National Institute 'Zouhaier Kallel' of Nutrition and Food Technology of Tunis (INNTA) over a period of five months, from November 2023 to March 2024.

Study Population

Were included in the study women with type 1 and type 2 diabetes, diagnosed prior to pregnancy, attending a follow-up consultation two months postpartum and accepted to join the study. Patients who did not adhere to the study protocol or didn't response to the dietary questionnaire, were excluded from the study.

Data collection

We collected data through anamnesis, clinical examination, and medical record information. Data were collected on general characteristics, obstetric history and current pregnancy, diabetes characteristics and breastfeeding practices. We used a dietary survey based on the food history method, with a 24-hour recall. Patients were asked to recall and report all foods and beverages consumed over the previous 24 hours. The analysis of the survey results was conducted using the nutritional software 'Bilnut'.

Anthropometric measures: After childbirth, the Body Mass Index (BMI) was calculated using this formula: BMI (kg/m²) = Weight (kg)/Height² (m²). We used the classification of the WHO. We used the reference's weight determined according to the Adult Nutrition Guide published by the University Hospital Center of Liège in 2019, to calculate the energy and macronutrient intake for each woman (8).

Dietary intake: We considered energy balance to be achieved when the overall energy intake was equivalent to the total energy expenditure (TEE). The TEE varies from one patient to another and depends on several factors, mainly basal metabolism, thermogenesis, physical activity, and energy dedicated to milk production in the case of breastfeeding. Basal metabolism (BM) was estimated in megajoules (MJ) using the formula proposed by Black et al., which was validated during the establishment of the recommended dietary allowances (RDA) in 2001 (9). It is necessary to multiply by 239 to convert megajoules to kilocalories (Kcal) (10).The level of physical activity (LPA) was determined for various daily activities related to work or sports. For interpreting the LPA, we chose the categories proposed by the 2001 report from the Food and Agriculture Organization (FAO), the WHO, and the United Nations (UN) (11). Thus, for each woman, we calculated the minimum and maximum total energy expenditure (TEE) by multiplying the basal metabolism (BM) by the minimum and maximum level of physical activity (LPA), respectively: TEE (Kcal/day) =BM (Kcal/day)×LPA

Subsequently, we added 500 Kcal to the result for women who exclusively breastfed their babies (12). We classified the daily energy intake as follows:

- Hypocaloric if the total daily energy intake (TDE) was less than the calculated minimum TEE.
- Normocaloric if the TDE was between the minimum and maximum TEE.
- Hypercaloric if the TDE was greater than the calculated maximum TEE.

To interpret the nutritional intake of macronutrients, we referred to the recommendations of the European Food Safety Authority (EFSA) 2017, updated in 2019 (6):the recommended protein intake is 0.83 g/kg of reference's weight/day, for non-breastfeeding women. For breastfeeding women, the recommended intake is higher than that for non-breastfeeding women by 19 g/day for exclusive breastfeeding and 13 g/day for partial breastfeeding. The recommended lipid intake is 20 to 35% of the TDE. For carbohydrate intake, in the absence of recommendations, it was determined using the following formula:

TDE (Kcal/day)−[(recommended protein intake per day in grams×4)+(recommended lipid intake per day in grams×9)]

We referred to the recommendations of the National Agency for Food Safety (ANSES) 2016 for the interpretation of cholesterol, saturated, monounsaturated, and polyunsaturated fatty acid intakes (13). For micronutrients, the likelihood of insufficient intake was nearly certain if spontaneous intakes were below 70% of the average nutrient requirement (ANR) (9). For the different classes of micronutrients, we referred to the recommendations of the EFSA 2019 (6). For fiber, we referred to the recommendations of the ANSES 2019. We considered intakes insufficient if they were below the recommended level of 30 g/day (14). We deemed a sufficient water intake to be 2.7 liters/day for breastfeeding women and 2 liters/day for non-breastfeeding women, including water from beverages and food (6).

Statistical analysis

All statistical analyses were performed using the Statistical Package for Social Science (SPSS), version 26.0. We calculated absolute frequencies and relative frequencies (percentages) for qualitative variables. We computed means, medians, and standard deviations and determined extreme values (minimum and maximum) for quantitative variables. One-way ANOVA, also known as single-factor ANOVA was used to compare means more than two groups. Percentage comparisons were performed using the Pearson chi-square test or Ficher's exact bilateral test. The relationship between two quantitative variables was studied using the Pearson correlation coefficient. We conducted a multivariate analysis using stepwise descending logistic regression method. In the first step, all factors with univariate 'p' values < 0.05 were introduced, along with those with 'p' values between 0.05 and 0.15. At each subsequent step, the least significant factor, based on 'p' value, was eliminated. The multivariate analysis allowed us to calculate adjusted odds ratios, measuring the individual contribution of each factor. For all analyses, a two-tailed P-value of 0.05 was considered significant.

Ethical considerations

The study protocol was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Prior to enrollment, all participants provided informed consent after being fully informed of the study's purpose. The ethical committee of the National Institute 'Zouhaier Kallel' of Nutrition and Food Technology in Tunis approved this study on March 28, 2023, under reference 12/2023.

Results

General Characteristics of the Study Population

Overall, 52 diabetic patients were included in this study. Table 1 summarizes the general characteristics of the population at the first consultation in diabetology.

Table 1. The characteristics of the study population

Average age (years):	**35,4±4,04 Ext [23-44]**
Level of education n (%):	
• Higher education	10(20)
• Secondary	22(43)
• Primary	15(29)
• Illiterate	5(8)
Socioeconomic level n (%) :	
• Low	16(31)
• Medium	34(65)
• High	2(4)
Type of diabetes n (%):	
• Type 1	10(20)
• Type 2	42(80)
Comorbidities n (%):	
• High blood pressure	2(3)
• Hypothyroidism	3(6)
• Hypercholesterolemia	21(41)
• Hypertriglyceridemia	8(16)
• Iron-deficiency Anemia	14(26)
Obstetric history:	
• Average gravidity	3 [ext :1-7]
• Average parity	1,61 [ext :0-4]

Energy intake of diabetic women two months after childbirth

The average caloric intake was 2086 kcal/day, with extremes ranging from 1240 to 3820 kcal/day. Women who exclusively breastfed their babies had a lower caloric intake than those who did not breastfeed or who partially breastfed their babies (p<0.001) (table 2).

Table 2. Association between breastfeeding patterns and energy intake

Breastfeeding n (%)		**Exclusive breastfeeding**	**Formula feeding**	**Partial breastfeeding**	**P**
Energy intake	**Hypocaloric**	17 (74)	7 (58)	3 (18)	**<0.001**
	Normocaloric	6 (26)	5 (42)	5 (29)	
	Hypercaloric	0 (0)	0 (0)	9 (53)	

Macronutrient intake in diabetic women two months after childbirth

Table 3 summarizes the intake of macronutrients, fatty acids, and sucrose according to the breastfeeding modalities.

Micronutrient intake in diabetic women two months after childbirth

Women who did not breastfeed their babies had an insufficient daily intake of phosphorus (p=0.03). Regarding the other micronutrients, we did not find any statistically significant differences (table 4).

Table 3. Intake of macronutrients, fatty acids, and sucrose according to breastfeeding modalities

	Mean daily intake ± Standard deviation	Interpretation of daily intake n (%)	Breastfeeding modalities			P
			Exclusive breastfeeding	Formula feeding	Partial breastfeeding	
Proteins (g/Kg/day)	1.17±0.37	**Insufficient**	13 (65)	3 (15)	4 (20)	0.07
		Normal	3 (43)	3 (43)	1 (14)	
		Excessive	7 (28)	6 (24)	12 (48)	
Lipids (g/Kg/day)	1.22±0.46	**Insufficient**	2 (40)	1 (20)	2 (40)	**<0.001**
		Normal	21 (68)	5 (16)	5 (16)	
		Excessive	0 (0)	6 (37)	10 (63)	
Carbohydrates (g/Kg/day)	4.09±0.99	**Insufficient**	18 (82)	3 (14)	1 (4)	**<0.001**
		Normal	5 (20)	9 (36)	11 (44)	
		Excessive	0 (0)	0 (0)	5 (100)	
SFA (%TEI)	9.1±2.5	**Normal**	17 (47)	7 (19)	12 (34)	NS
		Excessive	6 (38)	5 (31)	5 (31)	
MUFA (% TEI)	13±6.1	**Insufficient**	6 (47)	2 (15)	5 (38)	NS
		Normal	8 (36)	6 (28)	8 (36)	
		Excessive	9 (52)	4 (24)	4 (24)	
PUFA (% TEI)	12.7±7	**Insufficient**	1(20)	1 (20)	3 (60)	NS
		Normal	3 (33)	3 (33)	3 (33)	
		Excessive	19 (50)	8 (21)	11 (29)	
Sucrose (% TEI)	4.43±4.36	**Normal**	20 (40)	11 (25)	14 (35)	NS
		Excessive	3 (43)	1 (14)	3 (43)	
Cholesterol (mg/day)	225.9±200	**Normal**	16 (45)	10 (24)	14 (31)	NS
		Excessive	7 (58)	2 (17)	3 (25)	

MUFA: monounsaturated fatty acids; **NS**: not significant; **PUFA**: polyunsaturated fatty acids **SFA**: saturated fatty acids; **TEI**: total energy intake

Table 4. Intake of micronutrients according to breastfeeding modalities

	Mean daily intake ± Standard deviation	Interpretation of daily intake n (%)	Breastfeeding modalities			P
			Exclusive breastfeeding	Formula feeding	Partial breastfeeding	
Calcium (mg/day)	657.3±267.9	**Insufficient**	6(32)	7(36)	6(32)	NS
		Normal	17(51)	5(15)	11(34)	
Magnesium (mg/day)	178.4±88.6	**Insufficient**	19(46)	9(22)	13(32)	NS
		Normal	4(36)	3(28)	4(36)	
Phosphorus (mg/day)	820.9±315.3	**Insufficient**	1(25)	3(75)	0(0)	**0.03**
		Normal	22(46)	9(18)	17(36)	
Iron (mg/day)	12.1±4	**Insufficient**	1(33)	2(67)	0(0)	NS
		Normal	22(45)	10(20)	17(35)	
Sodium (mg/day)	1222±556.4	**Excessive**	2(50)	0(0)	2(50)	NS
		Normal	21(44)	12(25)	15(31)	
Potassium (mg/day)	1675.2±608.6	**Insufficient**	20(44)	10(22)	15(34)	NS
		Normal	3(44)	2(28)	2(28)	
Vitamin B1 (mg/day)	0.91±0.31	**Insufficient**	7(58)	5(42)	0(0)	0.08
		Normal	14(41)	6(18)	14(41)	
Vitamin B9 (µg/day)	139.5±67	**Insufficient**	20(44)	10(22)	15(34)	NS
		Normal	3(44)	2(28)	2(28)	
Vitamin E (mg/day)	10.7±9.6	**Insufficient**	9(43)	5(24)	7(33)	NS
		Normal	14(45)	7(23)	10(32)	
Vitamin C (mg/day)	80.9±69.9	**Insufficient**	18(53)	6(18)	10(29)	NS
		Normal	5(28)	6(33)	7(39)	
Zinc (mg/day)	12.6±5.3	**Insufficient**	13(48)	5(19)	9(33)	NS
		Normal	9(45)	5(25)	6(30)	

NS: not significant

Dietary fiber and water intake in diabetic women two months after childbirth

The average intake of dietary fiber among breastfeeding women was 17.58±8.13 g/day, compared to 15.45±8.05 g/day in non-breastfeeding women. The daily water consumption for breastfeeding women was 2688.25±333.52 ml/day, while non-breastfeeding women had a daily intake of 2123.33±316.55 ml/day. We did not identify a statistically significant association between average dietary fiber intake and breastfeeding practices (p=NS), nor did we find such an association for average water intake (p=NS).

Discussion

At two months postpartum, about half of both breastfeeding and non-breastfeeding women had a hypocaloric energy intake. Regardless of breastfeeding practices, nearly half of the women had an excessive carbohydrate intake. In the study conducted by Achong et al, there was a trend toward higher carbohydrate consumption in women who breastfed compared to those who formula-fed, with no difference in insulin doses or hypoglycemia. This suggests that the increased metabolic demand during breastfeeding was met by an autonomous increase in caloric intake (15). Similarly, for non-diabetic patients, Hu et al. showed that the average carbohydrate intake exceeded the recommended nutritional guidelines (RNP) for all women (16). For women with type 1 diabetes, a daily intake of 210 g of carbohydrates was recommended during the breastfeeding period for all women, regardless of their pre-pregnancy weight, to maintain acceptable glycemic control while avoiding ketoacidosis and hypoglycemia. Dietary recommendations during pregnancy and breastfeeding primarily targeted women with type 1 diabetes, but they could also apply to pregnant and breastfeeding women with type 2 diabetes as well as those with gestational diabetes treated with insulin. Fasting ketosis could occur in cases of insufficient carbohydrate intake (17). Half of the non-breastfeeding women had an excessive protein intake. However, among breastfeeding women, this intake was insufficient in 42% of cases. This result was similar to that found in the study by Angeles-Agdeppa et al., which showed that 37% of breastfeeding non-diabetic mothers had a protein intake below the recommended levels (18). Previous studies have shown that insufficient protein intake in breastfeeding mothers reduced prolactin secretion, which could affect milk production (19). Another study showed that protein restriction during breastfeeding directly impacted the weight of infants, who weighed less than their counterparts (20). Lipid intake was excessive in half of the non-breastfeeding women. Hu et al. suggested that the higher lipid consumption was consistent with the trends of an increasingly affluent population and the stronger influence of Western dietary habits (16). An insufficient intake of magnesium, potassium, vitamin B9, and vitamin C was noted in most diabetic women, regardless of breastfeeding practices. Angeles-Agdeppa et al. showed a high prevalence of inadequate micronutrient intake among breastfeeding non-diabetic women, particularly in iron (99%), folate (96%), vitamin B6 (63%), vitamin B12 (46%), riboflavin (39%), and thiamine (22%) (18). Similarly, Hu et al. found that more than 70% of women did not meet the RNP for calcium [25]. We did not find a difference in folate intake between breastfeeding practices among our patients. Indeed, maternal folate reserves are mobilized into breast milk to maintain secretion levels, so women who breastfeed with low intake will have very low nutrient levels as breastfeeding progresses (21). Folate deficiency could lead to megaloblastic anemia, which could be critical for next pregnancy, as maternal folate deficiency may lead to neural tube defects in the developing fetus (22).

In our study, we found that non-breastfeeding women had insufficient phosphorus intake (p=0.03). Numerous studies have shown that serum phosphorus levels increased during breastfeeding, with average values exceeding the upper limit of normal in some studies (23,24). Renal tubular reabsorption of phosphorus also increased (25). However, since intestinal absorption of phosphorus was likely normal, this rise in serum phosphorus in breastfeeding women was probably due to the effects of increased bone resorption (26).

In our study, most patients had an insufficient intake of dietary fiber, and about half of the breastfeeding women had inadequate water intake. According to the study conducted by Hu et al., dietary fiber intake was insufficient, with the average intake being less than half of the adequate intake (16).

Some studies have shown that the nutritional status of breastfeeding women seemed to influence the fat concentration and thus the energy content of breast milk, as well as its composition of fatty acids, vitamins, and immunological properties (27,28). However, Other study has suggested that maternal diet had no impact on the protein content of milk or the total fat content in human milk, but it did affect the types of fatty acids present in breast milk (29). Maternal fat stores remain an important source of nutrients for breast milk, although women with higher fat mass do not produce more milk or milk richer in fat (30). The various lipids were the most variable component of human milk. The variability in lipid composition was inversely related to the degree of breast fullness and milk volume. In addition to essential macronutrients and micronutrients, there is moderate evidence that the flavors from maternal diet during lactation were transferred into breast milk and that infants could detect the flavors transmitted through the diet (31).

Study limitations

The dietary survey was conducted using the 24-hour recall method which does not reflect the patients' usual dietary habits and generally needs to be combined with a dietary history, which was not the case in our study. Another limitation of our study is the use of the Bilnut software which does not allow a precise analysis of micronutrient intake.

Conclusion

Adequate nutrition during breastfeeding is crucial for ensuring the good health of mothers and babies. Considering our results, providing nutritional education to ensure sufficient intake of both micro- and macronutrients and to prevent weight gain is essential. A healthy diet is not only important to support breastfeeding, but also to preserve the mother's long-term health and promote optimal child development. Diabetic women should receive personalized advice on their diet. There is still an ongoing debate on the need for nutritional supplementation during breastfeeding; it seems that this depends on several factors, such as socioeconomic status or the dietary habits of the mother. Thus, personalized nutrition plans, developed in consultation with health care professionals, are critical to optimizing maternal and infant health outcomes.

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