

Eating habits and nutritional adequacy in breastfeeding and formula-feeding mothers. A pilot study

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ABSTRACT

Introduction: Dietary pattern and nutritional adequacy strongly affect maternal health and overall condition during early motherhood. Studies on dietary behaviour in breastfeeding (BF) and formula-feeding (FF) mothers are sparse and need to be updated regularly. During the COVID-19 pandemic, being metabolically healthy and boosting the immune system by having a well-balanced diet is a matter of particular importance. We aimed to identify whether maternal eating patterns are consistent with nutritional standards for breastfeeding and non-pregnant non-breastfeeding healthy women during postpartum.

Material and methods: Exclusively BF and exclusively FF mothers were recruited for this pilot study. Energy and nutrient intakes were estimated using 7-day food records. For qualitative and quantitative analysis of food intake, Dietetyk 2016 computer software was used, and data were compared with Polish standards. The obtained results were also compared between 2 study groups.

Results: The following daily dietary references were used: estimated energy requirement (EER) – for energy, reference intake (RI) – for fats and carbohydrates, and estimated average requirement (EAR), adequate intake (AI), recommended maximum intake – for other tested nutrients. Dietary intake differed between BF and FF groups in terms of calories, carbohydrates, digestible carbohydrates, cholesterol, proteins, folate, and fluid consumption. All of them were higher in BF mothers. Maternal diet was characterised by insufficient intake of the following: energy, fibre, fluids, calcium, vitamin D, folates, and excessive consumption of iron.

Conclusions: Maternal nutritional behaviours do not conform to dietary recommendations, and standards dedicated to exclusively FF mothers are required. There is a need for specialistic counselling providing a valuable understanding about a safe and well-balanced diet for all postpartum mothers.

KEY WORDS: breastfeeding, dietary recommendations, maternal health, formula-feeding, nutritional adequacy.

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INTRODUCTION

Adequate nutrition and dietary attitudes among postpartum women play a fundamental role in mater-

nal health, which is particularly important during the COVID-19 pandemic. Considering that early motherhood is often frustrating and related to chronic fatigue,

sleep deprivation, and huge psychological effort, proper nutrition promoting optimal maternal health is crucial for both breastfeeding (BF) and formula-feeding (FF) mothers, preventing them from malnutrition or over-nutrition and chronic health problems. Therefore, to avoid any negative health consequences, postpartum women should be familiar with the current nutrition recommendations provided by world nutrition societies, e.g. the World Health Organization (WHO) Department of Nutrition for Health and Development in collaboration with the Food and Agriculture Organization (FAO), Federation of European Nutrition Societies (FENS), or European Food Safety Authority (EFSA). Physicians and other healthcare providers, such as registered dietitians, should be involved in a professional nutritional counselling to supply lactating and non-lactating mothers with practical and understandable advice and an acceptable menu. Unfortunately, in Poland, no standardised guidelines for the frequency of routine postpartum visits offering nutritional care have been established and little is known about the diet advice women receive during early motherhood. As a research institute focussed on public health, the National Institute of Public Health – National Institute of Hygiene or NIPH–NIH (*Polish: Narodowy Instytut Zdrowia Publicznego – Państwowy Zakład Higieny, NIZP-PZH*) is the most reliable and opinion-forming institution regarding nutrition for different populations in Poland, including lactating women. In 2020, new recommendations were released [2]; however, dietary references ensuring adequate nutrition for postpartum non-lactating mothers are still missing, and the standards published by NIPH–NIH for lactating women need to be extended.

The importance of maternal adequate nutrition during the postpartum period is indisputable, but little is known about dietary behaviour in exclusively breastfeeding (BF) and exclusively formula-feeding (FF) mothers, because most studies are focused on the nutritional status of infants. Therefore, the aim of the present study was to investigate feeding practices of postpartum lactating and non-lactating women, and to extend and update the knowledge about their nutritional status.

MATERIAL AND METHODS

STUDY POPULATION

In this pilot study, a total of 75 healthy postpartum women comprising BF and FF mothers met the inclusion criteria and were recruited from the outpatient clinics in Poznan during routine postnatal paediatric visits for the assessment of their infants. Of them, 20 mothers were not included in the final analysis. The study was approved by the Bioethics Committee of Poznan University of Medical Sciences (Ref. KB-1096/16, annexed by Ref. KB-246/19), and informed written consent for participation was obtained from each subject. Data collection ended in 2019, before the COVID-19 pandemic.

The following were the inclusion criteria: vaginal delivery, healthy exclusively BF mothers who were between the 3rd and 6th month post-partum, and completely FF mothers without any known medical reason for use of breast-milk substitutes (formula milk and other fluids), who were between the 3rd and 6th month post-partum. Exclusion criteria were as follows: women on specific and/or restrictive diet (e.g. vegan, vegetarian, and ketogenic diet), food allergies, any chronic disease, drug treatment, acute infection during data collection, and holidays and special occasions that might change the routine nutrition pattern.

According to the definition by the WHO, exclusive BF was recognized as feeding an infant with only breast milk and no supplementary food, water, or other fluids since birth [3]. Complete formula feeding was defined as a feeding an infant with formula milk instead of BF since birth. All subjects underwent a medical examination and completed an assessment survey on general health, age, education, marital status, physical activity, use of supplements, and source of knowledge about healthy nutrition. To avoid day-to-day variation in nutrient intake, all study participants were asked to maintain their ordinary dietary and physical activity behaviour, and data were collected within 2 autumn months (October–November). All study participants were urban residents.

ANTHROPOMETRICS

Weight was measured to the nearest 10 g (electronic personal scale, Mensor WE150P1). Height was measured to the nearest 5 mm using a wall-mounted stadiometer (Comed). Body mass index (BMI; kg/m²) was calculated as weight (kg)/height (m)². The reference range for BMI was 18.5–24.9 kg/m².

FOOD INTAKE MEASUREMENT AND DIETARY ASSESSMENT

Dietary patterns were identified from food diaries that recorded consumption of food products over 7 days. The questionnaires were distributed in paper form. Respondents were asked to record foods, beverages, and dietary supplements (e.g. vitamins and minerals) as they were consumed throughout the reporting day (a “real-time” accounting) and were trained to record adequately the food items consumed, including the name of the food and the amount consumed. Food intake recording was carried out for 7 consecutive days (day-by-day), including weekends. To estimate portion sizes, study participants relied on home measures and/or a photo album of meals and products by Szponar *et al.* [4]. Comprehensive written instructions were given to respondents and were also explained orally in detail.

The nutritional analysis included key elements (energy, macronutrients, and micronutrients) that potentially influence maternal health and their consumption should be elevated during lactation, according to the current recommendations provided by NIZP–PZH [2].

For qualitative and quantitative analysis of daily food intake, Dietetyk 2016 computer software (JuMaR, Poland), translating dietary data to nutrient and energy content, was used. The software database contains the nutritional values of supplements that are available in Poland. The results were next compared with the nutrition standards of the National Institute of Public Health – National Institute of Hygiene [2] for healthy women and healthy lactating women at age and body mass corresponding to the study population. Data obtained from BF mothers were compared with standards provided for breast feeders, while the results of FF women were compared with the recommendations for non-pregnant and non-lactating women. Based on the survey data on physical activity, and calculations of total energy expenditure provided by FAO/WHO/UNU experts [5], the physical activity level of study participants was estimated as low.

COMPARISON WITH NUTRITIONAL GUIDELINES

To compare the results, we used the following daily dietary references: estimated energy requirement (EER) – for energy, reference intake (RI) – for fats and carbohydrates, and estimated average requirement (EAR), adequate intake (AI), recommended maximum intake – for other tested nutrients.

STATISTICAL ANALYSIS

Descriptive statistics are presented as mean value, standard deviation (SD), median value, and standard error (SE). The normal distribution was tested with the Shapiro-Wilk test, while the variance homogeneity was checked by Levene's test. Statistically significant differences between BF and FF mothers in the values of each parameter were tested with the use of Student's *t*-test (for normally distributed variables showing the homogeneous variance), Welch test (for normally distributed variables showing non-homogeneous variance), and *U* Mann-Whitney test (for variables with non-normal distribution). The results for each study participant were compared to dietary standards with the use of Student's *t*-test (for normally distributed variables showing the homogeneous variance; to compare with standards presented both as a limit value and as a reference range), *U* Mann-Whitney's test (for variables with non-normal distribution; to compare with standards presented as a reference range), and Wilcoxon test (for variables with non-normal distribution, to compare with standards presented as a limit value). For the results that were within the reference range, the χ^2 test was applied to examine statistically significant differences between BF and FF mothers. The percentage of BF and FF mothers with daily nutrient intake below, within, and above the standards were calculated to investigate the prevalence of inadequate intake. The α significance level was set at 0.05. Calculations were carried out with the use of Statistica 13.1 software (TIBCO Software Inc.) and PQStat software (Wilcoxon test).

RESULTS

The characteristics of the study participants are presented in Table 1. The nutrient requirements provided by NIZP-PZH for non-pregnant, non-lactating women as well as for lactating women are shown in Table 2. Based on data obtained from Dietetyk software, Table 3 presents descriptive statistics of energy and nutrient intake for BF and FF mothers. Figure 1 presents statistically significant differences in energy and all nutrient intakes between BF and FF mothers. Comparing BF with FF mothers, we found that BF women consumed significantly greater amounts of digestible carbohydrates (DCHO; $p = 0.003$), which was also expressed in higher overall carbohydrate ingestion (CHO; $p = 0.002$), whereas fibre consumption did not differ between the groups ($p = 0.754$). Regarding fats, only cholesterol ingestion differed between the groups; in BF mothers its intake was significantly higher ($p = 0.028$). Also, BF mothers drank more fluids ($p = 0.001$), and consumed more proteins ($p = 0.027$) and folates ($p = 0.04$). The overall calorie intake was higher in the BF group ($p = 0.011$). The remaining food ingredients did not differ significantly between compared groups ($p < 0.05$). The percentage of BF and FF mothers with daily nutrient intake below, within, and above the standards as well as the statistical difference between results which were within reference range (BF vs. FF groups) are shown in Table 4.

DISCUSSION

To our knowledge, this paper presents for the first time the nutritional status of both BF and FF Polish mothers during early motherhood. The authors discussed inadequate intakes of energy and nutrients, and possible risks associated with observed insufficient or excessive consumption.

ENERGY

Dietary intake differed between the BF and FF groups in terms of energy (calorie), CHO, DCHO, CHOL, proteins, folate, and fluid consumption. The energy load and the consumption of the mentioned nutrients were higher in BF mothers, but, although all study participants reported that they were not on restrictive diets, 65% of BF and more than one third of FF mothers did not meet the standards for calorie intake. It looks like BF mothers partially understood their responsibility for childcare and the need for higher energy delivery, and/or their appetite increased due to lactation-related energy expenditure; however, their knowledge about the overall quantity and quality of recommended daily nutrition was not sufficient. Interestingly, and in contrast to a number of studies [6], the majority of postpartum urban mothers from our study were not overweight or obese. This may indicate an adequate energy balance because BMI is considered to be one of the most important indicators of energy homeostasis. However, postpartum weight change is a dynamic

process that requires continuous observation to control the course of weight shifts and energy balance. Losing weight gradually, not rapidly through dieting, is the best way to improve long-term health. The target of this reduction should be a normal BMI value (18.5-24.9 kg/m²); restrictive diets are not recommended. According to NIZP-PZH, a nursing mother within the first 6 months of lactation should increase the energy intake by 505 additional kcal/day beyond what is recommended for non-pregnant and non-BF women (2000 kcal/day). At that time the increased requirements for energy are even higher, but some calories should come from the fat accumulated during pregnancy. Women with low body fat may increase their energy intake by 650 kcal [2]. Szajewska *et al.* suggested higher daily caloric value of a nursing woman's diet (3100 kcal/day) [7]; nonetheless, a mother's "baseline" need for calories is individual and depends on lifestyle, including physical activity, body weight before pregnancy, gestational weight gain, and nutritional status. Some women, however, become frustrated because of the expectations about their body image after pregnancy, and the known risk of postpartum weight retention or weight gain [8]. In our study population, the choice of food was related to self-monitoring of nutritive behaviour, largely based on popular science publications and social media available on the Internet, or dietary habits, without professional dietary counselling. This, in turn, could be related to low awareness of standards for lactating women and/or nutritional neglect. Chronic fatigue, low physical activity, no time for regular eating, the possibility of underreporting of calorie intake, plus a strong desire to lose weight resulted, in this case, in a calorie reduction without scientific rationale. This, in turn, might increase the risks for nursing mothers associated with not getting the right balance of nutrients. Whether this type of nutritive behaviour occurs in large urban population of breastfeeders in the province of Greater Poland requires further investigation.

FIBRE

In the present study, we observed insufficient fibre ingestion in most women from both studied groups (in 65% of BF and 60% of FF mothers), when compared with the standard provided by NIZP-PZH, which is 25 g of fibre daily. Regarding this guidance, we should highlight that the NIZP-PZH recommends fibre consumption at the adequate ingestion (AI) level for the whole female population and does not specify a certain amount of fibre in the diet of pregnant and lactating women, leaving this issue to the individual decision of a doctor or dietitian. If there is no individual indication to reduce fibre, pregnant and lactating women should consume the amount recommended for the entire Polish female population [2].

For lactating women, it is important to meet recommended values, because dietary fibre significantly impacts their health and the physical condition of their infants.

TABLE 1. Study participants' characteristics

Study group	Age, years	BMI [kg/m ²]	Weight gain/loss [kg]	Supplements (% of women)	Marital status (% of women)	Source of knowledge about healthy nutrition (% of women)
BF (n = 32)	28 ± 3.5	24.53 ± 4.06	-0.70 ± 7.23	Iron - 9 Iodine - 4.5 Multivitamin with DHA - 9 Multivitamin with no DHA - 23 Vitamin D - 9 Vitamin D + DHA - 4.5 Probiotics - 4.5	Married - 87.5 Never married - 4.2 Divorced - 0 Living common-law - 8.3	Nutritional counselling - 9 Internet and social media - 27 Popular science publications - 23 Nutritional habits - 36 Other - 5
FF (n = 23)	27 ± 4.3	21.91 ± 1.61	+3.00 ± 2.65	Iron - 7.7 Vitamin D - 15 Vitamin C - 15 Folates - 7.7	Married - 38.4 Never married - 7.7 Divorced - 7.7 Living common-law - 46.2	Nutritional counselling - 0 Internet and social media - 32 Popular science publications - 18 Nutritional habits - 44 Other - 6
p	NS	NS	0.020	0.002	0.003	0.045

P-values are associated with the Wilcoxon test (age, BMI, weight gain/loss) and the Fisher's test (the remaining variables). Values with p < 0.05 are considered statistically significant.

TABLE 2. Daily nutrient requirements for non-pregnant and non-lactating women as well as during pregnancy and lactation according to Public Health – National Institute of Hygiene in Poland [2]

Nutrient	Non-pregnant, non-lactating women (per day)	Pregnancy (per day)	Lactation (per day)
Energy ¹ [kcal]	2000	+85-475	+505
Macronutrients			
Proteins ^{2,3}	10-20%; 33-58 g	+0%; +11-20 g	+0%; +20-36 g
Fats ²	20-35%; 44-78 g	+0%; +3-19 g ^a	+0%; +11-20 g
LA ⁴	4% of energy	+0%	+0%
ALA ⁴	0.5% of energy	+0%	+0%
LA	g, NA	g, NA	g, NA
ALA	g, NA	g, NA	g, NA
SFA	% of energy, NA	% of energy, NA	% of energy, NA
SFA ⁵	14-17 g	+0 g	+0 g
CHOL ⁵	< 300 mg	< 300 mg	< 300 mg
CHO ²	45-65%; 225-325 g	+0%; +10-77 g ^a	+0%; +57-82 g
DCHO	g, NA	g, NA	g, NA
Fiber ⁴	25 g	The amount should be consulted with a doctor or dietitian nutritionist	
Fat-soluble vitamins			
Vitamin A ³	500 µg	+30 µg	+400 µg
Vitamin D ⁴	15 µg	+0 µg	+0 µg
Water-soluble vitamins³			
Vitamin C	60 mg	+10 mg	+40 mg
Vitamin B ₁	0.9 mg	+0.3 mg	+0.4 mg
Vitamin B ₆	1.1 mg	+0.5 mg	+0.6 mg
Vitamin B ₁₂	2.0 µg	+0.2 µg	+0.4 µg
Folates	320 µg	+200 µg	+130 µg
Minerals³			
Calcium	800 mg	+0 mg	+0 mg
Magnesium	260 mg	+40 mg	+5 mg
Iron	8 mg	+15 mg	7 mg
Zinc	6.8 mg	+2.7 mg	+3.6 mg
Others			
Fluids ⁴	2000 ml	+300 ml	700 ml

During the first months of postpartum, a diet rich in fibre helps the mother to lose weight and maintain a normal BMI [9]. What is more, dietary fibre significantly affects the composition, diversity, and richness of the health-promoting gut microbiota and improves the motor function of intestines [10]. Studies show that products of fibre bacterial fermentation, short chain fatty acids, beneficially modulate immune, epithelial, vascular, and neural system functioning through the complex interplay between gut-brain, gut-liver, and liver-brain axes [11]. Therefore, low fibre intake, which is characteristic for western diets, may result in a number of metabolic disorders, including

obesity and diabetes, as well as in allergies, autoimmune diseases, asthma, cancer, and cardiovascular and central nervous system disorders [12]. Certainly, more effort is needed to improve our understanding of the favourable effects of dietary fibre and to help postpartum mothers change their nutritional habits.

FLUIDS

To meet proper hydration, nursing mothers, because they produce milk in the amount of about 750 ml/day, must drink more than non-pregnant and non-lactating women. The adequate level of hydration ensures the

TABLE 3. Descriptive statistics of energy and nutrient intake for breastfeeding and formula-feeding mothers

Nutrient	Mode of nursing								p-value
	FF (n = 23)		BF (n = 32)		FF (n = 23)		BF (n = 32)		
	Mean	SD	Mean	SD	Median	SE	Median	SE	
Energy [kcal]	1661	548	1901	640	1636	69	1907	54	0.011 ^{*,1}
Proteins [%] ^a	16.21	3.68	15.76	4.58	15.70	0.46	15.58	0.39	0.349 ²
Proteins [g]	65.04	20.13	72.47	25.60	59.59	2.54	71.66	2.16	0.027 ^{*,3}
Fats [%] ^a	32.51	9.58	30.96	7.88	32.51	1.21	30.22	0.67	0.119 ²
Fats [g]	62.64	32.12	65.83	28.41	59.69	4.05	62.44	2.40	0.398 ²
LA [%] ^a	3.74	2.20	3.55	1.93	3.28	0.28	3.10	0.16	0.849 ²
ALA [%] ^a	0.61	0.42	0.56	0.35	0.44	0.05	0.44	0.03	0.835 ²
LA [g]	7.06	4.93	7.62	5.46	5.36	0.62	6.18	0.46	0.260 ²
ALA [g]	1.16	0.98	1.21	0.90	0.85	0.12	0.95	0.08	0.397 ²
SFA [%] ^a	11.94	4.54	11.71	3.57	12.21	0.57	11.18	0.30	0.567 ³
SFA [g]	23.14	12.97	24.97	11.57	20.76	1.63	23.07	0.98	0.267 ²
CHOL [mg]	242.94	178.22	294.96	195.44	188.30	22.45	235.99	16.52	0.028 ^{*,2}
CHO [%] ^a	51.27	9.21	53.28	9.38	51.40	1.16	54.87	0.79	0.054 ²
CHO [g]	227.69	73.57	271.10	102.83	224.41	9.27	267.57	8.69	0.003 ^{*,2}
DCHO [g]	208.37	69.43	251.90	98.33	206.13	8.75	246.29	8.31	0.002 ^{*,2}
Fibre [g]	19.32	7.63	19.20	9.03	17.72	0.96	18.16	0.76	0.755 ²
Fluids [ml]	1465.68	762.47	1959.16	1117.06	1363.44	96.06	1778.44	94.41	0.001 ^{*,2}
Vitamin A [µg]	1377.55	3165.39	869.63	625.73	623.22	398.80	728.50	53.46	0.939 ²
Vitamin D [µg]	2.72	5.07	2.31	3.33	1.35	0.64	1.79	0.28	0.165 ²
Vitamin C [mg]	60.51	46.07	76.28	61.79	49.92	5.80	59.31	5.22	0.086 ²
Vitamin B ₁ [mg]	0.99	0.44	1.08	0.48	0.91	0.06	1.00	0.04	0.150 ²
Vitamin B ₆ [mg]	1.54	0.62	1.67	0.65	1.45	0.08	1.64	0.06	0.157 ²
Vitamin B ₁₂ [µg]	2.98	2.47	3.14	2.25	2.37	0.31	2.72	0.19	0.424 ²
Folates [µg]	221.30	89.71	258.75	133.98	209.93	11.30	242.17	11.32	0.040 ^{*,2}
Ca [mg]	576.79	276.69	580.90	338.68	525.80	34.86	470.15	28.62	0.610 ²
Mg [mg]	274.85	98.15	280.73	104.57	270.30	12.37	262.06	8.84	0.689 ²
Fe [mg]	9.74	3.89	10.60	4.27	9.10	0.49	10.06	0.36	0.184 ²
Zn [mg]	8.48	3.31	9.01	3.10	7.89	0.42	9.00	0.26	0.141 ²

FF – formula-feeding mothers, BF – breastfeeding mothers, SFA – saturated fatty acids, LA – linoleic acid (18: 2n-6); ALA – α -linolenic acid (18: 3n-3), CHOL – cholesterol, CHO – carbohydrates, DCHO – digestible carbohydrates, a % of energy

*Statistically significant (¹Student's t-test; ²U Mann-Whitney test; ³Welch test); for normally distributed data mean values were compared, while for variables with not normal distribution median values were compared.

desirable volume and composition of milk; thus, Polish standards provided by the NIZP-PZH, which are based on EFSA recommendations, include fluid intake at the level of 700 ml/day above the adequate intake of non-lactating women of the same age [13]. About 80% of required fluids usually comes from drinking water, whereas the remaining 20% is from beverages and from food moisture ingested [14]. The inadequate fluid intake in more than 66% of FF and 70% of BF mothers observed by us may put these women at increased risk of hypertonic dehydration with all the associated negative effects on maternal health.

The first signs are often overlooked because fatigue, decreased mood, and headaches caused by hypertonic dehydration mimic the symptoms of postpartum-related exhaustion. On the other hand, dryness of skin and mucous should warn a nursing mother about water deficiency in the body. To objectively monitor whether BF and FF women from the present study were dehydrated, urinary and haematological hydration biomarkers should be determined, including 24-h urine collection assessed for volume and colour, osmolality and specific gravity, serum osmolality, haematocrit, and serum protein

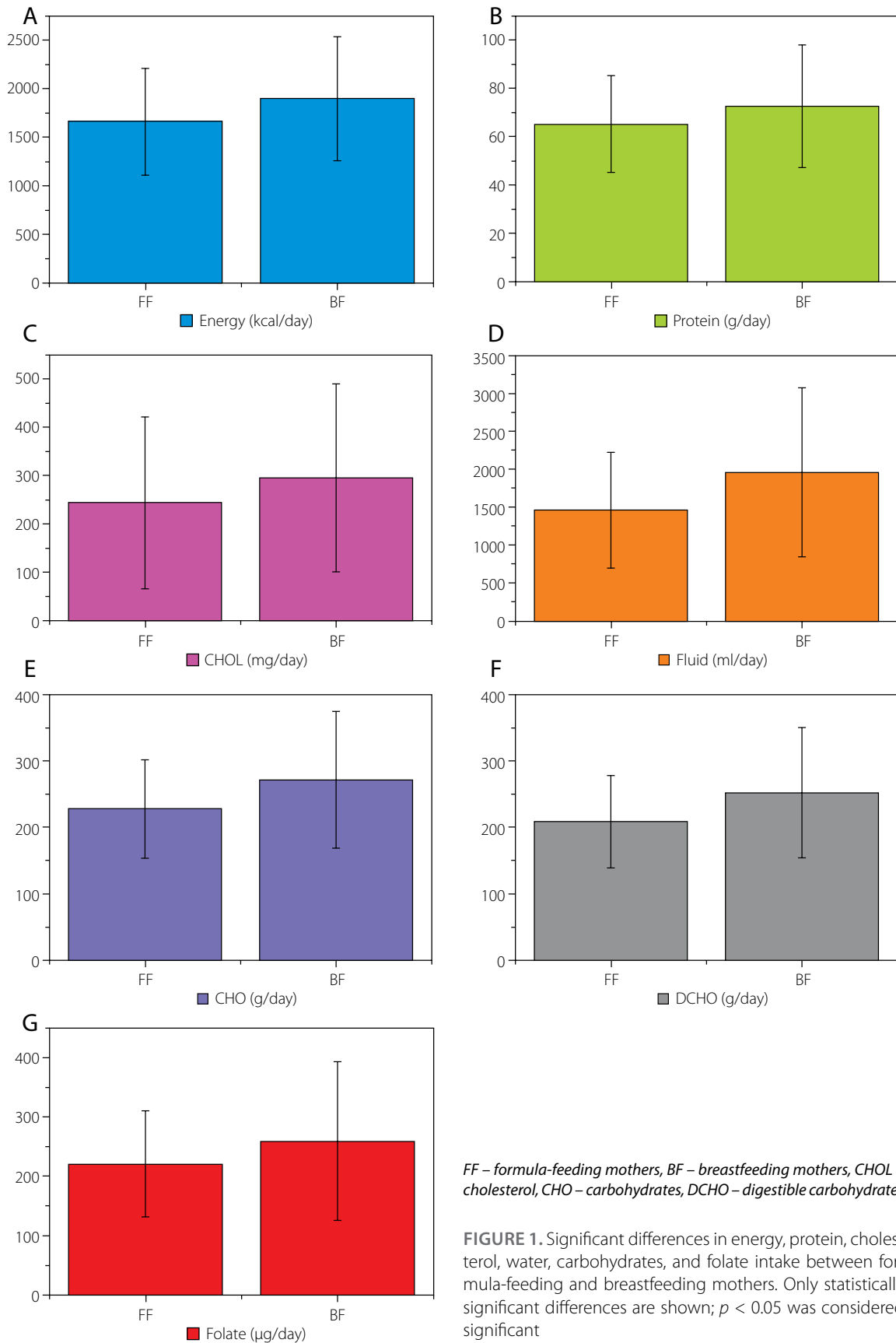


FIGURE 1. Significant differences in energy, protein, cholesterol, water, carbohydrates, and folate intake between formula-feeding and breastfeeding mothers. Only statistically significant differences are shown; $p < 0.05$ was considered significant

TABLE 4. Percentage of breastfeeding and formula-feeding mothers with daily energy and nutrient intake below, within, and above the standards provided by the Public Health – National Institute of Hygiene in Poland

Nutrient	Dietary intake compared to standards	Mode of nursing		p-value
		%FF (n = 23)	%BF (n = 32)	
Energy [kcal]	Below	33.3	65.0	0.109
	Within	66.7	35.0	
	Above	0.0	0.0	
Proteins [%]	Below	0.0	0.0	1.000
	Within	100.0	100.0	
	Above	0.0	0.0	
Proteins [g]	Below	0.0	0.0	0.029*
	Within	77.8	100.0	
	Above	22.2	0.0	
Fats [%]	Below	0.0	0.0	1.000
	Within	100.0	100.0	
	Above	0.0	0.0	
Fats [g]	Below	0.0	5.0	0.495
	Within	100.0	95.0	
	Above	0.0	0.0	
LA [%]	Below	33.3	30.0	0.450
	Within	55.6	70.0	
	Above	11.1	0.0	
ALA [%]	Below	0.0	15.0	0.065
	Within	100.0	70.0	
	Above	0.0	15.0	
SFA [g]	Below	0.0	0.0	0.928
	Within	88.9	90.0	
	Above	11.1	10.0	
CHOL [mg]	Below	44.4	10.0	0.034*
	Within	55.6	90.0	
	Above	0.0	0.0	
CHO [%]	Below	0.0	0.0	1.000
	Within	100.0	100.0	
	Above	0.0	0.0	
CHO [g]	Below	11.1	25.0	0.393
	Within	88.9	75.0	
	Above	0.0	0.0	
Fibre [g]	Below	66.7	65.0	0.859
	Within	33.3	30.0	
	Above	0.0	5.0	
Fluids [ml]	Below	66.7	70.0	0.664
	Within	22.2	30.0	
	Above	11.1	0.0	
Vitamin A [µg]	Below	0.0	25.0	0.664
	Within	77.8	70.0	
	Above	22.2	5.0	
Vitamin D [µg]	Below	88.9	95.0	0.549
	Within	11.1	5.0	
	Above	0.0	0.0	

TABLE 4. Cont.

Nutrient	Dietary intake compared to standards	Mode of nursing		p-value
		%FF (n = 23)	%BF (n = 32)	
Vitamin C [mg]	Below	22.2	55.0	0.100
	Within	77.8	45.0	
	Above	0.0	0.0	
Vitamin B ₁ [mg]	Below	0.0	40.0	0.120
	Within	88.9	60.0	
	Above	11.1	0.0	
Vitamin B ₆ [mg]	Below	0.0	5.0	0.087
	Within	55.6	85.0	
	Above	44.4	10.0	
Vitamin B ₁₂ [µg]	Below	0.0	20.0	0.351
	Within	77.8	60.0	
	Above	22.2	20.0	
Folates	Below	66.7	85.0	0.260
	Within	33.3	15.0	
	Above	0.0	0.0	
Ca [mg]	Below	55.6	50.0	0.780
	Within	44.4	50.0	
	Above	0.0	0.0	
Mg [mg]	Below	0.0	15.0	0.491
	Within	77.8	65.0	
	Above	22.2	20.0	
Fe [mg]	Below	0.0	0.0	0.183
	Within	66.7	40.0	
	Above	33.3	60.0	
Zn [mg]	Below	0.0	30.0	0.859
	Within	66.7	70.0	
	Above	33.3	0.0	

FF – formula-feeding mothers, BF – breastfeeding mothers, SFA – saturated fatty acids, LA – linoleic acid (18: 2n-6), ALA – α-linolenic acid (18: 3n-3), CHOL – cholesterol, CHO – carbohydrates, DCHO – digestible carbohydrates

*Statistically significant (χ² test)

concentrations. Drinking enough water and other fluid types is important for both BF and FF mothers because even mild-to-moderate chronic dehydration may lead to increased risk of recurrent urinary tract infections, chronic kidney disease, neoplasm, thrombosis-related events, depression and other mood disorders, metabolic syndrome, and other pathologies [15, 16].

IRON

Regarding iron ingestion, we observed excessive ingestion of this microelement in 60% of BF women and in one-third of FF mothers. Dietary sources of iron included iron-rich food, supplements containing pure iron (9% of BF and 7% of FF mothers used iron supplements), and iron-containing vitamin-mineral supplements (used by 32% of BF mothers). Physiologically, dietary iron absorption from the intestine is limited due

to the activity of hepcidin – a hepatic peptide involved in the regulation of iron absorption – and largely depends on the body’s current iron status [17]. On the other hand, a body of evidence indicates that long-term high dietary intake of highly bioavailable iron may lead to secondary iron overload, with negative health consequences including haemochromatosis with liver, heart, and endocrine gland failure [18]. Furthermore, in response to high prolactin level and inhibited gonadotropins release, BF is associated with temporary infertility and prolonged amenorrhoea followed by reduced iron loss. Additionally, even WHO guidelines indicate that further research is necessary to determine the adverse effects of iron supplementation in the postpartum period, including iron overload [19].

Considering the above and the fact that all exclusively BF mothers from our study experienced lacta-

tional lack of menses, it is important to underline that for healthy lactating women iron intake should not be increased beyond physiological requirements.

CALCIUM

In the present study, half of the BF and more than half of FF mothers represented a group with deficiency of calcium supply. This observation remains intriguing because usually BF mothers are aware of suggestion that adequate calcium intake is beneficial for milk production and maintenance of proper maternal bone density during lactation [20]. In addition, we compared calcium consumption with standards by the NIZP-PZH, while other Polish authors indicate even higher norms for BF mothers [6]. The low calcium and low vitamin D intake observed by us might have profound clinical consequences in postpartum women. Low dietary calcium may evoke secondary hyperparathyroidism, which, in turn, increases the catabolism of 25 hydroxyvitamin D leading to additional, secondary vitamin D deficiency [21]. Such a situation is not common, but requires highlighting.

VITAMIN D

Up to 90% of vitamin D comes from the skin synthesis; however, to prevent deficiency of this “sunshine” vitamin, 20 minutes of sun exposure daily with over 40% of skin exposed is required [22]. Therefore, considering factors such as geographic latitude and season (summer vs. winter), Polish postpartum women should consume vitamin D in high doses. Because very few foods contain vitamin D naturally (fatty fish livers, eggs, and fortified food), the combined dietary sources from foods and supplements need be considered. NIZP-PZH set the daily ingestion standard for vitamin D at 15 µg (600 IU; adequate intake [AI]) for both healthy women and healthy lactating women [2], whereas in 2013 several international experts postulated its prophylactic intake at 1500-2000 IU/day (37.5-50.0 µg/day) for pregnant and lactating women, and 800-2000 IU/day (20.0-50.0 µg/day) for healthy adults [23]. Other authors indicated that during lactation, daily vitamin D dosing should be elevated even to 4000 IU (100 µg), which is most effective in optimizing serum vitamin D concentrations in mothers and their infants [24]. In our study, we noticed large dietary deficiency of vitamin D in 95% of BF women and almost 89% of FF mothers. What is more, none of them reported supplementation with high doses (2000 IU), and only 15% of mothers used multivitamins containing no more than 200 IU of vitamin D. This situation remains common in many countries and, when deficiency is severe, may lead to clinical consequences for postpartum mothers, including higher risk of cardiovascular disease, cancer, diabetes, depression, osteomalacia, or immune problems [25]. Whether postpartum women from our study were vitamin D deficient requires blood testing because a large

part of vitamin D is stored in adipose and other tissues for months [26].

FOLATE (VITAMIN B₉)

Folates are synthesized by several gut bacterial strains, but their amount provided by microbe-derived synthesis is too little to meet human requirements; therefore, they must be obtained from exogenous sources. Because folate bioavailability from a mixed diet is only 50% [27], supplementation with this vitamin is required to prevent the consequences of its deficiency, e.g. megaloblastic anaemia, high homocysteine levels followed by elevated risk of coronary artery disease, or development of neural tube defects [28]. The latter is the main reason for folate supplementation in women of childbearing age or during gestation. However, the maternal health importance must be also considered. According to the NIZP-PZH, BF women should ingest 450 µg of dietary folate equivalent per day (given as an estimated average requirement, EAR), while the Polish Society of Gynaecologists and Obstetricians recommends even higher daily ingestion of between 600 and 800 µg. This amount can be achieved by supplementation – the bioavailability from supplements is much greater than from food [29]. For non-pregnant non-lactating women 320 µg/day is standard. In our study, 80% of BF and more than 66% of FF mothers did not meet the standards, which, when considering dietary source, is similar to the situation in other countries [30]. Hence, many of them have introduced mandatory fortification of flour and other food with folic acid as a successful public health intervention. On the other hand, all women supplementing folates in the form of folic acid should be warned that excessive intake of this highly bioavailable supplement may evoke some adverse neurological effects in people with vitamin B₁₂ deficiency or may increase the risk of certain cancers [31, 32]. Therefore, an upper level intake (UL) for folic acid (1000 µg/day) has been established by the European Food Safety Authority (EFSA) in 2006 [33].

For the postpartum women, nursing is a time of considerable energy output. Therefore, meeting dietary recommendations is crucial to ensure optimal quality and quantity of food ingested by mothers. According to continuous changes in the behavioural, cultural, and socio-economic conditioning, nutritive habits also change [34]. For example, it has recently been shown that higher quality of food in Poland, expressed as an Alternate Healthy Eating Index (AHEI), is associated with the urban female community and with a higher level of education [35]. Therefore, nutritional status assessment should be conducted systematically because nutritional screening allows the quick detection of postpartum women at risk of malnutrition/overnutrition. On the other hand, opinion-forming institutions, responsible for nutritional standard settings, must be familiar with the actual changes in lifestyle and carefully adjust the rec-

ommendations to the current women's requirements. In the ATLAS study, maternal dietary intakes were tested in 7 European countries (Norway, Sweden, France, Romania, Italy, Portugal, and Spain), and large nutrient inadequacies in lactating mothers were reported [36]. However, results from all 7 countries were compared to EFSA recommendations only, without considering factors such as geographic latitude, seasonality, nutritional standards for a particular country, or restrictive diet use. Available data regarding recommended postpartum nutrition focus on breastfeeders, and standards for a population of FF mothers are missing. Although FF mothers do not produce milk and their energy output is not elevated for this reason, they experience huge mental and physical effort during early motherhood. The night-time feeding, care, and sleeping patterns of infants are related to poor quality of maternal sleep and chronic fatigue [37], and similarly to night-shift workers, postpartum women must deal with circadian disruption [38]. A growing body of evidence suggests that inadequate nutrition negatively affects the oscillators of the circadian clock and may impair diurnal metabolic pathways [39]. This, in turn, increases the risk of adverse effects on cardiometabolic health, depression, dysfunction of the immune system, and many other complications [40]. Hence, established coherent dietary guidelines for both BF and FF mothers would be a good starting point for the strategies helping to alleviate the risk of maternal health problems.

The limitations of the current study need to be acknowledged. Firstly, the study population was small; however, we aimed to obtain a potentially uniform study group, and it was hard to find women who matched our narrow inclusion criteria in this pilot study. Additionally, we analysed only completely filled surveys, and this also affected the final number of study participants. Secondly, this questionnaire-based recording method is subjective and might be associated with under- and overreporting or large day-to-day variation in intake. Therefore, all study participants were asked to maintain their ordinary dietary and physical activity behaviour, to avoid holidays and special occasions that might change their routine nutrition pattern, and data were collected during one autumn season. Finally, it would be interesting to match the average daily dietary intake level with the blood concentrations of particular nutrients and to perform long-term observation that includes monitoring of body weight.

CONCLUSIONS

Our results indicate that during postpartum, a very demanding time for every woman, eating behaviours of BF and FF mothers do not conform to dietary recommendations. To ensure maternal well-being and general health, standards for exclusively FF mothers need to be established. Women's nutrition knowledge and healthy-eating attitudes are mainly based on social media; therefore, routine specialist counselling provid-

ing a valuable understanding about a safe and well-balanced diet is required.

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DISCLOSURE

The authors report no conflict of interest.

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AUTHORS' CONTRIBUTIONS

JN and MGD prepared the concept of the paper. JN, MW collected data. JN, MW, KM, ZB interpreted data. MW, KM, ZB, MGD wrote the article. All authors approved the final version of the paper.