General Section

Role of exclusive breastfeeding in energy balance and weight loss during the first six months postpartum

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Summary

Purpose: To investigate the energy intake (EI), energy expenditure (EE), and body weight changes of solely breastfeeding women during the first six months postpartum. *Materials and Methods:* This is a prospective observational study of lactating women (n = 64). Three-day dietary records were filled in to assess EI. EE was calculated with a short physical activity questionnaire. Energy cost of milk production was not included in EE estimation. *Results:* Daily EI and EE for the six-month period was 2,000 Kcal and 1,870 Kcal, respectively. Women had a positive energy balance throughout the study period. Nevertheless, they had a significant weight loss of 0.7 kg/month by the first trimester of lactation, but a non-significant weight loss of 0.5 kg/month by the second trimester. Overall, women lost 86% of the weight gained during pregnancy. *Conclusion:* Exclusively breastfeeding women manage to lose weight during the first six months postpartum as part of the natural process of energy cost of lactation.

Key words: Energy intake; Weight change; Lactation.

Introduction

The period of breastfeeding is the stage in a woman's life with the greatest energy demands, even greater than those during pregnancy [1]. The production of milk just up to the fourth month of lactation represents a sum of energy equal to the total energy cost of the nine months of pregnancy [2]. Lactation requires an increased intake of nutrients and excess fat gained throughout pregnancy is generally considered to be the main supply of extra energy needed for lactation. After delivery, many women although willing to lose weight, fear that restricting their dietary intake can lead to a reduction in their milk's volume and quality [3]. This is why they may choose to increase their energy intake more than recommended during the lactation period [3].

This study was designed to assess the energy intake, energy expenditure, and weight changes of Greek mothers who exclusively breastfeed their offspring for the first six months postpartum. It is the first study to research and describe the Greek data in this field.

Materials and Methods

Inclusion, exclusion criteria, and outcomes

This was a prospective observational study with a cohort of n = 64 pregnant women delivering healthy full-term neonates (> 37 weeks, weight > 2.5 Kg) in private maternity hospitals of Athens, Greece. All participants stated their intention to exclusively breastfeed their infants for up to six months and were followed up until the sixth month of lactation. Mothers who were following specific diet because of diabetes or hypertension, or were taking medicines known to influence their appetite were excluded.

Main outcome measures were to assess the lactating mothers' energy intake (EI), energy expenditure (EE), energy balance (EB), as well as body weight changes at first, third, and sixth month of lactation. Secondary outcome was to evaluate any possible correlations of these with maternal characteristics.

Study protocol

Data collection

At the initial meeting, study requirements were clearly explained to the participants and an information sheet was given describing the goals of the study. They were asked to sign a written informed consent form. Ethical approval was obtained by Harokopio University Ethics Committee.

Participants were asked to fill in a questionnaire with demographic, socio-economic, and obstetric data. Three home visits during the morning hours, were made by a member of the research group at first month (i.e.: 25-30 days postpartum) and at the beginning of the third and sixth month of lactation. Weight and height were measured with subjects wearing only underwear and using a digital electronic balance (range 0.1 - 150 Kg) and a tape measure (range 0 - 200 cm). Body mass index (BMI) (kg/m^2) was thus calculated.

Energy intake was assessed at first, third, and sixth month of lactation by giving lactating mothers a three-day dietary record to complete. Prior to diet-record keeping, the mothers were thoroughly instructed on how to fill in their food consumption, how to measure portions of food, and how important it was not to miss out any food or snack. They were also advised not to change their habitual diet during the three days of recording. Mothers recorded the type and amount of food and beverages consumed for two consecutive weekdays and one weekend day,

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using standard household measures (cups, tablespoons, etc). On site, a member of the research team reviewed the records with the respondent to clarify entries, number and size of servings, and forgotten foods. Clarification of foods involved the use of food models, pictures, and measuring devices.

Energy expenditure was assessed at the above time points by asking women in this study to fill in a short physical activity questionnaire (Harokopio physical activity questionnaire-HAPAQ). HAPAQ is a questionnaire that consists of 22 items, which examine physical activity of the respondent and is based on previous work done by Ainsworth *et al.* [4]. HAPAQ has been validated for both men and women by comparing its outcomes against the activity monitored by an accelerometer [5].

Data processing

Energy intake was estimated by using an appropriate diet analysis software to assess food intake data for their energy and macro-nutrient intake. Traditional Greek foods were also included in the food database.

Energy expenditure as estimated by HAPAQ was the sum of basal metabolic rate and physical activity cost. The energy cost for milk production was not included in the estimations of energy expenditure, due to great variations in women's reports regarding the duration of breastfeeding during the day. Energy intake and energy expenditure were both adjusted for body weight in order to evaluate their correlation with body weight changes.

Energy balance was determined by energy intake and energy expenditure, as defined previously without the energy cost for milk production. If EB is positive, this indicates that energy intake is greater than energy expenditure. If EB is positive and there is an established body weight loss of women during lactation, then this finding should be attributed to the energy cost for milk production, although it was not calculated and included in the energy expenditure estimation.

Pre-pregnancy weight (PPW) was derived from women's medical records and kept at the maternity hospitals where they delivered. Permission to access those records was secured from the clinic's executive board. PPW was taken as a baseline in order to estimate body weight changes at first, third, and sixth month of lactation. In addition, the rate of body weight change between the first and third and third and sixth month of lactation was calculated to assess body weight loss during lactation.

Statistical analysis

Descriptive characteristics of investigated variables were expressed as mean ± standard deviation. Correlation between EI and body weight changes with parameters of interest was evaluated by computing *Spearman's correlation coefficient*. Evaluation of body weight changes, EI, EE, and EB changes were calculated using *paired-samples t-test* and applying Bonferroni corrections to reduce the possibility of type II error. Comparisons were done in pairs because sample sizes were unequal at the three time points of measurement. Equality of means within the three measurements (first, third, and six months) for the parameters of interest was tested with *repeated measures analysis of variance (ANOVA).* The level of significance was defined at $p < 0.05$. Statistical analysis was performed using SPSS version 17.0 software.

Results

Population characteristics-EI and EE

Lactating mothers' mean age was 32.5 ± 3.1 years (25-39 years) and 78.1% were nulliparous. All subjects were married and almost all were employed (93.7%), while two-thirds (65.6%) had a university degree. Mothers' mean pre-pregnancy BMI (ppBMI) was 22.2 ± 4.1 kg/m^2 and 10/64 (15.6%) were classified as overweight or obese (BMI > 25). From the 64 mothers who entered the study, 39 (60.9%) continued to exclusively breastfeed up to the third month and only 24 (37.5%) up to the sixth month postpartum.

Lactating mothers' mean daily energy intake during the first, third, and sixth month of lactation was 1,999.8 ± 452.3 kcal, 2,031.7 ± 464.7 kcal, and 2,048.7 ± 558.8 kcal, respectively. Energy intake did not show any statistically significant difference among the three time points measured. The three-day dietary records indicated that protein contributed an average of 14.9%-16.2%, while lipids provided 36.5%-38.5% of the daily EI, with 16% being monounsaturated fat. Daily energy expenditure did not differ significantly among the three time points of the study (Table 1).

Table 1. — *Energy intake, energy expenditure, and energy balance at first, third, and sixth month of lactation (results obtained from repeated measures ANOVA). The energy cost of lactation was not included.*

	1st month (n = 64)	3rd month (n = 39)	6th month (n = 24)	*p* value
Energy intake (kcal)	1,999.8 ± 452.3	2,031.7 ± 464.7	2,048.7 ± 558.8	NS
Energy expenditure (kcal)	1,865.7 ± 315.8	1,866.8 ± 375.1	1,882.8 ± 326.8	NS
Energy balance (kcal)	134.1 ± 548.3	164.9 ± 480.2	165.9 ± 583.2	NS

*NS = Non significant ($p > 0.05$).

Table 2. — *Body weight changes at first (n = 64), third (n = 39), and sixth (n = 24) month of lactation.*

First month of lactation (n = 64)		
	1st month (B_1)	*p* value
Weight (kg)	68.7 ± 15.4	
B_1-PPW (kg)	6.6 ± 4.9	< 0.001
B_1-Weight at delivery (kg)	-8.5 ± 2.9	< 0.001

Third month of lactation (n = 39)			
	1st month (B_1)	3rd month	*p* value
Weight (kg)	68.6 ± 12.5	67.2 ± 12.8	NS
Weight-PPW (kg)	5.7 ± 5.1	5.3 ± 4.7	0.001
Weight-Weight at delivery (kg)	-8.4 ± 2.6	-9.8 ± 3.4	0.001
EI (kcal)	2,023.9 ± 402.8	2,031.7 ± 464.7	NS
EE (kcal)	1,863.1 ± 343.9	1,866.8 ± 375.1	NS
EB (kcal)	160.8 ± 508.6	164.9 ± 480.2	NS

Sixth month of lactation (n = 24)				
	1st month	3rd month	6th month	*p* value
Weight (kg)	69.1 ± 8.8	67.4 ± 9.1	66.3 ± 11.7	0.03
Weight-PPW (kg)	5.5 ± 5.9	3.9 ± 5.4	2.8 ± 4.9	0.02
Weight-Weight at delivery (kg)	-8.2 ± 2.6	-9.8 ± 3.8	-11.1 ± 4.1	0.04
EI (kcal)	2,048.7 ± 558.8	2,464.2 ± 456.8	2,048.7 ± 558.8	NS
EE (kcal)	1,882.8 ± 326.8	1,918.2 ± 323.9	1,882.8 ± 326.8	NS
EB (kcal)	317.6 ± 466.3	545.9 ± 448.4	182.7 ± 667.6	NS

*NS = Non significant ($p > 0.05$).

Body weight changes during lactation

The 64 women that were recruited for the study had a mean PPW of B_{pp} = 62.2 ± 11.5 kg (45 - 106). Mean weight increase during pregnancy was 15 ± 5.9 kg (0 -

30). The mean weight increase between the first month postpartum and their PPW was 6.6 ± 4.9 kg ($p < 0.001$). The 39 mothers who continued to breastfeed until the third month postpartum had a mean PPW of B_{pp} = 62.9 ± 13.2 kg (45 - 106). The mean weight increase between the third month and PPW was 5.3 ± 4.7 kg ($p < 0.001$). By the third month mothers were weighing an average of 1.5 ± 2.4 kg less than during the first month of lactation ($p = 0.004$). In other words, weight loss for women who continued to breastfeed (n = 39) during the first trimester was significant and was estimated to be 0.7 kg/month. Finally, the 24 mothers who continued to breastfeed their babies for six months had a mean PPW of B_{pp} = 63.5 ± 13.1 kg (47 - 106). The mean weight increase between the sixth month of lactation and PPW was 2.8 ± 4.9 kg ($p = 0.02$). At six months mothers were weighing an average of 1.3 ± 2.5 kg less than during the third month of lactation (NS: $p = 0.06$). This signifies that weight loss during the second trimester postpartum for women who continued to breastfeed (n = 24) until the sixth month was non-statistically significant and was shown to be 0.5 kg/month. Mothers' BMI at first, third, and sixth month postpartum was 24.6 ± 4 kg/m^2, 24.2 ± 4.5 kg/m^2, and 23.5 ± 3.5 kg/m^2, respectively. It is noteworthy that BMI changes are also significant during the first three months of lactation ($p < 0.001$), whereas they do not manage to gain statistical significance over the second trimester. During the first six months postpartum, women managed to lose an average of 85.6% of the weight gained during pregnancy.

Correlations

Spearman's correlation coefficients were used to correlate energy intake and body weight changes with maternal characteristics. Energy intake was correlated positively at first month of lactation with parity and negatively with the weight increase during pregnancy. There were no significant correlations with age, educational level, number of cigarettes smoked, and ppBMI. Weight change at the end of the first, third, and sixth month of lactation in comparison to PPW had a significant positive correlation with the number of cigarettes smoked per day. There was also a significant negative correlation with PPW and ppBMI, and finally a significant positive correlation with the weight increase during pregnancy. There were no significant correlations with age, educational level, and number of children.

Discussion

This study was conducted in a sample of 64 mothers, who were exclusively breastfeeding their infants for a time period of six months. In this group, 60.9% (39/64) continued to exclusively breastfeed up to the third month and 37.5% (24/64) up to the sixth month postpartum. Samples of similar size have also been reported by other researchers in the past for the same follow-up period of six months [6, 7].

This study is one of very few studies designed to assess the EI, EE, and weight changes of south-Mediterranean lactating mothers. Specifically, daily EI was found to be an average of 1,970 - 2,100 kcal (28 - 31 kcal/kg,) similar to the EI mentioned in studies from other countries [6, 8-10]. Maternal EI well-covered what is considered to be the energy requirements during exclusive breastfeeding [11-13]. It was also noted that mothers had a relatively high daily fat intake of 36.5% - 38.5% of EI, while 16% was monounsaturated fat, probably due to the variety of foods consumed by the mothers of the sample, which were rich in monounsaturated and total fat. These findings are in accordance with literature concerning other south European populations' habitual diets [14]. The mean daily EE (energy cost of milk production not included) was approximately 1,870 kcal during the first six months of lactation, and did not differ significantly throughout the study period. In other studies as well, EE was also similar throughout the entire period of lactation [8].

Results show that over the six-month period, mothers of the sample had a positive energy balance. Nevertheless, a significant weight loss was indeed achieved at the end of the six-month period of 11.1 ± 4.1 kg in comparison to the body weight women had at their delivery (Table 2). During the first six months postpartum, it was estimated that women managed to lose an average of 85.6% of the weight gained during pregnancy. However, at the end of the six months women retained an average of 2.8 ± 4.9 kg in comparison to their pp weight. This finding is in accordance with other reports, which indicates that mothers do return to their pp weight after longer than six month periods of observation (9, 12, or 18 months postpartum) [15-17]. Statistical analysis showed that women had a significant weight loss of 0.7 kg/month during the first trimester of lactation, which was followed by a non-significant weight loss of 0.5 kg/month during the second trimester of lactation. This degree of weight loss is also in accordance with previous findings [18]. Weight loss of ~0.5 kg/month during lactation is considered to be common and safe [19]. Furthermore, a review of 17 studies has shown that well-nourished mothers lose weight with a rate of 0.8 kg/month, while undernourished ones with a rate of only 0.1 kg/month [20]. In literature, mothers lose more weight during the second trimester of lactation and not during the first trimester as the present study showed [15, 21]. In those reports however, larger cohort samples were used. Perhaps if a larger number of women had continued to breastfeed (> 24/64) beyond the third month postpartum in this study, then statistical significance might have also been achieved for weight loss in the second trimester.

The fact that mean energy balance was kept positive throughout the entire study period, but at the same time women were losing weight, leads to the conclusion that this weight loss was probably due to the energy cost of lactation, which was not measured in this protocol. On review of literature, during the first six months of exclusive breastfeeding, mean daily energy cost for milk production is estimated to be approximately 2,800 KJ (or 675 kcal) [22, 23] and mean daily breast milk production is considered similar among women of different cultural and socio-economic background [6].

The present study bears some limitations and constraints that need to be addressed. Firstly, a random sample was used which was restrained to women who gave birth at the area of the capital, Athens. Secondly, an additional limitation was the small sample size. The study initially recruited 64 women, however only 24 of them continued breastfeeding and hence remained in the study until the end. Other similar studies, which also did not use a control group and followed up mothers for ≤ six months, had larger sample sizes [16, 18, 24]. Next, the energy expenditure was not measured by experimental methods, as in previous studies, but with use of physical activity questionnaires, where energy cost of lactation was not measured. Concerning the use of three-day dietary records, it is generally highly-regarded for its validity by numerous researchers that have used them for similar studies [10, 25]. However, there is always the risk of under-reporting foods with a low nutrient density and over-reporting "healthy" food groups, especially by women who are overweight [23]. Such discrepancies together with the large number of tests carried out and the small sample size may have resulted in type I error and findings that may not be entirely applicable to a representative population [26].

On literature review and to the best of the authors' knowledge, this study is the first to assess the EI, EE, and weight changes of Greek mothers who exclusively breastfed for the first six months postpartum. Therefore it provides additional knowledge with regards to the changes of EI throughout the lactation period, an issue that was not fully investigated by previous research. This study has shown that in exclusively breastfeeding women with usual physical activity postpartum, normal energy intake, and without basal metabolic rate disorders, EE comprising of basal metabolic rate and physical activity almost fully compensates EI. The authors can presume therefore that weight loss recorded postpartum in exclusive breastfeeding women can be attributed to the energy cost of lactation.

The practical implications of this study includes the fact that health professionals have additional data to properly counsel women to follow an appropriate diet without exaggerations in dietary EI and to perform normal physical activity. Hypocaloric diets and excessive physical activity may be well-avoided during exclusive breastfeeding, since they are not necessary for weight loss purposes. In this way mothers do not need to follow strict diets, the amount and quality of breast milk is not disrupted, and weight loss can be achieved as part of the natural process of energy cost of lactation.

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