Global Advanced Research Journal of Physical and Applied Sciences Vol. 3(2) pp. 025-030, July, 2014
Available online http://www.garj.org/garjpas/index.htm

Full Length Research Paper

Relationships between maternal nutritional status, quantity and composition of breast milk in Egypt

Salwa M. Soliman [1], Abdelmohsen M. Soliman[2*], Mohamed S. Bakr[3]

[1]Food Sciences and Nutrition Department
[2]Therapeutic Chemistry Department, National Research Centre, Dokki, Cairo, Egypt
[3]Pediatric Department, Al Sahel Teaching Hospital, Cairo, Egypt

Accepted 04 March, 2014

The relationships between maternal nutritional status and volume and composition of mother's milk and its reflection on the infant were studied in fifty seven mothers, attending in child Welfare Clinic IN Ain Shams University Hospital and El Sahel Teaching Hospital. Two sets of analysis were performed. The first one was to assess the production of milk of moderately nourished mothers. The second one was undertaken to determine whether changes in nutritional status within individual woman affected their milk production. Mother and infant anthropometric measures were recorded monthly through the first 4 months of location. The amount of milk, fat, lactose and protein concentrations were measured by test weighing method, Gerber method, gravimetric method and micro-Kjeldahl method respectively. The metabolic energy concentration of milk specimen was calculated. The present study showed that milk production increased gradually through the time of the study. Milk, fat and protein concentration showed gradual decrease with increasing infant age, while lactose concentration showed progressive increase. The positive effects of breast feeding on the health of infants have been increasingly recognized, particularly for those in developing countries. Concurrently, interest in factors that influence the production of milk of mothers from less privileged countries has been of particular concern because a sizable portion of these women are marginally nourished or at times frankly undernourished. Conclusion: The quantity and quality of milk produced by mothers studied, considering their level of under nutrition were remarkably good, with milk amount and energy concentration only mildly less than well nourished mothers.

Keywords: maternal nutrition, Breast milk, anthropometric measures

INTRODUCTION

A mother's capacity to produce milk of sufficient quantity and quality to support infant growth is resilient and remarkably resistant to nutritional deprivation (Allen 1994). However, milk production normally affects maternal body composition (Brown and Dewey 1992), nutritional status (Dewey 1997) and lactating women have increased nutrient demands (González et al, 1998).

The changes in maternal nutritional status during lactation, effect of maternal nutrition on milk volume and composition, and nutrient requirements of lactating women are reviewed here.

Maternal nutritional status

Lactation is supported partially by mobilization of tissue stores (Lawrence 1994). This, in turn, affects maternal weight and nutritional status (Krasovec et al, 1991).

*Corresponding author Email: solimanmohsen@yahoo.com

Body weight — Postpartum weight changes in lactating women are highly variable (Brewer et al, 1989). Mild, gradual weight loss typically occurs during the first six months postpartum (Brown et al, 1986). Average weight loss in this period is greater in affluent than poor populations (0.8 versus 0.1 kg per month). These differences are thought to depend upon differences in weight gain in pregnancy, cultural practices, level of physical activity, and availability of food (Linkages 1999).

Gestational weight gain is the most consistent and strongest predictor of postpartum weight change in most studies (Butte 1984). Other factors that contribute to weight loss after pregnancy include pregnancy weight, age, parity, race, smoking, exercise, return to work outside the home, and lactation (Merchant et al, 1990).

Morales and Schanler (2007) and Onis et al (2009), indicated that "given emotional support and favorable circumstances, 96 % of new mothers can breast feed successfully".

This work aims at studying the relationships between maternal nutritional status and volume and composition of mother's milk and its reflection on the infant. This will be done by examining the extent to which varying levels of nutritional status of different mothers can explain the variation in the milk production and consequently infant growth. This work will also study the effect of ongoing changes within individual maternal nutritional status and its practical implication on lactation.

MATERIALS AND METHODS

- Participants in the study were recruited from a group of mothers, attending the Child Welfare Clinic in Ain Shams University Hospital and El Sahel Teaching Hospital.
- Fifty seven mothers were followed regularly.
- All were moderately healthy with no chronic illness.
- All were pimiparous, and none was receiving hormonal contraceptives.
- Infant's age ranged from 2-3 weeks at time of entry into the study. All were exclusively breast fed.
- Mother infant pairs remained in hospital for around one and a half day for each time of admission.
- Mother's weight, height, left arm circumference, and left triceps skinfold thickness were measured.
- Mother's hematocrite and serum albumin were measured.
- Anthropometric measures of the baby were recorded, including weight, recumbent length, head circumference and chest circumference.
- A morning mid-fed milk sample was analysed for milk fat by Gerber method, milk protein by semi-micro-Kjeldahl method and milk lactose by gravimetric method. The metabolic energy concentration of milk specimen was calculated.
- The amount of milk consumed was measured by test weighing method.
- Infants were followed bi-monthly for growth chart determination.
- Mother-Infant pairs were admitted monthly for 3 more times for determination of milk volume, analysis of milk samples and determination of anthropometric measures.

RESULTS

Results of this study were presented in the tables and figures correlating the different data.

Statistics on mother's weight, height, arm circumference and triceps skinfold thickness, hematocrite percent and serum albumin were presented in table (1) as mean + S.D. Data for all milk variables were plotted by infant age to characterize the change by stage of location as shown in table (2). It was apparent that milk amount increased with infant age. Milk fat concentration decreased gradually as the infant grew. Milk protein concentration declined more rapidly than milk fat pattern. Milk lactose displayed the opposite pattern as it increased gradually with infant age. With these trends, milk energy concentration decreased linearly.

The effects of maternal nutritional status on milk production were first examined by comparing the mean values for all milk variables among women at different age intervals of infants (< 2 months and > 2 months). As presented in tables (3) and (4), milk fat and energy concentrations were greater in mothers with larger arm circumference and triceps skinfold thickness during both age intervals. By analysis of variance (A.N.O.V.A) and F test, there were statistically significant relationships between maternal anthropometric measures and milk fat and energy concentrations ($P < 0.01$) during both age intervals; but it was significant for milk protein and lactose ($P < 0.05$) for younger age group only. For age group > 2 months, there were no significant relationships between maternal anthropometric measures and milk protein and lactose concentration, except for maternal T.C.S.F and milk lactose concentrations ($P < 0.05$).

To study the effects of changes in maternal nutritional status within individual mothers on their milk amount and milk constituents, mothers were classified according to their initial weight (greater or lesser than 64 kg. which was the median value) and their changes in nutritional status during two infant age intervals < 2 months and > 2 months. Mean values for milk variables i.e. milk amount and milk concentrations of protein, lactose and energy were compared for each category as shown in table (5). By analysis of variance (A.N.O.V.A) and "T" test, it was found that there was significant difference between the two groups of change in maternal weight (< 0.5 kg. and > 0.5 kg.) for milk volume per day ($P > 0.01$). On the other hand, there was no significant difference for milk fat,

Table 1 Anthropometric characteristics, hematocrite values and serum albumin concentrations of mothers: (n=57):

Clinical Characteristics	Mean ± S.D.	Minimum	Maximum
Weight (kg.)	64.0 ± 11.01	35	87
Height (cm.)	157.19 ± 4.69	143	169
A.C. (cm.)	26.97 ± 4.29	18	35.5
T.C.S.F. (mm)	16.10 ± 5.46	5.8	24.3
Hematocrite %	35.27 ± 3.19	17	40
Serum Albumin (g/dl)	4.30 ± 0.40	3.0	4.9

Table 2 Milk amount per –day and milk concentrations of fat, protein, lactose and energy by infant age:

Month	No. of Infants	Milk amount (g/day) Mean ± S.D.	Fat Concentration (g/dl) Mean ± S.D.	Protein Concentration (g/dl) Mean ± S.D.	Lactose Concentration (g/dl) Mean ± S.D.	Energy Concentration (Kcal/dl) Mean ± S.D.	Energy amount (Kcal/day) Mean
1	57	694.04 ± 91.4	3.48 ± 0.48	1.26 ± 0.12	7.38 ± 0.55	66.01 ± 3.30	458.14
2	57	767.72 ± 83.67	3.33 ± 0.43	1.18 ± 0.13	7.65 ± 0.52	65.38 ± 3.09	501.94
3	57	855.61 ± 89.02	3.21 ± 0.40	1.10 ± 0.11	7.87 ± 0.47	64.70 ± 3.11	553.58
4	57	936.40 ± 73.62	3.06 ± 0.36	1.02 ± 0.09	8.08 ± 0.43	63.9 ± 2.8	595.36

Table 3 Concentrations of milk fat, protein, lactose, and energy by maternal A.C. and infant age interval:

Age & A.C.	(Mothers) Maternal (cm)	No. of Cases	Fat Concentration (g/dl) Mean ± S.D.	Protein Concentration (g/dl) Mean ± S.D.	Lactose Concentration (g/dl) Mean ± S.D.	Energy Concentration (Kcal/dl) Mean ± S.D.
≤ 2m:			X	xx	xx	X
A.C.	< 27	55	3.18 ± 0.23	1.19 ± 0.11	7.64 ± 0.42	64.00 ± 2.46
A.C.	27 - 29	23	3.36 ± 0.53	1.27 ± 0.18	7.58 ± 0.42	65.65 ± 2.34
A.C.	29	36	3.79 ± 0.58	1.23 ± 0.11	7.30 ± 0.72	68.28 ± 2.99
		114				
> 2m:			X	xxx	xxx	X
A.C.	< 27	54	2.94 ± 0.21	1.05 ± 0.12	8.05 ± 0.46	62.83 ± 2.12
A.C.	27 – 29	24	3.10 ± 0.16	1.07 ± 0.08	7.98 ±0.39	64.11 ± 1.89
A.C.	> 29	36	3.45 ± 0.47	1.07 ± 0.10	7.85 ± 0.48	66.52 ± 2.76
		114				

X : P 0.01
xx : P 0.05
xxx : P not significant

protein, lactose and energy conc. between the two groups as shown by A.N.O.V.A and "T" test.

It was found that there was positive coefficient correlation between milk amount and maternal weight (P < 0.01), milk amount and infant weight (P < 0.01) and milk amount and maternal weight (P < 0.01), Table (6).

Infant anthropometric measures were presented as mean + S.D. infants showed satisfactory growth during the period of study, table (7). Three of them suffered from gastro-enteritis attacks which were mild and did not necessitate admission to hospital.

Also, there were significant positive relationships between maternal nutritional status (arm circumference and triceps skinfold thickness) and milk composition namely, fat and energy concentration of both age intervals (< 2 months and > 2 months) and protein and lactose for the younger age group only (< 2 months). This study demonstrated that increasing maternal weight resulted in increasing milk volume but not milk constituents.

DISCUSSION

The present study was performed to determine how and to what extent maternal nutritional status can be related

Table 4 Concentrations of milk fat, protein, lactose, and energy by maternal T.C.S.F. and infant age interval:

Age & T.C.S.F.	(Mothers) Maternal (mm)	No. of Cases	Fat Concentration (g/dl) Mean ± S.D.	Protein Concentration (g/dl) Mean ± S.D.	Lactose Concentration (g/dl) Mean ± S.D.	Energy Concentration (Kcal/dl) Mean ± S.D.
≤ 2m:			x	xx	xx	x
T.C.S.F.	< 16	52	3.19 ± 0.26	1.19 ± 0.11	7.63 ± 0.41	64.10 ± 2.57
T.C.S.F.	16 – 18	15	3.30 ± 0.23	1.30 ± 0.24	7.65 ± 0.41	65.50 ± 2.50
T.C.S.F.	> 18	47	3.68 ± 0.54	1.22 ± 0.09	7.36 ± 0.68	67.53 ± 3.10
		114				
> 2m:			x	xxx	xx	x
T.C.S.F.	< 16	52	2.94 ± 0.21	1.06 ± 0.12	8.05 ± 0.42	62.88 ± 2.07
T.C.S.F.	16 – 18	14	2.31 ± 0.21	1.08 ± 0.09	8.11 ± 0.39	63.79 ± 2.30
T.C.S.F.	> 18	48	3.38 ± 0.43	1.07 ± 0.09	7.84 ± 0.49	66.09 ± 3.16
		114				

x : P 0.01
xx : P 0.05
xxx : P not significant

Table 5 Amount of milk per day and concentration of milk fat, protein, lactose and energy by initial maternal weight and change in maternal weight during period of observation, infants were three months of age (n=57):

Milk Component & Initial Maternal Weight (kg.)	Change In Maternal Weight (kg.)	
	< 0.5	≥ 0.5
x Milk Amount (g/day): < 64 ≥ 64	 740.0 ± 80.0 (9) 860.56 ± 55.25 (18)	 871.18 ± 75.98 (17) 908.46 ± 85.23 (13)
xxx Milk Fat (g/dl): < 64 ≥ 64	 2.98 ± 0.14 (9) 3.36 ± 0.31 (18)	 3.02 ± 0.24 (17) 3.40 ± 0.58 (13)
xxx Milk Protein (g/dl): < 64 ≥ 64	 1.01 ± 0.11 (9) 1.12 ± 0.10 (18)	 1.12 ± 0.13 (17) 1.12 ± 0.05 (13)
xxx Milk Lactose (g/dl): < 64 ≥ 64	 8.12 ± 0.36 (9) 7.77 ± 0.47 (18)	 7.84 ± 0.49 (17) 7.88 ± 0.44 (13)
xxx Milk Energy (Kcal/dl): < 64 ≥ 64	 63.4 ± 1.49 (9) 65.66 ± 2.24 (18)	 62.92 ± 2.47 (17) 66.61 ± 4.17 (13)

x : P 0.01
xx : P 0.05
xxx : P not significant

Table 6 Multiple regression analysis of milk amount (9/day) on infant weight, maternal weight and arm circumference:

Independent Variables	No.	Mean ± S.D.	P
Infant Weight	228	5.22 ± 1.13	< 0.01
Maternal Weight	228	64.36 ± 10.85	< 0.01
Maternal A.C.	228	27.07 ± 3.99	< 0.01

to the production of human milk. Breast milk amount and concentration of milk fat, protein, lactose and energy produced by mothers of moderate to low socio-economic class and the changes in milk production by stage of

Table 7 Anthropometric measures of infants i.e. weight, recumbent length, H.C. and C.C. as reported monthly

Month	Weight (kg.) Mean ± S.D.	Recumbent Length (cm.) Mean ± S.D.	Head Circumference (cm.) Mean ± S.D.	Chest Circumference (cm.) Mean ± S.D.
1	4.18 ± 0.66	53.60 ± 1.86	36.45 ± 0.84	36.21 ± 0.83
2	4.995 ± 0.65	56.35 ± 1.92	37.76 ± 0.90	37.68 ± 0.90
3	5.83 ± 0.73	59.00 ± 1.96	39.1 ± 0.88	39.11 ± 0.88
4	6.71 ± 0.67	61.50 ± 1.95	40.35 ± 0.84	40.43 ± 0.81

lactation were determined. Follow up of anthropometric measures of infants were done. Test weightings were carried out for 24 hour periods. All mothers were primipara, so parity did not influence the results. Infant age was controlled by grouping infants into these < 2 months and these > 2 months. The study was performed in a pediatric ward and mothers were allowed to live socially as if at home.

The anthropometric and laboratory data indicated that on average, these mothers were more or less moderately undernourished. The pattern of milk production at different stages of lactation was similar to that reported by Picciano (2001), Butte et al. (1984) and Brown et al. (1986). Milk production increased gradually throughout the time of study to reach a mean value of 936 ml/day at the 4 month. Daily milk output in well nourished mothers ranged from 600-900 ml/day for the first six months of lactation (Morbacher and Stock, 1997). Milk volume seemed to be lowest in communities with poor levels of nutrition and with inadequate living conditions (Naing 1987). Brown et al. (1986) found that milk output was 90 % that of well nourished mothers.

In the present study, it was found that there was positive coefficient correlation between weight and milk production, beside positive coefficient correlation between maternal arm circumference and milk production. The progressive decrease in fat concentration with increasing infant age, as observed in the present study, was consistent with the findings of other studies by Lozano (2007), Butte et al. (1984) and Brown et al. (1986). Hammam (1986) found that mean value of fat concentration was 4.66 g/dl in Egypt. Hamada (1988) reported a level of 5.68 g/dl in Egypt. The protein concentration in the present study was 1.26 g/dl in the first month and 1.02 g/dl in the fourth month. Butte et al. (1984) described similar pattern.

The pattern of increase of lactose concentration with infant age in the present study was similar to that reported by Brown et al. (1986) and Schanler (2011). A mean level of 7.38g/dl in the first month and 8.08 g/dl in the fourth month were obtained. Hammam (1986) reported a level of 8.51 g/dl. Sisk et al. (2006) found that lactose concentration was significantly higher regarding the underweight group.

The present study showed that there were significant positive relationships between maternal status (arm circumference and triceps skinfold thickness) and milk quantity and chemical and chemical composition namely; fat and energy concentration at both two age intervals (> 2 months and > 2 months) and protein and lactose for younger age group (< 2 months) only. Brown et al. (1986) found also that there was significant positive relationship between arm circumference and triceps skin fold and milk fat. The present study demonstrated that increasing maternal weight resulted in increase in milk production but not milk constituents: fat, protein, lactose or energy. Brown et al (1986) found that increasing maternal weight improved milk production, milk protein and energy which were not the case in the present study. Sisk et al. (2009) studied macronutrient content of milk samples and found that there was no significant change in milk fat, protein or lactose concentration during increasing milk production. Actually, the nutritional statuses of mothers of the present study were mildly disturbed.

CONCLUSION

From the present study, it can be concluded that the quantity and quality of milk produced by mothers studied, considering their level of under nutrition were remarkably good, with milk amount and energy concentration only mildly less than well nourished mothers. Nevertheless, the data indicated that the potential level of milk production could be increased by improving maternal nutritional status. Thus, efforts to improve the nutritional status of marginally nourished mothers should be rewarded with enhanced milk production.

REFERENCES

Brewer MM, Bates MR, Vannoy LP (1989). Postpartum changes in maternal weight and body fat depots in lactating vs nonlactating women. Am. J. Clin. Nutr. 49: 259-265.

Butte NF, Garza C, Stuff JE, Smith EO, Nichols BL (1984). Effect of maternal diet and body composition on lactational performance. Am. J. Clin. Nutr. 39: 296-306.

de Onis M, Garza C, Onyango AW, Rolland-Cachera MF (2009). le Comité de nutrition de la Société française de pédiatrie. [WHO growth standards for infants and young children]. Arch. Pediatr., 16: 47-53.

Dewey KG(1997). Energy and protein requirements during lactation. Ann. Rev. Nut. , 17: 19-36.

González-Cossío T, Habicht JP, Rasmussen KM, Delgado HL (1998). Impact of food supplementation during lactation on infant breast-milk intake and on the proportion of infants exclusively breast-fed. J. Nut., 128: 1692-1702.

Hamada NAE (1988). M Sc Thesis (Pediatrics), El-Ashar University.

Hammam AH (1986). M Sc Thesis (Nutrition), Ain Shams University,

Women College.
Krasovec K, Labbok MH, Queenan JT (eds) (1991). Breastfeeding and borderline malnutrition in women. Journal of Tropical Pediatrics 37 (suppl 1).
Lawrence RA (1994). Breastfeeding: A Guide for the Medical Profession, 4th edition. Mosby: St. Louis.
Linkages (1999). Recommended Feeding and Dietary Practices to Improve Infant and Maternal Nutrition, Academy for Educational Development: Washington, DC.
Lozano de la Torre MJ (2007). [New growth references of the World Health Organization based on breast fed infants]. An Pediatr (Barc). 66: 177-83.
Merchant K, Martorell R, Haas J (1990). Maternal and fetal responses to the stresses of lactation concurrent with pregnancy and of short recuperative intervals. Am. J. Clin. Nut., 52: 280-288.
Morales Y, Schanler RJ (2007). Human milk and clinical outcomes in VLBW infants: how compelling is the evidence of benefit? Semin. Perinatol., 31: 83-8.
Morbacher N, Stock J (1997). The Breastfeeding Answer Book (revised edition). Schaumburg, IL: La Leche League International.
Naing KM, Oo TT (1987). Effect of dietary supplementation on lactation performance of undernourished Burmese mothers. Food and Nutrition Bulletin., 9, 59-61.
Picciano MF (2001). Nutrient composition of human milk. Pediatr. Clin. North. Am., 48: 53-58.
Schanler RJ (2011). Outcomes of human milk-fed premature infants. Semin Perinatol., 35: 29-33.
Sisk PM, Lovelady CA, Dillard RG, Gruber KJ (2006). Lactation counseling for mothers of very low birth weight infants: effect on maternal anxiety and infant intake of human milk. Pediatrics., 117, 67-75.
Sisk PM, Lovelady CA, Dillard RG, Gruber KJ, O'Shea TM (2009). Maternal and infant characteristics associated with human milk feeding in very low birth weight infants. J Hum Lact., 25, 412-9.