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ORIGINAL ARTICLE

IMPACT OF FEEDING PRACTICES, MATERNAL DIETARY HABITS AND MATERNAL BODY MASS INDEX ON GROWTH PATTERN IN BREAST-FED AND FORMULA-FED INFANTS

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ABSTRACT

OBJECTIVE: To assess the influence of feeding practices, maternal dietary habits and maternal body mass index (BMI) on growth pattern of breast-fed and formula-fed infants.

METHODS: This cross-sectional study was performed on 50 healthy infants. Twenty-five each breast-fed (BF) and formula-fed (FF) infants along with their mothers were enrolled. The infants' weight, height, BMI, head circumference and skinfolds (biceps and triceps) were recorded. Infant's mother weight, height, BMI, mid-arm circumference and skinfolds were also recorded. The mothers filled 24-hours dietary-recall proforma. The 24-hours dietary-recall was then analyzed by windiet® software.

RESULTS: Age of infants was 78.40±35.88 days at time of assessment. Height and weight standard deviation score (SDS) was found to be -2.759±3.10 and -0.538±2.05 with SDS of BMI was 1.59±2.30. Mean anthropometric measurements between the two groups were not significantly different except for head circumference (BF=38.12±4.46, FF=40.32±2.34; p-value=0.036). BMI and age of mothers were 26.49±4.93 kg/m^2 and 29.54±2.86 years at assessment. Anthropometric analysis of mothers showed an increasing trend of different parameters especially waist circumference (cm) in breast-feeding mothers (lactating=75±15.6, non-lactating=61±18.2, p-value=0.007). Dietary intake of lactating mothers (energy=3032±12 Kcal; % energy intake=125.9±53.3) was more as compared to non-lactating mothers (1878±99 Kcal; % energy intake=78±41.2). Similarly intake of carbohydrates (lactating=414±186, non-lactating=274±175), fats (lactating=109±60.4, non-lactating=66.6±33.7), proteins (lactating=98.2±52.5, non-lactating=60.2±54.2), zinc (lactating=14.64±7.28, non-lactating=8.08±8.53), selenium (lactating=30.4±22.3, non-lactating=4.12±7.64) and dietary fiber (lactating=41.3±19.5, non-lactating=20.4±15.5) were significantly different.

CONCLUSION: Growth pattern of both breast-fed and formula-fed infants were not significantly different. Energy intake, percentage energy intake and intake of macronutrients & micronutrients are more in lactating mothers.

KEY WORDS: Breast Feeding (MeSH); Lactation (MeSH); Non-lactating (Non-MeSH); Bottle Feeding (MeSH); Body Mass Index (MeSH); Dietary Record (MeSH); Dietary Recall (Non-MeSH); Feeding Behavior (MeSH); Feeding practices (Non-MeSH); Dieting Behavior (MeSH); Eating (MeSH); Diet (MeSH).

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INTRODUCTION

Mother and infant's health are influenced by the dietary habits of the breastfeeding females. Malnutrition is one of the major causes of childhood mortality in early infancy.[1-3] Infants up to the age of 6 months get most of their essential macronutrients and many micronutrients from the mother milk in majority of cases and even the non-nutritive oligosaccharides of breast-fed milk contribute to infant health and body composition in early years of life.[4] For instance the levels of glucose and insulin in mother milk are the positive predictor for adiposity in infants who are borne to non-diabetic mothers.[5] It is evident from literature that body mass index (BMI) is a better indicator of body composition during early infancy. Prompt weight gain at infancy is also related to childhood obesity by the researchers.[6] In the year 2006 World Health Organization (WHO) marketed BMI-for-age growth charts for children aged less than 2 years which are obsolete for pediatric use in routine nowadays.[7] When growth indices (weight for age, length for age and weight for length) of both formula fed (FF) and breast-fed infant (BFI) were compared it was observed that in BFI at one, two and three months they were significantly higher whereas in formula-fed infants (FFI) only weight for age was significantly higher at one month interval up to 6 months and both the groups of infants exhibit different growth pattern during first 12 months of life.[8] It has been reported that breast feeding reduces the risk of obesity in infants but there are some research based evidence that point towards the fact that babies fed with mother milk show significant weight gain in first month and maintained it for the whole period of lactation and needs further exploration.[9,10]

Accrual of body fat is one of the outcomes of pregnancy, mothers are

TABLE I: ANTHROPOMETRIC CHARACTERISTICS OF INFANTS

Variables	Mean	SD
Height (cm)	53.420	5.845
Weight (kg)	5.374	1.013
Age at Assessment (days)	78.40	35.88
SDS_height	-2.759	3.106
SDS_weight	-0.538	2.056
BMI (kg/m^2)	19.175	4.115
SDS_BMI	1.598	2.309

SDS = Standard deviation score; BMI = Body Mass Index;

TABLE II: MEAN DIFFERENCES IN THE DIETARY CHARACTERISTICS OF LACTATING AND NON-LACTATING MOTHERS

Variables	Lactating mothers		Non-Lactating mothers		P-value§
	Mean	SD	Mean	SD	
Energy (Kcal)	3032	1284	1878	992	0.001**
% Energy intake	125.9	53.3	78	41.2	0.001**
Carbohydrate (g)	414	186	274	175	0.008**
Carbohydrate % intake	54.7	10.9	54.76	9.78	0.972
Fat (g)	109	60.4	66.6	33.7	0.004**
Fat % intake	31.5	11.4	33.0	12.6	0.659
Protein (g)	98.2	52.5	60.2	54.2	0.015*
Protein % intake	13.82	4.39	12.27	4.42	0.220
Zinc (mg)	14.64	7.28	8.08	8.53	0.005**
Iron (mg)	20.06	7.39	25.0	48.4	0.616
Vitamin A (µg)	1211	2106	446	279	0.085
Selenium (µg)	30.4	22.3	4.12	7.64	0.000***
Dietary Fiber (g)	41.3	19.5	20.4	15.5	0.000***

Significant levels (*P<0.05, **P=<0.01, ***P<0.0001); § = Independent sample t-test

TABLE III: MEAN DIFFERENCES IN ANTHROPOMETRIC PARAMETERS BETWEEN BREAST-FED AND FORMULA-FED INFANTS

Variables	Breast-fed infants		Formula-fed infants		P-value§
	Mean	SDS	Mean	SDS	
Head circumference (cm)	38.12	4.46	40.32	2.36	0.036*
Biceps (mm)	0.14	0.05	0.14	0.05	0.78
Triceps (mm)	0.15	0.06	0.14	0.05	0.63
BMI_SDS	1.25	2.41	1.94	2.19	0.29
SDS_height	-0.65	3.67	-0.86	2.49	0.81
SDS_weight	-0.76	2.49	-0.31	1.53	0.44

Significant levels (*P<0.05); SDS = Standard deviation score, BMI = Body Mass Index; § = Independent sample t-test

anxious to regain their pre-pregnancy status rephrased. Researchers have yielded that lactation is an efficient mean of weight loss in postpartum period due to high-energy expenditure.[11] Hatsu, et al.[12] in 2008 elaborated the effect of breastfeeding on maternal body composition. Exclusive breast feeding, has more pronounced impact in some cases on mother's weight gain during pregnancy as the percent body fat loss in mixed feeding mothers is more when compared with exclusively breast feeding, due to more caloric intake in breast feeding group as compared to mixed feeding group. Moreover, the physical activity was higher in mixed feeding group than in breast feeding group.[12] Anthropometric parameters of the breast feeding mothers when taken after one month postpartum in study of Kramer, et al.[13] revealed that the hip circumference is significantly reduced in breast feeding as compared with formula feeding mothers. Furthermore, infant's feeding practices influence anthropometric changes in postpartum women.[13] To ascertain the effect of feeding practices on infant's body composition and also to investigate how BMI of lactating and non-lactating mothers respond to these practices this study was carried out.

METHODS

This cross sectional study was carried out in district Peshawar, Khyber Pakhtunkhwa Pakistan. The study was approved by the Research Ethics board of Khyber Medical University, Peshawar, Pakistan. This study was started in October 2017 and ended in March 2018. In this whole period, identification of the participants, their enrollment and data collection was carried out. Based on median difference of 14.3 mmol/kg total short chain fatty acids between breast fed and formula fed infants at 2 months of age from the study of Siigur et al 1993[14] and considering margin of error of 5%, total of 25 infants are required in each group (total n=50). Each patient was screened (Figure 1) using a health check questionnaire to rule out conditions related to changes in physiology of the gut which can alter gut microbiota composition and metabolic activity such as medications, gut surgeries, systemic use of prebiotics and probiotics.

Anthropometric assessment of infants and mothers: Weight and length measurement of an infant was performed once. Infant crown-heel length was measured once by using headpiece and foot piece both applied perpendicular to the hard surface and non-stretch tape was used to measure the length in centimetres. Head circumference was measured at a level passing from supraorbital protuberance anteriorly and occipital protuberance posteriorly using non-stretch tape to the nearest 0.1cm. Infant's weight was determined by using Beurer Digital Baby Scale (BY-80) in kilograms. Skin folds (biceps and triceps) were measured by using skinfold caliper (Holtain LTD, Crosswell, UK). Height of the mothers was measured with a portable stadiometer with the head in horizontal Frankfort plane. Mid upper arm circumference was measured to the nearest 0.1cm using a plastic measuring tape. Weight of the mother was measured by Beurer digital scale

TABLE IV: MEAN DIFFERENCES IN ANTHROPOMETRIC PARAMETERS BETWEEN LACTATING AND NON-LACTATING MOTHERS

Variables	Lactating mothers		Non-lactating mothers		P-value§
	Mean	SDS	Mean	SDS	
Waist circumference (cm)	75	15.6	61	18.2	0.007***
Biceps (mm)	16.92	1.87	15.88	2.03	0.066
Triceps (mm)	18	2.04	16.92	2.06	0.069
Body Mass Index (kg/m^2)	27.32	5.19	25.68	4.62	0.243

***P<0.0001; SDS = Standard deviation score; § = Independent sample t-test

"GS 200 Allium" to the nearest 100gm.

Dietary assessment of mothers: Mothers were handed over a form to complete a 24hr food recall (food diary). They were encouraged to recall their dietary intake during 24hr. Majority of the mothers who were illiterate filled the form retrospectively. The 24hrs dietary recall was then analysed by using windiet ® 2005 software. This software was updated with approximately 200 Pakistani local food items from food composition table of Pakistan. All food items and food groups were entered into the software were analyzed for major macronutrients along with vitamin A and some basic minerals of nutritional importance taken per day. Also, total caloric intake (energy intake) per day was calculated from macronutrients (carbohydrates, proteins and fats) were presented as168% proportion of total energy intake.

All the data collected during the study span were arranged and organized on Microsoft Excel 2013. The anthropometric data were then copied to statistical tool (Minitab 17) for descriptive statistics and normal distribution of the data to be evaluated. The normality of the data was assessed by Anderson-Darling test. This test evaluates the normal distribution of continuous variables like standard deviation score (SDS) height, SDS weight, SDS BMI and BMI. Probability plots signifies that the anthropometric data were normally distributed hence parametric statistics were applied. For comparison between the means of two groups 2 sample t-test was applied. All the data were expressed as mean ± SD. P-values of less than 0.05 were considered significant.

RESULTS

The age of infants at the time of assessment was 78.40 ± 35.88 days. Height and weight SDS was found to be -2.759±3.106 and -0.538±2.056 with SDS_BMI of 1.598 ±2.309. Similarly the BMI of mothers were 26.499±4.930, age of mothers were 29.540±2.866 at the time of assessment (Table I).

The dietary characteristics of mothers were also analyzed among the lactating and non-lactating groups. Dietary intake of lactating mothers (energy=3032±1284 Kcal; % energy intake=125.9±53.3) was more as compared to non-lactating mothers (1878±992Kcal; % energy intake=78±41.2) [p-value=0001]. Similarly, intake of carbohydrates, fats, proteins, zinc, selenium and dietary fiber were significantly increased in lactating as compared to non-lactating mothers (Table II).

It was observed that the mean anthropometric measurements between the infants of the two groups were not significantly different except for head circumference, which is significantly higher in formula fed infants (40.32±2.34) as compare to breast fed infants (38.12±4.46) [Table III]. On the other hand, Lactating mothers got significant increase in waist circumference (75±15.6) when compared with non-lactating mothers (61±18.2) [p-value=0.007]. Similarly, increasing trends were also observed in lactating mothers in their biceps and triceps measurements (Table IV).

DISCUSSION

All the mothers had BMI near upper limit of normal range but the BMI of the lactating mothers was higher with no significant difference from the formula fed infants' mothers. This may be attributed to the fact that majority of the

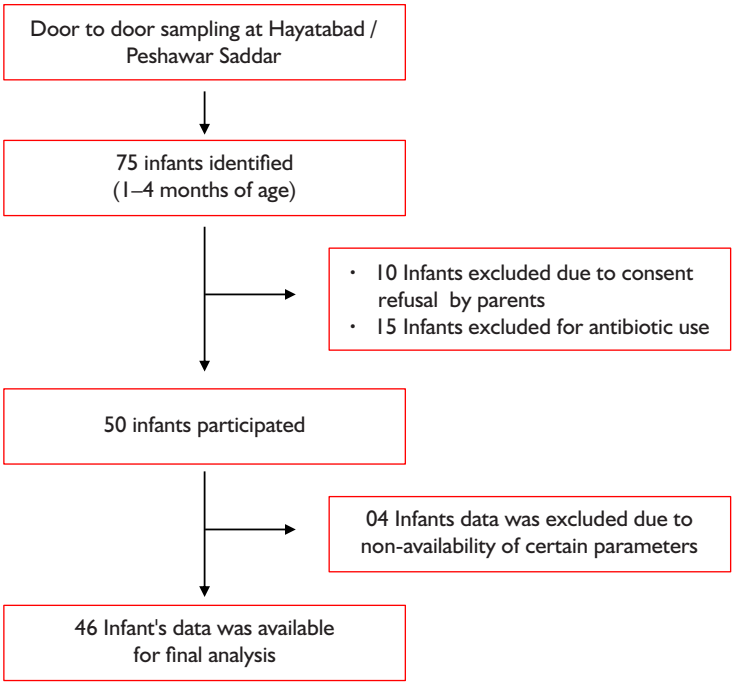

Figure 1: Flow chart of participant screening

formula fed infant's mothers were on diet to lose their weight and relatively the increased BMI of the lactating mothers can be related to increase energy intake and macronutrients. These findings are consistent with the report of the national academy of science.[15] In contrast, the BMI of lactating mothers fell to a significant level between 4 and 6 months of exclusive breast feeding.[16] Similar results were reported by Rasmussen K, et al.[17] The energy intake in the lactating mothers was higher than the recommended energy intake for this category whereas the mothers of formula fed infants energy intake was low. A report on breastfeeding mothers in Nigeria revealed significantly increased energy intake.[18] The difference between their study and our results might be at least partially due to small sample size in our study although levels of energy intake were positively associated with the BMI of lactating mothers as has been reported by Lano-Maduagu, et al.[19]

The anthropometric and dietary data were analyzed for assessing the nutritional status of mothers. Mean energy intake of the mothers increased after delivery as has been observed in American women for 4 months postpartumly.[20] The 24 hours dietary recall of the lactating mothers showed that their protein, carbohydrates and fats intake was significantly higher than the non-lactating mothers. Further analysis showed that in both lactating and non-lactating mothers, the intake of macronutrients was higher than the recommended intake but it was significantly higher in lactating groups as cited in Brazilian lactating mothers.[21] Dietary intake of micronutrients such as, selenium and iron along with vitamin A were also considerably normal in fact more than the required intake. This can be related to the fact that iron and vitamin A can be stored by the human body, whereas, zinc intake and zinc levels in plasma were very low than the required levels.[21] Iron intake was adequately higher in lactating mothers in our study supporting the outcome of Moser PB, et al. who studied lactating mothers in Nepal. Consumption of selenium in lactating mother was significantly low and very low in non-lactating mothers matching with a report of a study carried out in Nepal.[22] It is cited in literature that zinc intake does not influence the plasma zinc levels of mother, as there was no association of intake with the plasma levels.[23] Similar trends was observed in our study with positive but insignificant association of zinc intake and plasma levels. Beshgetoor D, et al. studied the same relationship in animal model by feeding the lactating and pregnant rats with marginal zinc supplemented diet and found no effect on zinc levels in breast milk and on zinc concentration.[24]

It is learnt from the literature that milk is an excellent source of nutrients for the infants and is considered to be the only source of nutrition in the first 6 months of life. It has been reported that human milk has the ability to protect infants against massive weight gain and later on obesity in adulthood.[9] The finding of this study second the above statement, as it was found that the infants mean BMI_SDS in breast fed infants was lower than the formula fed infants although the difference was not significant.[25] It is well known fact that traditional formula milk are having higher contents of protein than breast milk. Protein-rich formulae are considered to be a factor that accelerate plasma insulin levels which in turn leads to release of insulin-like growth factor-1, as a consequence there is weight gain and later on obesity in adulthood.[9,25] Other studies have also reported that the mean SDS_weight of formula feeding groups was lower when compared with breast feeding group.[2] We found the mean values of SDS_weight were higher but not significant in BFI as compared to FFI. Recent researches support the fact that human milk contains more non-nutritive carbohydrates like human milk oligosaccharides (HMOs) that have the potential to affect the body composition and infants growth, inviting further research to identify the possible contributors of infants growth and body mass composition during early and late infancy.[4,10,26] The means of SDS height of breast fed and formula fed infants are almost identical, the differences were very small and statistically insignificant though the formula fed infants mean length gain was higher than breast fed infants, sharing a similarity with the available data.[26-28] The head circumference mean measurement significantly varied between the breast fed and formula fed infants, being higher in formula fed infants. On contrary, study done in Denmark revealed no difference in the mean measurement of both groups.[3] Indices of adiposity like biceps and triceps skin fold measurements in our study were not significantly different between the groups and are consistent with findings of Ziegler EE et al[29] and are contradictory to the outcome of earlier research where adiposity indices were higher in breast fed infants than formula fed infants.[30]

CONCLUSION

It was observed that the growth pattern of both breast-fed as well as formula-fed infants were not significantly different, revealing a comparable impact of the two modes of feeding on infant growth. It is also inferred from the data that energy intake, percentage energy intake and intake of macronutrients as well as micronutrients are more in lactating mothers as compared to non-lactating mothers, suggesting that lactating mothers be educated regarding their caloric intake and dietary habits to avoid obesity and the co-morbidities related to it.

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AUTHORS' CONTRIBUTIONS

Following authors have made substantial contributions to the manuscript as under:

MD: Conception and study design, acquisition, analysis and interpretation of data, drafting the manuscript, final approval of the version to be published

RN: Study design, critical review, final approval of the version to be published

SF & MA: Acquisition, analysis and interpretation of data, drafting the manuscript, final approval of the version to be published

MS: Analysis of data, drafting the manuscript, critical review, final approval of the version to be published

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity ofany part of the work are appropriately investigated and resolved.

CONFLICT OF INTEREST

Authors declared no conflict of interest

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