

ORIGINAL ARTICLE

Lipid profile of term infants on exclusive breastfeeding and mixed feeding: a comparative study

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Objectives: To compare the lipid profiles of exclusively breastfed and mixed-fed term healthy infants in the first 6 months of life.

Design: Prospective comparative study.

Setting: Study was carried out in a tertiary care hospital.

Subjects: Four hundred consecutive term healthy infants, 200 on exclusive breastfeeding (group 1) and 200 receiving mixed feeding (group 2) were recruited at 14 weeks of age. At 6 months, 149 and 150 mother–infant pairs were followed up in groups 1 and 2, respectively.

Methods: Anthropometric measures of the mother and baby were recorded. Serum lipid levels of the mother and babies were determined at 14 weeks. Babies were followed up till 6 months and their lipid levels were determined again at 6 months. Statistical analysis was carried out using SPSS.

Results: Two groups were comparable in birth weight and maternal characteristics ($P > 0.05$). Weight and head circumference were significantly more in the breastfed group at 14 weeks as well as at 6 months ($P < 0.001$). Mean total cholesterol (TC) was 205.27 ± 47.31 and 176.55 ± 32.01 mg/dl in groups 1 and 2, respectively at 14 weeks (CI = 20.77–36.66, $P < 0.001$). At 6 months TC was 192.79 ± 40.52 and 161.05 ± 22.53 mg/dl in the two groups (CI = 24.26–39.22, $P < 0.001$). Change in total cholesterol from 14 weeks to 6 months was also significant in both groups ($P < 0.001$). Low-density lipoprotein cholesterol (LDL-C) and triglycerides were significantly higher in the breastfed groups at 14 weeks and 6 months. The high-density lipoprotein cholesterol (HDL-C)/LDL-C significantly improved at 6 months in exclusively breastfed group ($P = 0.045$). A positive correlation was found only at 14 weeks between mother's TC and baby's TC ($r = 0.332$), mother's LDL-C with baby's LDL-C ($r = 0.223$) in mixed fed group.

Conclusion: Breastfed babies have significantly higher TC and LDL-C compared to mixed fed babies in the first 6 months of life with improving HDL-C/LDL-C ratio at 6 months.

Sponsorship: None.

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Introduction

Breast milk is the optimal source of nutrition for infants in early months of life. Exclusive breastfeeding is sufficient to

support optimal growth and development for the first 6 months after birth (American Academy of Pediatrics Work Group on Breastfeeding, 1997). WHO, UNICEF and all child health intervention agencies in World Health Assembly recommended exclusive breastfeeding for first 6 months (WHO/UNICEF Global Strategy for Infant and Young Child Feeding, 2003). According to a recent study, 19% of all under-five deaths can be prevented, if infants are exclusively breastfed during the first 6 months and continued breastfeeding along with complementary feeds till 2 years (Jones *et al.*, 2003).

Breastfeeding has been found to be protective against atherosclerotic cardiovascular disease (Fall *et al.*, 1992) and its risk factors (Pettitt *et al.*, 1997; Singhal *et al.*, 2001).

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Contributors: DH collected the data, analyzed serum lipids and wrote the manuscript. MMAF designed the study, critically analyzed the results and finalized the manuscript. AA analyzed statistical results and did literature search and modified discussion. SBS helped in serum lipid analysis and interpretation and preparations of results.

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It affects the lipoprotein profile later in life (Marmot *et al.*, 1980; Ravelli *et al.*, 2000; Owen *et al.*, 2002), but the results are variable. There is growing evidence that risk of coronary heart disease (CHD) begins to emerge from childhood. Serum lipid levels especially serum cholesterol is a major risk factor for atherosclerotic heart disease. Although total cholesterol (TC) and low-density lipoprotein (LDL) are influenced by adult diet and adiposity, levels of these factors 'track' with increasing strength from early childhood (Farris *et al.*, 1982). Nutrition in the neonatal and early infancy may have major, long-term 'programming' effect on physiology and metabolism of cholesterol. Hence the influence of infants' eating patterns, on subsequent cholesterol levels, are of growing interest. It has been seen that infants on different feeding regimens, have different lipid profiles (Kallio *et al.*, 1992). Majority of studies have compared lipid levels in exclusively breastfed babies with formula-fed infants (Friedman and Goldberg, 1975; Wagner and Stockhausen, 1988; Wong *et al.*, 1993). These studies were carried out in developed countries; however, in developing countries like ours, infants are either exclusively breastfed or mixed fed with bovine milk. According to National Family Health Survey-3, only 46.3% of infants were exclusively breastfed at 4 months of age, remaining babies were mixed fed (National Family Health Survey – 3, 2005–2006). There is paucity of studies comparing lipid profile of exclusively breastfed and mixed-fed babies. Hence, this study was carried out to compare babies' lipid profile on different feeding regimen during the first 6 months of life and its correlation with their mothers' lipid profile.

Subjects and methods

Two hundred exclusively breastfed and 200 mixed-fed infants with known gestation (37–41 weeks by LMP) and birth weight (between 10th and 90th percentile) (Lubchenco *et al.*, 1963) and apparently healthy, along with their mothers, were recruited at 14 weeks (± 2 weeks). Subjects were recruited consecutively from the Well Baby Clinic and the Immunization Clinic of our hospital from May 2004 to October 2004 during operational working period. Group 1 (exclusively breastfed) included infants on exclusive breastfeeding (babies receiving non-nutritional feed, i.e. water, ghutti, gripe water were also included). Group 2 (mixed fed) included infants who were given both breastfeeding and bovine milk. Babies who were taking at least two bovine milk feeds per day for at least two consecutive weeks before recruitment were included in the mixed-fed group. Parents of mixed-fed babies were first counseled to start exclusive breastfeeding. Only when the mother had chosen to mixed feed, she and her infant were included in the group 2 of the study. Feeding regimen of the baby was determined by the recall memory of the mother. She was asked what and when the feeding was started? What all they have been feeding their children since birth? When the mother said that she

was giving exclusive breastfeeding she was asked further questions to cross check. She was asked if she was giving any feeds other than breastfeeds, for example, water, ghutti, gripe water, bovine milk, formula milk. Babies receiving any kind of formula feed were excluded from the study. A written informed consent was taken from parents after explaining them the purpose and the method of study. The institutional ethical committee granted permission for this study.

Babies with perinatal problems, for example, birth asphyxia, premature rupture of membranes, hypoglycemia, hypothermia, meconium stained amniotic fluid, pathological jaundice, congenital malformations and clinical evidence of chromosomal anomalies were excluded. Infants born to mothers having diabetes mellitus, gestational diabetes, hypertension, pre-eclampsia, eclampsia, hypo/hyperthyroidism, long-term medication were also excluded.

Maternal data

At 14 ± 2 weeks of infant's age, maternal weight and height were recorded and body mass index (BMI) was calculated. Mothers of babies on mixed feeding were counseled to how to prepare hygienic replacement feed in proper amount. The mother and infant pair was followed up at 20 weeks (± 2 week) and 6 months (± 2 weeks) of age. At 20 weeks mothers were counseled to continue the feeding regimen, their babies were already on, not to start any semisolid feed and they were asked to come at 6 months. Mothers were asked specifically for any history of addictions to alcohol and smoking. About 4–5 ml of fasting venous blood sample was withdrawn under all aseptic precautions at 14 weeks for lipid profile. Serum was separated and stored at -20°C .

Infant data

Sex, period of gestation at birth and birth weight were recorded. Weight was taken using electronic weighing scale with an accuracy of 10g. Length was measured by infantometer to the nearest of 1 mm and head circumference was taken by a fiberglass tape to the nearest of 1 mm. Three ml of venous blood was taken under aseptic precautions for lipid profile estimation. Serum was separated and stored at -20°C . At 6 months (± 2 weeks), the infant's weight, length and head circumference were recorded and blood sample withdrawn for lipid profile estimation.

Lipid profile estimation

Serum was analyzed for lipid profile by auto analyzer RA 50 (Bayer Diagnostic India Ltd. Community centre, New Delhi, India) using colorimetric method for triglycerides (TG) and TC (ENZOKIT Ranbaxy, Ranbaxy, New Delhi, India). High-density lipoprotein cholesterol (HDL-C) was determined using AutoZyme HDL-cholesterol Precipitating Reagent (Accurex Biomedical Private Limited, Mahim, Mumbai, India). LDL cholesterol (LDL-C) and very low-density

lipoprotein cholesterol (VLDL-C) were calculated using formulae, that is $LDL-C = TC - (HDL-C + VLDL-C)$ and $VLDL-C = TG/5$.

Sample size

Sample size was calculated for difference in TC in two groups, taken as 20 mg/dl at 6 months, with a power of 80% and an α value of 0.05. Standard deviations SD_1 and SD_2 were taken from study by Kallio *et al.* (1992). Sample size came out to be 149 in each group. Assuming a loss to follow-up of 25%, we recruited 200 subjects in each group.

Statistical analysis was carried out by using SPSS version 6. Mean and standard deviation (s.d.) were calculated separately for each group. Unpaired (two-tailed) Student's *t*-test was applied to difference in means of various parameters between the two groups. Paired *t*-test was used to calculate difference in mean value of various parameters at 14 weeks and 6 months within two groups. *P*-value of <0.05 was taken as significant. Difference in number of patients with lipid levels higher than normal (American Academy of Pediatrics Work Group on Breastfeeding, 1992) between the groups was compared using χ^2 test. McNemar test was applied to determine any significant change in number of infants with abnormal lipid levels from 14 weeks to 6 months within the groups. Correlation between mother's lipid levels and baby's lipid levels was calculated by using Pearson correlation.

Results

Out of the total 400 infants, the follow-up at 6 months of age was 74.5% ($n=149$) and 75% ($n=150$) in groups 1 and 2,

respectively. At 14 weeks, the ratio of males:females were identical 1.6:1 in each group. At 6 months, the ratio became 1.8:1 and 1.6:1 in groups 1 and 2, respectively.

Anthropometric parameters of mothers and babies are shown in Table 1. At 14 weeks, the exclusively breastfed infants had a mean weight of 5.79 ± 0.66 kg (which clinically fell between 25th and 50th centile) (Needlman, 2002), which was significantly ($P=0.005$) higher than the mixed-fed infants' 5.62 ± 0.57 kg (25th–50th centile). At 6 months mean weight in exclusively breastfed infants was 7.34 ± 0.73 kg (50th–75th centile), which was significantly ($P=0.001$) more than the mixed fed infants 6.92 ± 0.59 kg (25th–50th centile). No significant difference was observed between the length of two groups at 14 weeks and 6 months. Exclusively breastfed babies had a significantly larger head circumference at both 14 weeks and 6 months ($P=0.001$) as compared to mixed-fed infants. The maternal weight, height and BMI were comparable in both groups.

The exclusively breastfed infants had significantly higher ($P<0.001$) TC and LDL-C as compared to mixed-fed infants at both 14 weeks and 6 months (Tables 2 and 3). At 14 weeks, TG was significantly higher ($P=0.021$) in breastfed infants as compared to mixed fed. At 6 months, the breastfed group although had higher TG but the difference was not statistically significant ($P=0.078$). At 6 months, HDL-C/LDL-C increased in exclusively breastfed from 0.391 to 0.464 ($P=0.045$) and decreased in mixed-fed infants from 0.519 to 0.460 ($P=0.057$).

As shown in Table 4, TC and LDL-C levels fell significantly from 14 weeks to 6 months in exclusively breastfed group. Similar pattern was also observed in mixed-fed group. There was a significant increase in TG levels from 14 weeks to 6

Table 1 Characteristics of the two groups at 14 weeks and 6 months

		Group 1 ($n=200$ at 14 weeks, $n=149$ at 6 months)	Group 2 ($n=200$ at 14 weeks, $n=150$ at 6 months)	<i>P</i> -value
Baby				
Weight (kg)	At birth	2.85 ± 0.34	2.80 ± 0.32	
	14 weeks	5.79 ± 0.66	5.62 ± 0.57	0.005
	6 months	7.34 ± 0.73	6.92 ± 0.59	0.001
Length (cm)	14 weeks	64.08 ± 3.24	64.18 ± 2.45	0.728
	6 months	68.53 ± 3.04	68.11 ± 2.52	0.203
Head circumference (cm)	14 weeks	40.31 ± 0.77	40.00 ± 0.76	0.001
	6 months	42.63 ± 0.75	42.28 ± 0.83	0.001
Mother				
Weight (kg)	At recruitment	57.65 ± 5.43	58.34 ± 5.58	0.210
Height (cm)	At recruitment	156.25 ± 3.35	156.27 ± 3.27	0.940
BMI (kg/m^2)	At recruitment	23.47 ± 1.91	23.75 ± 2.18	0.166
TC (mg/dl)	At recruitment	144.16 ± 27.24	143.68 ± 25.08	0.856
HDL-C (mg/dl)	At recruitment	46.74 ± 11.75	48.76 ± 11.77	0.087
VLDL-C (mg/dl)	At recruitment	20.16 ± 8.15	20.26 ± 7.31	0.892
LDL-C (mg/dl)	At recruitment	77.66 ± 25.59	74.94 ± 24.96	0.284
TG (mg/dl)	At recruitment	101.16 ± 40.66	101.65 ± 36.32	0.900

Abbreviations: BMI, body mass index; TC, total cholesterol, HDL-C, high-density lipoprotein cholesterol; VLDL-C, very low-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; TG, triglycerides.

Table 2 Lipid profile of babies in 2 groups at 14 weeks

Lipids	Group 1 (n = 200) Mean \pm s.d.	Group 2 (n = 200) Mean \pm s.d.	P-value	95% confidence interval
TC (mg/dl)	205.27 \pm 47.31	176.55 \pm 32.01	0.001	20.776–36.664
HDL-C (mg/dl)	46.22 \pm 10.83	48.18 \pm 10.07	0.030	–4.487–2.33
VLDL-C (mg/dl)	24.60 \pm 10.85	22.83 \pm 10.89	0.091	–0.286–3.836
LDL-C (mg/dl)	135.77 \pm 44.92	107.24 \pm 33.25	0.001	20.928–36.382
TG (mg/dl)	123.26 \pm 54.03	111.21 \pm 41.43	0.021	4.764–1.687

Abbreviations: TC, total cholesterol, HDL-C, high-density lipoprotein cholesterol; VLDL-C, very low-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; TG, triglycerides.

Table 3 Lipid profile of babies in two groups at 6 months

	Group 1 (n = 149) Mean \pm s.d.	Group 2 (n = 150) Mean \pm s.d.	P-value	95% confidence interval
TC (mg/dl)	192.79 \pm 40.52	161.05 \pm 22.53	0.001	24.261–39.217
HDL-C (mg/dl)	47.32 \pm 9.34	40.10 \pm 9.28	0.001	5.103–9.341
VLDL-C (mg/dl)	26.07 \pm 8.04	24.45 \pm 6.23	0.052	–0.011–3.265
LDL-C (mg/dl)	120.17 \pm 36.58	96.56 \pm 24.14	0.001	16.552–30.677
TG (mg/dl)	130.19 \pm 39.78	122.91 \pm 30.93	0.078	–0.834–15.396

Abbreviations: TC, total cholesterol, HDL-C, high-density lipoprotein cholesterol; VLDL-C, very low-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; TG, triglycerides.

Table 4 Comparison of lipid profiles within the two groups at 14 weeks and 6 months^a

	14 weeks (mean \pm s.d.)	6 months (mean \pm s.d.)	P-value	95% confidence interval
<i>Group 1 (n = 149)</i>				
TC (mg/dl)	207.04 \pm 47.26	192.79 \pm 40.52	0.001	6.484–22.026
HDL-C (mg/dl)	46.22 \pm 10.83	47.32 \pm 9.34	0.333	–3.339–1.138
VLDL-C (mg/dl)	24.60 \pm 10.85	26.07 \pm 8.04	0.157	–3.509–0.570
LDL-C (mg/dl)	135.77 \pm 44.92	120.17 \pm 36.58	0.001	7.949–23.233
TG (mg/dl)	123.26 \pm 54.03	130.19 \pm 39.78	0.177	–17.032–3.166
HDL-C/LDL-C	0.391	0.464	0.045	
<i>Group 2 (n = 150)</i>				
TC (mg/dl)	177.84 \pm 32.77	161.05 \pm 22.53	0.001	11.584–22.002
HDL-C (mg/dl)	48.18 \pm 10.07	40.10 \pm 9.28	0.001	5.942–10.218
VLDL-C (mg/dl)	22.83 \pm 10.89	24.45 \pm 6.23	0.125	–3.694–0.454
LDL-C (mg/dl)	107.24 \pm 33.25	96.56 \pm 24.14	0.001	5.165–16.195
TG (mg/dl)	111.21 \pm 41.43	122.91 \pm 30.93	0.006	–19.927–3.473
HDL-C/LDL-C	0.591	0.460	0.057	

Abbreviations: TC, total cholesterol, HDL-C, high-density lipoprotein cholesterol; VLDL-C, very low-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; TG, triglycerides.

^aLipid profile of the infants followed till 6 months.

months in mixed-fed group. HDL-C increased in breastfed infants from 14 weeks (45.67 \pm 11.39 mg/dl) to 6 months (47.32 \pm 9.34 mg/dl), although this difference was not statistically significant ($P > 0.05$). However, in mixed-fed group, the HDL-C decreased significantly ($P < 0.001$) at 6 months (40.10 \pm 9.28 mg/dl) as compared to 14 weeks (48.03 \pm 10.22 mg/dl). The ratio of HDL-C to LDL-C increased in exclusively breastfed group and it decreased in mixed-fed group from 14 weeks to 6 months.

We analyzed number of babies with cholesterol < 200 mg/dl and ≥ 200 mg/dl in the two groups based on the committee on Nutrition of American Academy of Pediatrics (AAP) definition of 200 mg/dl as 'high' (American Academy of Pediatrics Work Group on Breastfeeding, 1992). Similarly,

adult levels of LDL, VLDL, HDL and TG were taken to compare with the number of babies with normal and abnormal levels in the two groups. As shown in Table 5, there was a significant difference in the number of babies with normal and abnormal levels of TC and LDL at 14 weeks and 6 months ($P < 0.001$) in two groups, and in HDL-C at 6 months. In the exclusively breastfed group at 14 weeks, 75 babies had TC < 200 mg/dl of which 64 remained at a level of < 200 mg/dl at 6 months of age. Of the 74 babies who had a TC level ≥ 200 mg/dl, 37 had a level < 200 mg/dl at 6 months and 37 continued to have a level ≥ 200 . Using Mc Nemar test this was statistically significant ($P < 0.05$). Similar results were seen with TG in group 1. All lipid parameters in group 2 had significantly changed according to McNemar test.

Table 5 Distribution of babies with abnormal serum lipids in the two groups

Parameter (mg/dl)	Group 1 no. (%)	Group 2 no. (%)	P-value (χ^2 i square)
TC 14 weeks			
< 200	103 (39)	161 (61)	0.001
≥ 200	97 (71.3)	39 (28.7)	
TC 6 months			
< 200	101 (67.8)	143 (95.3)	0.001
≥ 200	48 (32.2)	7 (4.7)	
LDL-C 14 weeks			
< 110	62 (36.3)	109 (63.7)	0.001
≥ 110	138 (60.3)	91 (39.7)	
LDL-C 6 months			
< 110	58 (34.1)	112 (65.9)	0.001
≥ 110	91 (70.50)	38 (25.3)	
HDL-C 14 weeks			
< 35	36 (59)	25 (41)	0.126
≥ 35	164 (48.4)	175 (51.6)	
HDL-C 6 months			
< 35	14 (28.6)	35 (71.4)	0.001
≥ 35	135 (54)	115 (46)	
TG 14 weeks			
< 100	81 (50.6)	79 (49.4)	0.838
≥ 100	119 (49.6)	121 (50.4)	
TG 6 months			
< 100	32 (53.3)	28 (46.7)	0.544
≥ 100	117 (49)	122 (51)	

At 14 weeks, $n=200$; 6 months, $n=149$ (group 1), 150 (group 2).
Abbreviations: TC, total cholesterol, HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; TG, triglycerides.

Table 6 Comparison of present study with other studies

		Serum total cholesterol (mg/dl ± s.d.)	
		BM	FF
Present study	14 weeks	205.27 ± 47.31	176.55 ± 32.01 ^c
	6 months	192.79 ± 40.52	161.05 ± 22.53 ^c
Wagner and Stockhausen (1988)	3 months	169.7	125.7 ± 138.4 ^a
Jooste <i>et al.</i> (1991)	3 months	171.42 ± 3.08	150.96 ± 2.31 ^b
Kallio <i>et al.</i> (1992)	4 months	150.57 ± 32.81	190 ± 33
	6 months	126.25 ± 15.44	136.77 ± 21.23
Wong <i>et al.</i> (1993)	3 months	183 ± 47	112 ± 22 ^a
Akeson <i>et al.</i> (1999)	3 months	174.13 ± 28.57	179.92 ± 34.74
	6 months	137.45 ± 28.95	166.02 ± 33.5
Agostoni <i>et al.</i> (2000)	4 months	170.65 ± 47.84	147.49 ± 25.8 ^a

^aFormula feeding.

^bFormula feeding + breastfed.

^cBreastfed + bovine milk.

Abbreviations: BM, breastmilk; FF, formulafed.

There was no correlation between mother's and baby's lipid profiles in exclusively breastfed group at 14 weeks and 6 months. A positive correlation was found at 14 weeks between mother's TC and baby's TC ($r=0.332$), mother's LDL-C with baby's LDL-C ($r=0.223$) in mixed-fed group; however, this correlation was not seen at 6 months. No

correlation was found between babies weight and cholesterol levels.

Discussion

Dietary intake determines macronutrient and micronutrient levels in the body. The feeding regimen affects the lipid profile in human infants. In our study also, we found differences in lipid profile of infants on two different feeding regimens. At 14 weeks, the exclusively breastfed infants had significantly higher ($P<0.001$) TC and LDL-C as compared to mixed-fed group. HDL-C was significantly lower in exclusively breastfed group at 14 weeks ($P=0.030$) and VLDL-C was comparable in two groups. At 6 months, LDL-C and TC remained significantly higher ($P<0.001$) in exclusively breastfed group. VLDL-C and TG were comparable in both groups at 6 months.

Owen *et al.* (2002), Wong *et al.* (1993) and Agostoni *et al.* (2000) reported similar findings that breastfed infants had significantly higher TC and LDL-C than formula-fed infants. The differences observed between the absolute values of TC, HDL-C, LDL-C, VLDL-C and TG in our study, as compared to other studies, could be owing to many factors, for example methodology, type of sample (venous/capillary), time interval between last feeding, preparation of feed (dilution) and genetic composition (Agostoni *et al.*, 2000). Mean serum cholesterol in breastfed and formula- or bovine-milk-fed babies in various studies has been tabulated (Table 6).

The higher TC and LDL-C levels in breastfed infants in our study might be explained by the postulation given by Van Biervliet *et al.* (1986) They said that increased lipase activity or an increased concentration of cofactor apo E II in human milk might enhance exogenous and endogenous TG lipolysis and thus increasing serum lipid levels. The higher cholesterol levels in breastfed infants might also be owing to higher intake of dietary cholesterol because breast milk contain significantly higher amount of cholesterol as compared to cow's milk (Lane and McConathy, 1986). Although breastfed infants have higher concentration of those plasma lipids, considered to be atherogenic later in life, but various studies have shown that breastfed babies have lower risk of developing CHD and its risk factors in adult life (Marmot *et al.*, 1980; Pettitt *et al.*, 1997; Ravelli *et al.*, 2000; Singhal *et al.*, 2001; Owen *et al.*, 2002). This puts forth a question whether high lipid levels in early infancy are abnormal? Reiser and Seidman (1972) proposed an interesting hypothesis, based on studies in rat, that newborns exposed to high levels of dietary cholesterol 'would be able to cope better with dietary cholesterol in later life'. Mott *et al.* (1995) demonstrated that adult baboons, who were breastfed, had lower cholesterol production rate on high dietary cholesterol intake which was owing to differences in levels of lipoprotein lipases and cholesterol esterifying enzyme for the same cholesterol levels. Hence higher cholesterol levels in infants in first 6 months of life may prime them for lower

cholesterol production later in life. In our study, percentage of babies with TC >200 mg% decreased from 71.3 to 32.2% in the breastfed group (Table 4). Ratio of HDL-C/LDL-C increased in the breastfed group and decreased in mixed-fed group from 14 weeks to 6 months. This demonstrated that a shift toward a healthy lipid profile started early in life.

At present we do not know which are the most favorable concentrations of plasma lipids during infancy, receiving exclusive breastfeeding and mixed feeding (breastfeeding + formula feeding/breastfeeding + animal milk). Normal range of lipid profile for adults has been established but no standard values are available for infants and children (American Academy of Pediatrics Work Group on Breastfeeding, 1992). A higher HDL-C/LDL-C is known to be protective against atherosclerotic heart disease. In our study mean ratio of HDL-C/LDL-C improved significantly from 0.391 to 0.464 ($P=0.045$) in the exclusive breastfed group, whereas in mixed-fed group ratio fell from 0.519 to 0.460 ($P>0.05$). This improvement in HDL-C/LDL-C ratio in exclusively breastfed babies was seen because of decrease in LDL-C and increase in HDL-C. A positive correlation was found at 14 weeks between mother's TC and baby's TC, mother's LDL-C with baby's LDL-C in mixed-fed group; however, this correlation vanished at 6 months. This correlation is difficult to explain and may not be significant as no correlation was found later on.

Growth of the babies was adequate in terms of weight and length of the babies in the two groups. In our study, statistically significant differences ($P<0.001$) were observed in the head circumferences of the two study groups at both 14 weeks and 6 months. But this difference was not significant clinically as these values were corresponding with those between 10th and 25th percentiles on CDC charts for head circumference for that age (Needlman, 2002). Thus, the gain in head circumference in the two groups between 14 weeks to 6 months was comparable. This finding was in concordance with the studies carried out by Wagner and Stockhausen (1988) and Salmenpera *et al.* (1985) where they also found no significant difference in the head circumference of the exclusively breastfed and formula-fed infants. Statistically larger head circumference in breastfed babies might be owing to higher levels of docosahexaenoic acid and linolenic acid in breast milk. These are important building blocks of brain tissue and play a significant role in postnatal myelination (Agostoni *et al.*, 1995). Higher IQ scores have been demonstrated in exclusive breastfed babies (Florey *et al.*, 1995).

As breastfeeding is the natural method of feeding an infant and breastmilk is superior to formula/bovine milk with respect to the specific nutritional needs for the optimal growth and development of infants, the plasma lipid pattern of the breastfed infants must be considered physiological during infancy. It will be worthwhile to develop reference values for lipid profile of the infants and children.

On the basis of these findings, we conclude that the TC and LDL-C are significantly higher in exclusively breastfed

group at 14 weeks and 6 months. Higher lipid values, in early infancy, in exclusively breastfed children may be physiological and useful for cognitive development and programming for lipid metabolism in later life.

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