BREASTFEEDING MEDICINE
Volume 11, Number 5, 2016

DOI: 10.1089/bfm.2016.0033

Abdominal Fat Distribution Among Breastfed and Formula-Fed Infants

Vivianne O. Barros,[1] Melania R. Amorim,[1] Adriana O. Melo,[1] Jousilene S. Tavares,[1]
Andreza C. Silva,[1] and João G. Alves[2]

Abstract

Objectives: To compare abdominal subcutaneous and preperitoneal fat thickness among breastfed, mixed-fed, and formula-fed infants during the first 6 months of life.
Study Design: A cohort study started with 94 healthy newborns and 76 were followed during the whole first semester of life. Breastfeeding status was assessed by a personal interview. Abdominal subcutaneous and preperitoneal fat thickness was measured by ultrasound at the first, third, and sixth month of life.
Results: Subcutaneous and preperitoneal fat thickness showed no differences from the first to the sixth month of life among breastfed, mixed-fed,s and formula-fed infants, respectively; *subcutaneous*: 26.1 ± 10.2 to 57.4 ± 10.3 cm, 27.7 ± 10.5 to 55.4 ± 1.4, and 28.1 ± 10.9 to 52.7 ± 10.6; $p = 0.344$; *preperitoneal:* 10.6 ± 2.0 to 15.2 ± 1.7, 10.3 ± 2.8 to 15.5 ± 1.7, and 9.7 ± 2.6 to 15.6 ± 1.6; $p = 0.623$). No differences were observed among male and female infants.
Conclusion: Abdominal fat distribution measured by ultrasound seems not to be different among breastfed and formula-fed infants during the first semester of life.

Introduction

Environment in early life, especially infant feeding, may play an important role in fat distribution, and it is well known that excess visceral fat has been associated with insulin resistance and its metabolic consequences.[1–3] However, fat distribution has not been adequately studied in early life. Moreover, most of these studies have used cross-sectional designs, which are not more appropriate to evaluate fat distribution because it changes rapidly and nonlinearly over the first months of life, or the anthropometric method, which is not accurate to distinguish between subcutaneous and visceral fat.[4] Computed tomography (CT) and magnetic resonance imaging (MRI) have been considered the gold standard methods to measure subcutaneous and visceral fat tissue.[5] However, MRI is expensive and needs infant sedation, and CT lacks safety due to radiation exposure. Recently, ultrasound has been considered as a safe and accurate method to estimate infant abdominal fat distribution.[5–7] Breastfed infants have a different pattern of growth compared to formula-fed infants.[8,9] Exclusively, breastfeeding has been considered as an important prevention strategy to decrease obesity in childhood and later in life.[10,11] However, the question of fat distribution among breastfed and formula-fed infants has not been adequately studied and some studies showed conflicting results.[12,13] Our aim is to compare subcutaneous and preperitoneal thickness, both measured by ultrasound among breastfed, mixed-fed, and formula-fed infants during the first semester of life.

Materials and Methods

Subjects

This cohort study followed 94 healthy newborns during the first semester of life. All infants were recruited from the ISEA, a teaching hospital located in Campina Grande, Brazil. This research project was previously approved by the ISEA Review Board. All mothers signed an informed consent form.

Maternal mental disease, maternal diabetes mellitus (gestational and type 2 or type 1 diabetes), obese pregnant women (body mass index [BMI] >30 before pregnancy), twin pregnancy, neonatal infections, congenital malformations, or need of intensive care in the neonatal period were exclusion criteria. Low birth weight, preterm, and newborns with Apgar scores ≤7 were excluded.

Protocol

After obtaining the consent, the information from pregnant women was collected in a face-to-face interview using a

[1]Department of Mother and Child Care, Instituto de Pesquisa Prof. Joaquim Amorim Neto (IPESQ), Campina Grande, Brazil.
[2]Department of Mother and Child Care, Instituto de Medicina Integral Prof. Fernando Figueira (IMIP), Recife, Brazil.

questionnaire that consisted of identification, socioeconomic status (income ''per capita'' and mean years of schooling), anthropometry, and medical and obstetric history.

All the infants were evaluated at the first, third, and sixth month of life through an interview with the mother, anthropometric measurements, and ultrasound examination.

Infants were classified based on the mothers' information about their type of feeding during the first 6 months of life as follows: exclusively breastfed (fed only with breast milk according to the WHO criteria), formula-fed infants (fed with cow's milk formula and supplemental foods, including solid foods), and mixed-fed (receiving both breast and formula milk and supplemental foods, including solid foods).

Measurements

Preperitoneal and subcutaneous abdominal thickness was measured by an ultrasound Voluson 730 Expert, GE®, 7.5–12 MHz transducer and a linear (L 12–15 MHz) transducer according to the method described by Holzhauer et al.[5] The infants were always in a supine position and the linear transducer was placed perpendicular to the skin surface on the median abdomen without any pressure. Preperitoneal thickness was measured by a distance between the linea alba to the peritoneum on top of the liver and areas of 1 and 2 cm length along the midline, starting from the reference point in direction of the navel. Subcutaneous fat thickness was measured by a distance of the inner surface of subcutaneous tissue to the linea alba and areas of 1 and 2 cm length along the midline starting from the reference point in direction of the navel. Three ultrasound pictures were taken when infants were relaxed and showing no or little movements and the optimal image for measurement was chosen. All examinations were performed by the same trained physician, blinded to the feeding methods in the infants.

Weight was measured by a digital scale, accurate to 10 g, with the infant completely naked. Length was measured with an infant length board with the infant lying supine and recorded to the nearest 0.5 cm. Prepregnancy BMI was self-reported.

Data analysis

Subcutaneous and preperitoneal fat thicknesses were summarized by mean and standard deviation. These two fat thickness measurements were compared at the first, third, and sixth month of life among breastfed, mixed-fed, and formula-fed infants using ANOVA adjusted for current weight and height status, separately for male and female infants. A significance level of 0.05 was adopted.

Results

Ninety-four infants underwent an ultrasound examination at the first month of age, 81 at the third month of age, and 76 infants completed the follow-up at the sixth month of age; mothers of 18 infants did not attend the appointment for ultrasound examination on the third (11) and sixth month (7) of life of their children and did not justify their absences. Characteristics of mothers and newborn breastfed (16), mixed-fed (37), and formula-fed (23) infants are shown in Table 1. The three groups were comparable except for the mothers' age, which was slightly older in breastfed infants.

No differences were observed among male and female breastfed, mixed-fed, and formula-fed infants regarding subcutaneous and preperitoneal fat thickness during the first 6 months of life (Table 2). Female breastfed infants were heavier at the fourth month of life (Table 2).

Discussion

In this prospective cohort study, abdominal subcutaneous and preperitoneal thickness measured by ultrasound showed no differences in infants according to the type of feeding during the first semester of life. Growth in fetal life and early infancy may influence fat distribution during early years of life and adiposity tracks from infancy to adulthood. The growth of breastfed and formula-fed infants has some differences and our hypothesis is not confirmed in this study that abdominal fat distribution could be influenced by breastfeeding. Our findings are in agreement with Gale et al.[12] that using MRI did not find differences in adipose tissue among breastfed and formula-fed infants up to 2 months of age.

Table 1. Characterization of Study Participants

	Breastfed (± *SD),* n = *16*	*Mixed-fed* (± *SD),* n = *35*	*Formula-fed* (± *SD),* n = *24*	p
Mothers				
Age (years)	30.6 (5.0)	25.3 (5.7)	26.2 (5.5)	0.003
BMI (kg/m^2) prepregnancy	24.8 (5.1)	23.1 (4.1)	22.9 (7.2)	0.219
Weight gain (kg)	11.4 (3.6)	12.3 (6.0)	12.6 (6.6)	0.361
Primipara (%)	2 (14.2)	7 (30.0)	5 (35.7)	0.784
Gestation weeks	39.0 (1.5)	38.2 (2.0)	39 (1.1)	0.074
Cesarean section, *n* (%)	9 (23.1)	18 (46.1)	12 (30.8)	0.981
Income ''per capita''(US$)	82,14 (36.13)	92,84 (52.68)	90,77 (45.61)	0.329
Mean years of schooling	8.1 (0.5)	6.8 (0.8)	7.2 (0.4)	0.246
Infants				
Gender				
Male (%)	5 (14.3)	18 (51.4)	12 (34.3)	0.376
Female (%)	11 (26.8)	19 (46.4)	11 (26.8)	0.260
Birth weight (g)	3.185 (410)	3.145 (504)	3,110 (660)	0.251
Birth length (cm)	48.1 (1.7)	47.6 (2.4)	47.5 (2.8)	0.517

BMI, body mass index; SD, standard deviation.

Table 2. Weight, Height, Subcutaneous and Preperitoneal Thickness at First, Third, and Sixth Month of Life

Gender	*Age (months)*	*Breastfed* (n = *16)*	*Mixed-fed* (n = *37)*	*Formula-fed* (n = *23)*	p
Weight (g)					
Male		*n* = 5	*n* = 18	*n* = 12	
	1st	3,345 ± 508	3,205 ± 438	3,115 ± 433	0.602
	3rd	6,900 ± 554	6,630 ± 635	6,667 ± 719	0.726
	6th	8,910 ± 110	8,547 ± 220	8,781 ± 888	0.889
Female		*n* = 11	*n* = 19	*n* = 11	
	1st	3,346 ± 479	3,005 ± 649	3,134 ± 679	0.355
	3rd	7,144 ± 538	6,329 ± 921	6,076 ± 437	0.005
	6th	9,237 ± 952	8,508 ± 1,136	8,358 ± 551	0.101
Height (cm)					
Male		*n* = 5	*n* = 18	*n* = 12	
	1st	48.7 ± 0.8	48.1 ± 1.8	47.7 ± 2.1	0.659
	3rd	60.6 ± 1.8	61.3 ± 1.6	61.5 ± 2.2	0.675
	6th	66.4 ± 2.7	67.2 ± 1.9	67.2 ± 2.6	0.747
Female		*n* = 11	*n* = 19	*n* = 11	
	1st	48.3 ± 2.0	47.3 ± 2.9	47.6 ± 3.4	0.678
	3rd	63.0 ± 2.2	60.9 ± 2.5	60.7 ± 3.1	0.061
	6th	68.9 ± 2.8	67.3 ± 2.4	66.3 ± 3.2	0.110
Subcutaneous (mm^3)					
Male		*n* = 5	*n* = 18	*n* = 12	
	1st	27.3 ± 10.5	28.8 ± 10.4	23.3 ± 10.3	0.256
	3rd	48.1 ± 11.5	52.0 ± 10.9	50.0 ± 10.6	0.725
	6th	48.0 ± 10.2	53.1 ± 10.1	58.2 ± 10.7	0.406
Female		*n* = 11	*n* = 19	*n* = 11	
	1st	29.0 ± 10.0	27.1 ± 10.7	29.3 ± 10.5	0.752
	3rd	55.3 ± 10.1	53.3 ± 10.6	48.8 ± 10.3	0.502
	6th	56.1 ± 10.8	56.4 ± 10.8	56.7 ± 10.5	0.992
Preperitoneal (mm^3)					
Male		(*n* = 5)	(*n* = 18)	(*n* = 12)	
	1st	9.6 (2.8)	10.2 (2.9)	10.5 (2.1)	0.485
	3rd	14.2 (1.9)	13.8 (2.3)	12.4 (2.0)	0.085
	6th	15.6 (1.7)	15.1 (1.9)	14.9 (1.9)	0.836
Female		(*n* = 11)	(*n* = 19)	(*n* = 11)	
	1st	9.9 (2.2)	10.4 (2.8)	10.7 (2.0)	0.485
	3rd	13.8 (1.7)	14.1 (1.8)	13.7 (1.5)	0.085
	6th	15.6 (1.6)	15.9 (1.6)	15.5 (1.6)	0.836

Oakley[13] had reported a significantly greater increase in the skinfold thickness of infants fed only with artificial milk formula compared to breastfed infants. However, skinfold thickness has low accuracy to measure fat distribution in infants.[14]

A meta-analysis, including a variety of body composition methods, pointed out that healthy breastfed infants have a higher fat mass than their formula-fed counterparts before weaning.[4] However, this systematic review did not assess abdominal fat distribution (i.e., subcutaneous and visceral fat), which is related to insulin resistance and its metabolic complications. Furthermore, many of these studies that examined fat distribution according to feeding patterns had cross-sectional designs, small sample sizes, heterogeneity of infant feeding, and indirect measures of fat distribution. Besides, further differences between breastfed and formula-fed infant adiposity are more intense during the second semester of life[15] and we have only studied children up to 6 months of life.

Subcutaneous and visceral fat has a different development during the first year of life.[15] Subcutaneous fat has a significant increase during the first 4 months of life and a small decrease until one year of life. Abdominal visceral fat has a different pattern increasing from the first month of life up to the age of 1 year. There is some evidence that females have higher fat mass compared to males, but it has not been found in infants.[16] Our findings are in agreement with all these reports.

The key strengths of our study were a prospective cohort design and the use of standardized techniques. Besides, WHO criteria for exclusive breastfeeding were applied and we excluded a number of important confounding influences, such as low birth weight, prematurity, and maternal diabetes, all conditions that can affect fat distribution. We did not identify in our search, prospective cohort studies using ultrasound to compare abdominal fat distribution among breastfed and formula-fed infants.

Our study has some limitations. At first, as a cohort study with 6 months of follow-up, we had a drop out around 20% of the participants and a relatively low number of infants were included in each subgroup studied. Second, the measurement of abdominal fat by ultrasound in infants has some difficulties especially regarding visceral fat evaluation. However, we had a high intra- and inter-reliability in a previous study.[17] Finally, we could not identify among mixed-fed infants, those who were more breastfed or formula-fed over the period of 6 months. Besides, all the families were completely free to choose regarding the type of formula used for their infants and these formulae may have different energy contents.

Conclusion

In summary, abdominal fat distribution during the first 6 months of life seems to have no differences among breastfed and formula-fed infants. Further studies with a longer follow-up and involving a large number of children are needed to clarify this issue.

Acknowledgment

This work was supported by CNPq (n° 480761/20086), Brazilian government.

Disclosure Statement

No competing financial interests exist.

References

1. Polat TB, Urganci N, Caliskan KC, et al. Correlation of abdominal fat accumulation and stiffness of the abdominal aorta in obese children. *J Pediatr Endocrinol Metab* 2008; 21:1031–1040.
2. Liu KH, Chan YL, Chan WB, et al. Sonographic measurement of mesenteric fat thickness is a good correlate with cardiovascular risk factors: Comparison with subcutaneous and preperitoneal fat thickness, magnetic resonance imaging and anthropometric indexes. *Int J Obes Relat Metab Disord* 2003;27:1267–1273.
3. Medina-Bravo P, Meza-Santibáñez R, Rosas-Fernández P, et al. Decrease in serum adiponectin levels associated with visceral fat accumulation independent of pubertal stage in children and adolescents. *Arch Med Res* 2011;42:115–121.
4. Gale C, Logan KM, Santhakumaran S, et al. Effect of breastfeeding compared with formula feeding on infant body composition: A systematic review and meta-analysis. *Am J Clin Nutr* 2012;95:656–669.
5. Holzhauer S, Zwijsen RML, Jaddoe VWV, et al. Sonographic assessment of abdominal fat distribution in infancy. *Eur J Epidemiol* 2009;24:521–529.
6. Mook-Kanamori D, Holzhauer S, Hollestein L, et al. Abdominal fat in children measured by ultrasound and computed tomography. *Ultrasound Med Biol* 2009;35:1938–1946.
7. Alves JG, Vasconcelos SA, de Almeida TS, et al. Influence of catch-up growth on abdominal fat distribution in very low birth weight children–cohort study. *J Pediatr Endocrinol Metab* 2015; 28:153–156.
8. Stettler N, Stallings VA, Troxel AB, et al. Weight gain in the first week of life and overweight in adulthood: A cohort study of European American subjects fed infant formula. *Circulation* 2005;111:1897–1903.
9. Dewey KG. Growth characteristics of breast-fed compared to formula-fed infants. *Biol Neonate* 1998;74:94–105.
10. Arenz S, Rückerl R, Koletzko B, et al. Breast-feeding and childhood obesity—A systematic review. *Int J Obes Relat Metab Disord* 2004;28:1247–1256.
11. Harder T, Bergmann R, Kallischnigg G, et al. Duration of breastfeeding and risk of overweight: A meta-analysis. *Am J Epidemiol* 2005;162:397–403.
12. Gale C, Thomas EL, Jeffries S, et al. Adiposity and hepatic lipid in healthy full-term, breastfed, and formula-fed human infants: A prospective short-term longitudinal cohort study. *Am J Clin Nutr* 2014;99:1034–1040.
13. Oakley JR. Differences in subcutaneous fat in breast- and formula-fed infants. *Arch Dis Child* 1977;52:79–80.
14. de Bruin NC, van Velthoven KA, Stijnen T, et al. Body fat and fat-free mass in infants: New and classic anthropometric indexes and prediction equations compared with total-body electrical conductivity. *Am J Clin Nutr* 1995;61:1195–1205.
15. Brei C, Much D, Heimberg E, et al. Sonographic assessment of abdominal fat distribution during the first year of infancy. *Pediatr Res* 2015;78:342–350.
16. White UA, Tchoukalova YD. Sex dimorphism and depos differences in adipose tissue function. *Biochim Biophys Acta* 2014;1842:377–392.
17. Ferreira AP, da Silva Junior JR, Figueiroa JN, et al. Abdominal subcutaneous and visceral fat thickness in newborns: Correlation with anthropometric and metabolic profile. *J Perinatol* 2014;34:932–935.

Address correspondence to:
João G. Alves, PhD
Department of Mother and Child Care
Instituto de Medicina Integral
Prof. Fernando Figueira (IMIP)
Rua dos Coelhos
300–Boa Vista
Recife 50070-550
Brazil

E-mail: joaoguilherme@imip.org.br