Original Article

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Paediatrics Section

Late Preterm Infant Growth and Body Composition at Corrected Term Gestation: A Cohort Study

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ABSTRACT

Introduction: Worldwide major proportion of preterm births is late preterm infants. Preterm infants are deprived of optimal in-utero nutrition leading to immediate consequences of growth failure and long-term complications like adverse neurodevelopment outcomes whereas preterm infants with fast catch up growth after birth have health consequences like obesity and hypertension in adulthood.

Aim: To assess growth of late preterm infants at their term equivalent Gestational Age (GA) and compare their growth and body composition with term infants.

Materials and Methods: This was a cohort study of late preterm (34 0/7 to 36 6/7 weeks) infants that were Appropriate for Gestational Age (AGA) and controls that were AGA term infants (39 0/7 to 40 6/7 weeks). All enrolled late preterm infants were followed-up at term equivalent (39 0/7 to 40 6/7 weeks). Growth plotted on Fenton's chart and body composition were calculated using pre-defined formula for total mid-upper arm area (cm^2), mid-upper arm muscle area (cm^2), mid-upper arm fat area (cm^2), and the Arm Fat Index (AFI) (%). The data was analysed using Epi info (version 7.2) with student t-test for continuous variables and chi-square test for dichotomous variables. A p-value of <0.05 was considered statistically significant.

Results: Out of the 135 infants enrolled, 45 were late preterm and 90 were term born infants. Median GA of the case cohort was 35 (IQR 35-36) weeks and in the control cohort it was 39 (IQR 39-40) weeks. Total 45.7% (N=35) of the late preterm infants (after excluding loss to follow-up) were below 10^{th} percentile (EUGR) at term GA. At term follow-up, mean weight and length of late preterm infants compared to term born infants was less and statistically significant. The mean Skin Fold Thickness (SKT) (cm) at triceps level 0.55 (SD 0.07) vs. 0.49 (SD 0.06), mean of calculated AFI (%) 31.25 (SD 3.08) vs. 28.19 (SD 2.5) and among late preterm infants at follow-up was more than in term infants and was statistically significant.

Conclusion: Failure to thrive is common among the late preterm infants at term equivalent GA. Late preterm infants show postnatal growth characterised by predominant fat mass accretion and less lean mass.

Keywords: Body fat, Growth retardation, Neonate

INTRODUCTION

Globally, late preterm births comprises 70% of total preterm births [1]. Late preterm infants are deprived of optimal in-utero nutritional accretion, leading to extra-uterine growth retardation (EUGR) [2,3]. An EUGR infant is not only at risk for immediate morbidities but also can have adverse long term neurodevelopment outcomes and health consequences like obesity and hypertension during adolescence and adulthood [4,5]. Conversely, a fast "catch-up" growth in late preterm babies in the early months of life will lead to higher growth rates but can lead to altered body composition (increased fat deposition) different from that of the term baby [6]. Limited published studies have evaluated the late preterm baby's growth and body composition in the initial postnatal period [7-9]. Body composition can be measured by various methods like dual-energy X-ray absorptiometry or air displacement plethysmography, but these methods are more complex, not validated and not available across all countries [3,10]. Anthropometry with SKT measurements is a rapid, non-invasive method that can either be utilised to indicate regional fatness or to predict total body fatness using simple equations. Mid Upper Arm Circumference (MUAC) is a measure of subcutaneous fat and muscle mass and indices derived from it. Total mid-upper arm area and mid-upper arm muscle area are good indicators of protein nutritional status while mid-upper arm fat area and AFI reflect the fat content [11,12].

Currently, there is paucity of literature regarding late preterm growth outcomes and body composition among low middle-income countries. This study aimed to assess the growth and body composition of late preterm infants at their term equivalent

GA and compare their growth and body composition with term infants at birth.

MATERIALS AND METHODS

This cohort study was done over one year from January 2019 to December 2019, at a tertiary care neonatal paediatric centre in India, after obtaining ethical clearance from Institutional Review Board (215523/18).

Inclusion criteria: Among all the live inborn infants, cases were enrolled as late preterm infants (34 0/7 to 36 6/7 weeks) AGA as plotted on Fenton's growth chart and controls were term infants (39 0/7 to 40 6/7 weeks) AGA, as per World Health Organisation (WHO) Multicentre Growth Reference Study (MGRS) [13,14].

Exclusion criteria: Infants with congenital anomalies, chromosomal abnormalities, requiring Neonatal Intensive Care Unit (NICU) admission at birth and infants from multifetal pregnancy were excluded from study.

All eligible babies were recruited within 24 hours postnatally, after taking informed parental consent. For each case enrolled, two controls were enrolled in the study. Obstetric history and anthropometric measurements of the infants were recorded in a pre-designed case record proforma. Anthropometric details like weight, length, head circumference, MUAC, and SKT were calculated using appropriate tools within 24 hours of birth by a single person who was trained and supervised in the measurement techniques. The body composition of all the cases and controls was calculated at birth (within 24 hours of life). All the enrolled cases were followed-up at term equivalent GA (39 0/7 to 40 6/7 weeks) and their growth was plotted on the Fenton's growth chart. Anthropometry and body composition were calculated using a predefined formula [Table/Fig-1] [11,15-17]. Details like the method of feeding, oral supplements, any postdischarge hospital admissions were recorded.

Formula	
Total Mid-Upper Arm Area (TUA)	(Arm Circumference)2/(4×ϖ)
Arm Muscle Area (UMA)	{Arm Circumference-(Triceps × ϖ)}2/(4×ϖ)
Mid-Upper Arm Fat Area (UFA)	TUA-UMA
The Arm Fat Index (Percent Arm Fat Area)	(UFA/TUA) × 100

[Table/Fig-1]: Formula for calculating body composition indices.

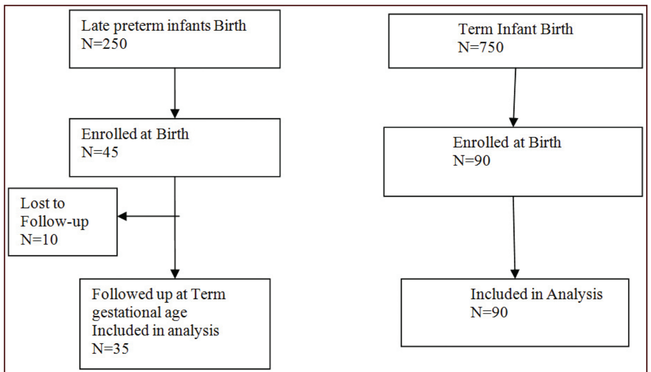
STATISTICAL ANALYSIS

Based on an earlier study which showed a mean weight difference of 300g between term-born babies and late preterm babies at the term corrected GA [18], a sample size of 65 infants, 21 late-preterm and 44 term infants were calculated to have a power of 80% and a type I error of 5%.

The data was collected; compiled and analysed using Epi info (version 7.2) using Student's t-test for continuous variables and Chi-square test for dichotomous variables was used. Descriptive statistical analysis was done using proportion, percentages, median (IQR) and mean±standard deviation. A p-value of <0.05 was considered statistically significant.

RESULTS

During the study period, there were 1000 live births. Of these, 135 babies were enrolled of which 45 were late preterm babies (34 to 36+6/7 weeks) and 90 were term-born babies (39 to 40+6/7 weeks). Among the cases, 10 were lost to follow-up at term GA and hence, 35 cases were included in the follow-up analysis [Table/Fig-2].



[Table/Fig-2]: Study flowchart.

Median GA of the case cohort was 35 (IQR 35-36) weeks and in the control cohort, it was 39 (39-40) weeks. The baseline maternal characteristics of both late preterm and term cohorts were comparable [Table/Fig-3].

Characteristics	Cases n=35	Controls n=90	p-value
Mode of delivery=LSCS n (%)	22 (62.8)	58 (64.4)	0.10
Sex-Female n (%)	17 (48.5)	43 (47.7)	0.27
Maternal age (Years) Mean±SD	24±6	23±6	0.42
Mean maternal BMI (kg/m^2)	29.7 (±2.2)	30.2 (±2.7)	0.37
Maternal haemoglobin level <11g/dL n (%)	23 (65.7)	58 (64.4)	0.09
Maternal parity-Primi n (%)	17 (48.5)	29 (32.2)	0.31
Kuppuswamy Socioeconomic status-Grade III, IV n (%)	20 (57.1)	65 (72.2)	0.09
Grade II n (%)	15 (42.8)	25 (27.7)	

[Table/Fig-3]: Baseline maternal characteristics of both groups.
LSCS: Lower segment caesarean section; BMI: Body mass index; SD: Standard deviation; p>0.05 non-significant (Chi-square test for categorical variables, Student t-test for continuous variables)

As expected at birth, late preterm infants weighed less and were shorter, even though there was no difference in head circumference. [Table/Fig-4,5] shows the comparison of anthropometric parameters and body composition indices of both groups at birth.

Anthropometric parameters	Late preterm infants Mean±SD	Term infants Mean±SD	p-value
Weight (gm)	2239±329.5	2867.29±235.56	0.04
Length (cm)	44.8±2.43	48.25±1.09	0.009
Head circumference (cm)	31.7±1.04	33±0.67	0.02
Mid upper arm circumference (cm)	8.45±1.04	10.1±0.63	0. 04

[Table/Fig-4]: Anthropometric parameters and indices at birth.
p-value significant <0.05 (Student t-test); SD: Standard deviation

Indices parameter		Late preterm infants Mean±SD	Term infants Mean±SD	p-value
Skin fold thickness (cm)	Triceps (T)	0.39±0.07	0.49±0.06	0.04
	Subscapular (S)	0.44±0.10	0.59±0.09	0.01
	T+S	0.83±0.15	1.08±0.13	0.01
Total mid upper arm area (cm²)		5.77±1.37	8.15±0.98	0.02
Arm muscle area (cm²)		4.20±1.03	5.85±0.71	0.01
Mid-upper arm fat area (cm²)		1.56±0.41	2.30±0.37	0.02
Arm fat index (%)		27.15±3.28	28.19±2.5	0.02
Ponderal Index (gm/cm³)		2.48±0.18	2.55±0.16	0.04

[Table/Fig-5]: Body composition parameters at birth.
SD: Standard deviation

In this study, 45.7% (16, N=35) of late preterm infants were below the 10th percentile EUGR at term corrected gestation. The mean of calculated AFI (%), Triceps and combined Triceps and subscapular thick term infants at corrected term GA was more than that of the infants born at term GA and this difference was statistically significant. [Table/Fig-6] shows the comparison of anthropometry and body composition indices of late preterm infants at term equivalent GA with infants born at term GA.

In this study, the most common feeding method noted among late preterm babies at follow-up was exclusive breastfeeding in 14 (40%, N=35) followed by mixed feeding of breast milk and infant formula in 10 (28.6%) and only formula feeding in 11 (31.4%). All the infants in term cohort were on exclusive breast-feeding.

In the late preterm follow-up cohort, 10 (28.6%) infants required rehospitalisation. Among them, six infants were admitted for neonatal jaundice and received phototherapy, three infants were admitted for acute gastro-enteritis and one infant was admitted for Lower Respiratory Tract Infection (LRTI). There was no mortality recorded in the late preterm infant cohort.

Measurements and indices	Late preterm infants (at term equivalent age)		Term infants		p-value
	Mean	SD	Mean	SD	
Weight (g)	2514.00	304.80	2867.29	235.56	<0.05
Length (cm)	46.35	2.47	48.25	1.09	<0.05
Head circumference (cm)	33.16	0.91	33.00	0.67	0.31
Mid upper arm circumference (cm)	10.06	0.65	10.10	0.63	0.43
Skin fold thickness (SFT) (cm)					
Triceps	0.55	0.07	0.49	0.06	<0.05
Subscapular	0.60	0.09	0.59	0.09	0.59
Triceps+sub scapular	1.15	0.15	1.08	0.13	<0.05
Total Mid Upper Arm Area (TUA) (cm²)	8.09	1.03	8.15	0.98	0.77
Arm Muscle Area (UMA) (cm²)	5.56	0.71	5.85	0.71	<0.05
Mid Upper Arm Fat Area (UFA) (cm²)	2.53	0.44	2.30	0.37	0.05
Arm Fat Index (AFI) (%)	31.25	3.08	28.19	2.50	<0.05
Ponderal Index (PI) (g/cm³)	2.52	0.20	2.55	0.16	0.40

[Table/Fig-6]: Comparison of body composition parameters and indices at term gestational age preterm infants at follow-up.
p≤0.05 significant (Chi-square test for categorical variables, Student t-test for continuous variables); SD: Standard deviation

DISCUSSION

The goal for growth of late preterm babies after birth is that, it should match with in-utero fetus growth and have similar body composition at term corrected GA. This cohort study provides insight into the growth of late preterm infants and their body mass distribution as derived from MUAC and triceps SKT involving 35 late preterm babies and 90 term babies enrolled.

In this study, 45.7% (n=16) of the late preterm babies were less than the 10th percentile (EUGR) at term corrected GA. The late preterm infants at term corrected GA were smaller and stunted as compared to term infants. The growth retardation among late preterm infants at corrected term gestation could be due to postnatal nutrition not matching up to the in-utero nutritional accretion rates over the same duration. As compared to an earlier study originating from the western countries [18], late preterm infants in this study cohort experienced higher growth failure rates; this could be explained by the socioeconomic differences and higher rates of exclusive breastfeeding in this cohort [18].

The late preterm cohort has a higher risk of postnatal growth failure both due to missing out on in-utero nutrient accretion and suboptimal feeding practices after birth [19,20].

In comparison with term babies, late preterm babies at corrected term GA had a higher SFT of triceps and subscapular region, with more arm fat area, higher mean AFI and a trend of less lean mass. Thus, the growth in the initial weeks of life shown by the late preterm babies is accompanied by a significant increase in the percentage of fat mass and less lean mass. This study finding were similar to studies by Gianni M et al., and Carberry AE et al., who concluded that preterm infants demonstrate a major deposition of fat mass in early postnatal life and have greater adiposity at term-corrected age [21,22]. The accelerated fat deposition could be an adaptive mechanism to prevent heat loss in postnatal life by creating an insulating layer. According to Al-Theyab NA et al., fat accretion creates an insulating layer and can play a role in the immediate survival of the late preterm babies following exit from the isothermic intrauterine environment. Fat accretion would in addition provide an energy reserve protecting against energy deficiency after separating from the continuous placental nutrient supply [23]. Nearly 40% of infants were on complete formula feed, which might have increased the rate of fat deposition in preterm babies. In this study, sample was not powered to find any difference in body composition among breastfed versus formula-fed infants.

In a recent study, it was concluded that preterm infants with higher weight gain until term had better neurodevelopmental outcomes [24]. Ong KK and Loos RJF in their meta-analysis concluded that preterm infants having accelerated growth during the postnatal period were at risk of long term obesity [25]. The neurodevelopmental outcomes in preterm infants were closely related to growth in Fat-Free Mass (FFM) and showed no relationship with growth in fat mass [24,26]. Thus, rather than assessing only weight gain, it is important to assess body composition by simple anthropometric techniques like SKT and MUAC.

Limitation(s)

Limitations were the exclusion of small for GA infants and the inclusion of only medically stable late preterm infants from birth to discharge. There is a need to develop normative reference values for the proportion of Fat Mass and FFM of preterm and late preterm infants at term equivalent age.

CONCLUSION(S)

Around 45.7% of the late preterm infants at term equivalent GA had failure to thrive (weight was below 10th percentile). Compared to infants born at term, late preterm infants had postnatal growth characterised by more fat mass accretion and less lean mass. A major strength of the study is the utilisation of simple, reliable, low-risk, cost-effective and validated body measurement techniques to calculate body composition indices.

REFERENCES

[1] Delnord M, Zeitlin J. Epidemiology of late preterm and early term births–An international perspective. Semin Fetal Neonatal Med. 2019;24(1):03-10. Doi: 10.1016/j.siny.2018.09.001.

[2] Dong Y, Yu JL. An overview of morbidity, mortality and long-term outcome of late preterm birth. World J Paediatr. 2011;7(3):199. Doi: 10.1007/s12519-011-0290-8.

[3] Engle WA, Tomashek KM, Wallman C. “Late-Preterm” infants: A population at risk. Paediatrics. 2007;120(6):1390-401. Doi: 10.1542/peds.2007-2952.

[4] Singhal A. Long-term adverse effects of early growth acceleration or catch-up growth. Ann Nutr Metab. 2017;70(3):236-40. Doi: 10.1159/000464302.

[5] Hsu CT, Chen CH, Lin MC, Wang TM, Hsu YC. Post-discharge body weight and neurodevelopmental outcomes among very low birth weight infants in Taiwan: A nationwide cohort study. PLoS ONE. 2018;13(2):e0192574. Doi: 10.1371/journal.pone.0192574.

[6] Roggero P, Giannì ML, Liotto N. Rapid recovery of fat mass in small for gestational age preterm infants after term. PLoS ONE. 2011;6(1):e14489. Doi: 10.1371/journal.pone.0014489.

[7] Asadi S, Bloomfield FH, Harding JE. Nutrition in late preterm infants. Semin Perinatol. 2019;43(7):151160. Doi: 10.1053/j.semperi.2019.06.008.

[8] Alexander T, Conlon CA, Gamble G, von Hurst PR, van Dorp L, Ichhpuniani B, et al. Body composition of New Zealand-born term babies differs by ethnicity, gestational age and sex. Early Hum Dev. 2020;140:104924. Doi: 10.1016/j.earlhumdev.2019.104924.

[9] Liotto N, Giannì ML, Taroni F. Is Fat mass accretion of late preterm infants associated with insulin resistance? Neonatology. 2017;111(4):353-59. Doi: 10.1159/000453523.

[10] Kuriyan R. Body composition techniques. Indian J Med Res. 2018;148(5):648-58. Doi: 10.4103/ijmr.IJMR_1777_18.

[11] Wells JCK, Fewtrell MS. Measuring body composition. Arch Dis Child. 2006;91(7):612-17. Doi: 10.1136/adc.2005.085522.

[12] Reilly JJ, Wilson J, Durnin JV. Determination of body composition from skinfold thickness: A validation study. Arch Dis Child. 1995;73(4):305-10.

[13] de Onis M. The WHO Multicentre Growth Reference Study (MGRS). World Health Organization, Department of Nutrition, Geneva, Switzerland. Accessed August 10, 2020. https://www.who.int/childgrowth/mgrs/en/.

[14] Fenton TR, Kim JH. A systematic review and meta-analysis to revise the Fenton growth chart for preterm infants. BMC Paediatr. 2013;13:59.

[15] Branson RS, Vaucher YE, Harrison GG, Vargas M, Thies C. Inter- and intra-observer reliability of skinfold thickness measurements in newborn infants. Hum Biol. 1982;54(1):137-43.

[16] Schmelzle HR, Fusch C. Body fat in neonates and young infants: Validation of skinfold thickness versus dual-energy X-ray absorptiometry. Am J Clin Nutr. 2002;76(5):1096-100. Doi: 10.1093/ajcn/76.5.1096.

[17] de Bruin NC, van Velthoven KA, Stijnen T, Juttmann RE, Degenhart HJ, Visser HK. 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(6):1195-205. Doi: 10.1093/ajcn/61.6.1195.

[18] Roggero P, Giannì ML, Liotto N, Piemontese P, Mosca F. Late preterm infants’ growth and body composition after discharge. Ital J Paediatr. 2014;40(Suppl 2):A27. Doi: 10.1186/1824-7288-40-S2-A27.

[19] Santos IS, Matijasevich A, Domingues MR, Barros AJD, Victora CG, Barros FC. Late preterm birth is a risk factor for growth faltering in early childhood: A cohort study. BMC Paediatr. 2009;9:71. Doi: 10.1186/1471-2431-9-71.

[20] Machado Júnior LC, Passini Júnior R, Rodrigues Machado Rosa I. Late prematurity: A systematic review. J Paediatr (Rio J). 2014;90(3):221-31. Doi: 10.1016/j.jped.2013.08.012.

[21] Giannì M, Roggero P, Liotto N. Postnatal catch-up after late preterm birth. Paediatr Res. 2012;72(6):637-40. Doi: 10.1038/pr.2012.128.

[22] Carberry AE, Colditz PB, Lingwood BE. Body composition from birth to 4.5 months in infants born to non-obese women. Paediatr Res. 2010;68(1):84-88. Doi: 10.1203/PDR.0b013e3181df5421.

[23] Al-Theyab NA, Donovan TJ, Eiby YA, Colditz PB, Lingwood BE. Fat trajectory after birth in very preterm infants mimics healthy term infants. Paediatr Obes. 2019;14(3):e12472. Doi: 10.1111/ijpo.

[24] Belfort MB, Rifas-Shiman SL, Sullivan T, Collins CT, McPhee AJ, Ryan P, et al. Infant growth before and after term: Effects on neurodevelopment in preterm infants. Paediatrics. 2011;128(4):e899-e906. Doi: 10.1542/peds.2011-0282.

[25] Ong KK, Loos RJF. Rapid infancy weight gain and subsequent obesity: Systematic reviews and hopeful suggestions. Acta Paediatr. 2006;95(8):904-08. Doi: 10.1080/08035250600719754.

[26] Bell KA, Matthews LG, Cherkerzian S, Palmer C, Drouin K, Pepin HL, et al. Associations of growth and body composition with brain size in preterm infants. J Paediatr. 2019;214:20-26.e2. Published online July 31, 2019. Doi: 10.1016/j.jpeds.2019.06.062.

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