Original Article

Growth status of small for gestational age Indian children from two socioeconomic strata

Vaman V. Khadilkar, Rubina M. Mandlik, Sonal A. Palande, Deepa S. Pandit, Meghna Chawla[1], Ruchi Nadar[2], Shashi A. Chiplonkar, Sandeep S. Kadam[3], Anuradha A. Khadilkar

Hirabai Cowasji Jehangir Medical Research Institute, Jehangir Hospital, [1]Smt. Kashibai Navale Medical College and General Hospital, Pune, Maharashtra, [2]St. Martha's Hospital, Bengaluru, Karnataka, [3]Ratna Memorial Hospital, Maharashtra Medical Foundation, Pune, Maharashtra, India

ABSTRACT

Aims: To assess growth and factors associated with growth in children born small for gestational age (SGA) from two socioeconomic strata in comparison to age- and sex-matched healthy controls. **Methods:** Retrospective study conducted at two hospitals in Pune, 0.5–5 years, 618 children: 189-SGA from upper socioeconomic strata (USS), 217-SGA from lower socioeconomic strata (LSS), and 212 appropriate for gestational age healthy controls were randomly selected. Birth and maternal history, socioeconomic status, length/height, and weight of children were recorded. Anthropometric data were converted to Z scores (height for age Z-score [HAZ], weight for age Z-score [WAZ]) using WHO AnthroPlus software. **Results:** The HAZ and WAZ of the SGA group were significantly lower as compared to the controls and that of the LSS SGAs were lower than USS SGAs ($P < 0.05$). Thirty two percent children were stunted (HAZ <–2.0) in USS and 49% in LSS ($P < 0.05$). Twenty nine percent children in the USS SGA group were stunted at 2 years and 17% at 5 years. In the LSS SGA group, 54% children were stunted at 2 years and 46% at 5 years. Generalized linear model revealed normal vaginal delivery ($\beta = 0.625$) and mother's age ($\beta = 0.072$) were positively associated and high SES ($\beta = -0.830$), absence of major illness ($\beta = -1.01$), higher birth weight ($\beta = -1.34$) were negatively associated for risk of stunting ($P < 0.05$). **Conclusion:** Children born SGA showed poor growth as compared to controls. Special attention to growth is necessary in children from LSS, very low birth weight babies, and those with major illnesses during early years of life.

Key words: Children, growth, small for gestational age

Introduction

Normal intrauterine growth depends on genetic potential and is influenced by hormonal and environmental factors, including maternal nutrition and health. Small for gestational age (SGA) refers to an infant born with a weight or length, two standard deviations (SDs) below the mean for his/her gestational age.

Corresponding Author: Dr. Anuradha A. Khadilkar,
Hirabai Cowasji Jehangir Medical Research Institute,
32 Sassoon Road, Pune - 411 001, Maharashtra, India.
E-mail: anuradhavkhadilkar@gmail.com

Access this article online	
Quick Response Code:	Website: www.ijem.in
	DOI: 10.4103/2230-8210.183473

In 2010, an estimated 32·4 million infants were born SGA in low- and middle-income countries (27% of live births), of whom 10·6 million infants were born at term and low birth weight (LBW). The prevalence of term-SGA babies ranged from 5·3% of live births in East Asia to 41·5% in south Asia. Most SGA infants were born in India, Pakistan, Nigeria, and Bangladesh.[1] The incidence of LBW in India is about 30% babies in contrast to 5–7% in developed countries.[2]

Impaired fetal growth can be caused by a number of fetal (genetic abnormality, congenital defects etc.)

Cite this article as: Khadilkar VV, Mandlik RM, Palande SA, Pandit DS, Chawla M, Nadar R, *et al*. Growth status of small for gestational age Indian children from two socioeconomic strata. Indian J Endocr Metab 2016;20:531-5.

maternal (disease condition, nutrition, drug use), and demographic (socioeconomic status, maternal age, obstetric history) factors.[3]

SGA infants have multi-fold increased risk of growth failure and adulthood disorders. It is related to an increased risk of perinatal morbidity and mortality, developmental disabilities, and a tendency to reduced postnatal growth with final short stature.[4] Those who experience rapid catch-up growth are at risk of developing metabolic syndrome whereas those without catch-up may end up with short stature. Thus, it is important to study the growth of children born SGA.

Growth and maturity of children is a sensitive index of health which can be influenced by many factors. However, studies suggest that very LBW children are often shorter than expected even after correction for gestational age.[5,6] Studies evaluating the effect of birth weight on growth of children report that birth weight is a significant marker of delayed growth and short stature.[7,8] Studies reveal that a large number of socioeconomic variables are associated with the physical development of children. These variables consist of parental profession, income, education,[9] birth order,[10] urbanization, etc.

About 90% of SGA children show some degree of accelerated growth during infancy that can be viewed as a compensatory mechanism for prenatal growth deficit, referred to as "catch-up growth." While 80% of infants born SGA show catch-up growth during the first 6 months of life, 90% have catch-up growth with a height SD score of more than 2 by 2 years of age. Approximately, 10% do not show catch-up growth, and most of these children continue to experience poor growth throughout childhood and remain short after the age of 2 years.[11] These individuals constitute a relatively high proportion of children and adults with short stature with a relative risk of 5–7 times than children born at normal size.[12]

Thus, the aims of this study were to assess the growth of children born SGA between two socioeconomic strata in comparison with age- and sex-matched healthy controls and assess factors associated with growth in SGA children.

Methods

This retrospective study was based on data retrieved from two hospitals in Pune city, Maharashtra, India (one catering to a lower socioeconomic class population and other to patients from upper socioeconomic class), from July 2012 to July 2014. Details regarding anthropometry and medical history were collected from case records of the hospitals. A total of 618 children of age range between 0.5 and 5 years were enrolled randomly from all 800 available records.

Children with birth weight Z-scores <−2 for their gestational age[13] were included in the study (SGA); for comparison of healthy controls were also selected. To compare growth in these SGA children across socioeconomic strata, data were selected from both lower and upper socioeconomic strata (USS). A total 189 SGA children from USS, 217 SGA from lower socioeconomic strata (LSS), and 212 appropriate for gestational age healthy controls were randomly selected.

Children with major congenital malformations and syndromic features were excluded from the study. Detailed birth history, maternal history (mode of delivery, presence of diabetes or hypertension), maternal anthropometry (height, weight), socioeconomic status, and anthropometry (length/height and weight) of the children were recorded. Anthropometric data were converted to Z scores; height for age Z scores, and weight for age Z scores (HAZ, WAZ) using WHO AnthroPlus software.[14] Data on neonatal morbidity and feeding history of children were recorded. The Institutional Ethics Committee approved the study.

Analysis was carried out using SPSS software (version 16.0.2007, SPSS Inc., Chicago, IL). Anthropometric parameters were presented as mean (SD). For quantitative variables, differences between two groups were tested by using *t*-test and between three groups were tested using one-way ANOVA. Categorical variables were analyzed using the Chi-square test and Fisher exact test when indicated. For controlling confounding variables, general liner model regression was used. The level of significance was set at $P < 0.05$.

Results

In this retrospective study, data were collected on a total 618 children (boys 52.9%). Children from both lower as well as USS were selected so as to study the growth pattern between the two groups. Around 65.5% children were from LSS and 34.5% belonged to the USS. Of the total children selected, 34.3% were of normal birth weight (weight > 2500 g) and rest of the 65.7% (50.3% LBW and 15.4% very LBW) were LBW (birth weight < 2500 g) as per the standard definition. Data analyses were performed between the three groups: Children born SGA from LSS and from USS and healthy controls.

Table 1 describes general characteristics of the subjects. Mean ages of all 3 groups were similar (2.6 years for USS, 2.8 for LSS, and 2.9 for controls) ($P > 0.1$). The HAZ and WAZ of the SGA group were significantly lower as compared to the controls ($P < 0.05$) and that of the LSS SGAs were lower than that of the USS SGAs ($P < 0.05$). However, other factors such as body mass index and mid parental height were not significantly different among the groups. Target height Z scores were significantly lower for LSS SGAs in comparison to USS SGAs and healthy controls ($P < 0.05$) [Table 1].

HAZ were further categorized as normal and stunted. Figure 1 illustrates the percentage of children who were stunted (HAZ <-2.0) in each group. Stunting was observed in 32% children in USS and 49% children in LSS ($P < 0.05$ for all). Thus, significantly higher percentages of children who were LSS SGAs were stunted.

Furthermore, when the percentage of stunted children was computed age-wise, it was noted that in the USS SGA group, 29% of children were stunted at 2 years and at 5 years, 17% were stunted whereas in the LSS SGA group, 54% of children were found to be stunted at 2 years and 46% at 5 years. Hence, there was a discrepancy in catch-up growth between LSS and USS children [Figure 2].

Table 1: General characteristics of the study subjects

	USS SGA (189)	LSS SGA (217)	Controls (212)
Age (years)	2.6±1.3	2.8±1.2	2.9±1.2
Birth weight (kg)	2±0.4*,a	1.9±0.5*,a	3.1±0.3
Height (cm)	85.2±10.8*,a	84.9±9.8*a	91.2±9.2
HAZ	−1.7±1.1*,a	−2.1±1*,a,b	-0.6±1
Weight (kg)	10.8±2.3*,a	10.7±2.2*,a	12.3±2
WAZ	−1.6±0.9*,a	−1.9±1*,a,b	−0.8±0.9
BMI (kg/m^2)	14.9±1.6	14.8±1.6	14.9±1.6
BAZ	−0.8±1.2	−0.8±1.2	−0.7±1.2
Head circumference (cm)	46.3±2.2*,a	46.5±2*,a	47.6±1.8
Mid-parental height (cm)	161.7±8.4	159.9±8.3	161.2±8.5
Target height Z score (WHO)	−1.1±1.5	−1.5±1.3*,a,b	−1.1±1.5
Mothers age (years)	27.4±4.3*,a	22.6±3.5*,a,b	24.2±4.1

*P<0.05, [a]Significantly different than controls, [b]Significantly different than USS SGA children. WAZ: Weight for age Z-score, HAZ: Height for age Z-score, BAZ: BMI for age Z score, USS: Upper socioeconomic strata, SGA: Small for gestational age, BMI: Body mass index, LSS: Lower socioeconomic strata

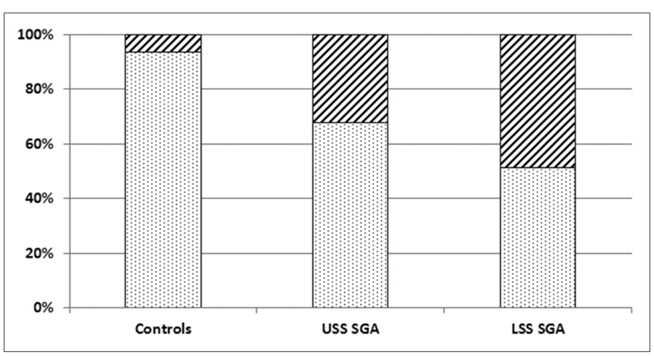

Figure 1: Percentage of stunted children ▒ normal height (>−2.0 height for age Z-score) ▨ Stunted (≤−2.0 height for age Z-score)

To determine factors associated with stunting in SGA children, generalized linear model (GLM) was used. Factors such as socioeconomic status, gestational diabetes, pregnancy induced hypertension, birth weight of children, neonatal events, breast feeding months, episodes of illness in children, maternal age, and mid parental height were considered as independent predictors for predicting stunting in children. GLM analysis revealed that children from LSS had 1.1 (0.9–1.1) times greater risk of stunting than children from USS ($P < 0.1$). Children with LBWs had 1.3 (1.2–1.4) times greater risk of stunting and those with very LBWs had 1.7 (1.4–1.8) times greater risk of stunting than controls ($P < 0.001$). Children who suffered from moderate to severe major illnesses had a 1.1 (1.0–1.1) times greater risk of stunting as compared to children who did not suffer from any major illnesses ($P < 0.1$). GLM also revealed that mother's age was positively associated with the risk of stunting (β =1.009 (1.0–1.01) ($P < 0.05$). However, other factors such as gestational diabetes, pregnancy induced hypertension, neonatal events, and mid parental height were not correlated with stunting in children ($P > 0.1$).

Discussion

Present study results revealed that the SGA group children were stunted as compared to the controls; higher percentages of children from the LSS, who were SGA, were stunted as compared to the USS. Further, there was a discrepancy in catch-up growth between LSS and USS children with higher percentage of the LSS children being stunted at 5 years. Socioeconomic status and birth weight (especially very LBW) influenced the variation in children's height. The other significant predictors for stunting in SGA children also included severe illness episodes and maternal age.

Maternal factors in pregnancy such as inadequate diet, intrauterine infection, and inflammation are the major determinants of LBW babies and SGA babies.[15] From epidemiological studies, it is apparent that suboptimal

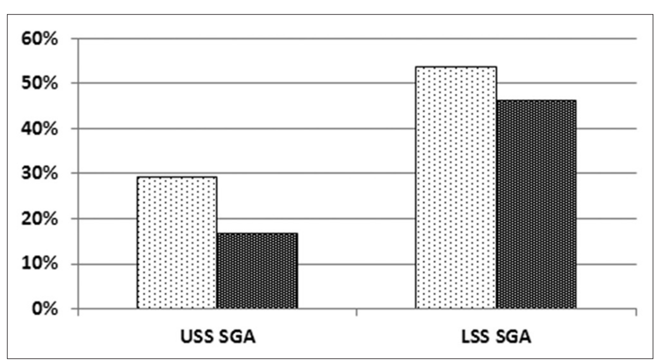

Figure 2: Percentage of Stunted children in upper socioeconomic strata and LSS at the age of 2 years and 5 years ▒ 2 years ▩ 5 years

breastfeeding and complementary feeding practices, recurrent infections, and micronutrient deficiencies are important proximal determinants of stunting.[16,17] However, in the present study, we did not find any association between breastfeeding and stunting. Linear growth failure also occurs within a complex interplay of more distal community and societal factors, such as access to healthcare and education, urbanization, population density, and social support networks, which have been captured in the WHO Conceptual Framework on Childhood Stunting, as recently reviewed.[18]

The major factor for stunting which was observed in our SGA children was economic status. Since socioeconomic and nutritional problems as well as preventable diseases are key contributors to LBW in developing countries, it is very important to assess the effect of socioeconomic status on growth in SGA infants, which may be compromised. Iranian study showed the effect of socioeconomic variables on growth of children. Along with socioeconomic status, education of parents had direct effect on growth.[19] Finding from Silva *et al*. study revealed that both socioeconomic status and birth weight were significantly correlated with stature whereas the sex of children, maternal age, size of family, and ordinal position of the child in the family were not related.[20] Our findings are in agreement with this study and have identified LBW and socioeconomic status as significant determinants of stunting in children.

In a cross-census study from Brazil, prevalence of stunting was 10.9%, which was higher for children whose mothers had 0–4 years of schooling, 13.3% were poorer, 14.8% had more than one child younger than 5 years at home.[21] Similarly, in a study by Saldiva *et al*.,[22] stunting was high in poorer section. Both the studies portray socioeconomic inequalities and lack of access to basic health care and social assistance. The unassisted children from these regions become vulnerable in their full development, as persistent nutritional deficiencies in childhood impair weight initially and then slow growth, finally affecting height, thus; socioeconomic level was associated as an important risk factor for stunting.[23] Studies have shown that repeated or prolonged episodes of diarrhea during childhood increases the risk of stunting; neonatal morbidity is thus a significant risk factor for poor growth in children.[24,25] Though we could not establish any association of stunting with maternal education in present study, the findings pertaining to economic class and illness in childhood are in accordance with the above studies.

Other variable that had significant effect on stunting in our study was maternal age. It is well known that children born to adolescent mothers are vulnerable to infant mortality and poor health outcome. Raj *et al*.[26] showed that children born to mothers who were married below the age of 18 were at a higher risk of stunting and underweight compared to children of women who had married at age 18 or older. Thus, maternal age has a significant effect on stunting in children. Another similar study enunciated that after controlling for maternal, paternal, and household and social factors, there was an improvement in child health outcomes (linear growth and weight) as the age of the mother at first birth increases to age 27–29 years.[27]

Nutritional catch-up patterns normally vary substantially across socioeconomic groups; rural study from Ethiopia found that average catch-up growth in height-for-age is almost perfect among children in relatively better-off households whereas among the poorer children, relative growth failure is more persistent. Household wealth, and in particular access to services, can lead to substantial catch-up growth early on in life.[28] In a large prospective British cohort study, differences in growth pattern of height in LBW infants between social classes were examined. Results show a graded association between birth weight and height at each of the follow-up examinations between ages 7 and 23 months with greater catch-up growth in upper social class.[29] Our results are on par with this where catch-up growth was more in higher economic class. Researchers have broadly mentioned two possibilities for greater "catching up" in growth in LBW infants born to higher socioeconomic class. First, environmental influences associated with social class affecting growth in the fetus as well as during childhood.[30] Another explanation is that the higher social condition has a favorable effect on the growth of LBW infants because of education, nutritional supplements, and health care.

Hence, the growth retardation in small for gestational age babies can be overcome by improved social conditions and proper health care from childhood to adulthood. We recommend that better socioeconomic condition can improve stature of children and can prevent the hazardous effect of high risk factors. On the other hand, there were certain limitations in the present study, there was no data available on diet history and history of illness otherwise the correlation of these social factors also would have been studied for stunting risk.

Conclusion

Children born SGA showed relatively poor growth and stature as compared to healthy controls; SGA children from the LSS, very LBW babies and those with major illnesses during early years of life are at a greater risk for growth deficit. Critical evaluation and special attention toward growth of children who are SGA is warranted.

Acknowledgments

We would like to greatly thank director of our institute Dr. Uma Divate, Pfizer India Ltd., for funding this project and for providing the necessary facilities and also would like to thank University Grants Commission, India, for funding Ms. Rubina Mandlik for this project. We appreciate the help of other staff members of institute during the data collection. Each of the authors made substantial contributions to the study design, data collection, data analyses, and the writing or editing of the manuscript.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Lee AC, Katz J, Blencowe H, Cousens S, Kozuki N, Vogel JP, *et al.* National and regional estimates of term and preterm babies born small for gestational age in 138 low-income and middle-income countries in 2010. Lancet Glob Health 2013;1:e26-36.
2. Bhargava SK, Ramji S, Srivastava U, Sachdev HP, Kapani V, Datta V, *et al.* Growth and sexual maturation of low birth weight children: A 14 year follow up. Indian Pediatr 1995;32:963-70.
3. Bernstein PS, Divon MY. Etiologies of fetal growth restriction. Clin Obstet Gynecol 1997;40:723-9.
4. de Zegher F, Francois I, van Helvoirt M, Van den Berghe G. Clinical review 89: Small as fetus and short as child: From endogenous to exogenous growth hormone. J Clin Endocrinol Metab 1997;82:2021-6.
5. Kean V. Assessment of growth. In: Kliegman R, Bhrman R, Jenson HB, Stanson BF, editors. Nelson Textbook of Pediatrics. 18th ed., Ch. 14. Philadelphia, Pa, USA: Saunders Elsevier; 2007. p. 72.
6. Ford GW, Doyle LW, Davis NM, Callanan C. Very low birth weight and growth into adolescence. Arch Pediatr Adolesc Med 2000;154:778-84.
7. Gutbrod T, Wolke D, Soehne B, Ohrt B, Riegel K. Effects of gestation and birth weight on the growth and development of very low birthweight small for gestational age infants: A matched group comparison. Arch Dis Child Fetal Neonatal Ed 2000;82:F208-14.
8. Ranke MB, Vollmer B, Traunecker R, Wollmann HA, Goelz RR, Seibold-Weiger K, *et al.* Growth and development are similar in VLBW children born appropriate and small for gestational age: An interim report on 97 preschool children. J Pediatr Endocrinol Metab 2007;20:1017-26.
9. Belmont L, Stein ZA, Susser MW. Comparison of associations of birth order with intelligence test score and height. Nature 1975;255:54-6.
10. Eiben OG, Barabás A, Kontra G, Pantó E. Differences in growth and physical fitness of Hungarian urban and rural boys and girls. Homo 1996;47:191-205.
11. Albertsson-Wikland K, Boguszewski M, Karlberg J. Children born small-for-gestational age: Postnatal growth and hormonal status. Horm Res 1998;49 Suppl 2:7-13.
12. Chaudhari S, Otiv M, Hoge M, Pandit A, Mote A. Growth and sexual maturation of low birth weight infants at early adolescence. Indian Pediatr 2008;45:191-8.
13. Oostdijk W, Grote FK, de Muinck Keizer-Schrama SM, Wit JM. Diagnostic approach in children with short stature. Horm Res 2009;72:206-17.
14. WHO AnthroPlus Software. Available from: http://www.who.int/growthref/tools/en/. [Last accessed on 2014 Jun 04].
15. Prendergast AJ, Humphrey JH. The stunting syndrome in developing countries. Paediatr Int Child Health 2014;34:250-65.
16. Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, *et al.* Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet 2013;382:427-51.
17. Dewey KG, Mayers DR. Early child growth: How do nutrition and infection interact? Matern Child Nutr 2011;7 Suppl 3:129-42.
18. Stewart CP, Iannotti L, Dewey KG, Michaelsen KF, Onyango AW. Contextualising complementary feeding in a broader framework for stunting prevention. Matern Child Nutr 2013;9 Suppl 2:27-45.
19. Mohammadzadeh A, Farhat A, Amiri R, Esmaeeli H. Effect of birth weight and socioeconomic status on children's growth in Mashhad, Iran. Int J Pediatr 2010;2010:705382.
20. Silva PA, Birkbeck J, Williams S. Some factors influencing the stature of Dunedin 7 year old children: A report from the Dunedin Multidisciplinary Health and Development Research Unit. Aust Paediatr J 1985;21:27-30.
21. Ramos CV, Dumith SC, César JA. Prevalence and factors associated with stunting and excess weight in children aged 0-5 years from the Brazilian semi-arid region. J Pediatr (Rio J) 2015;91:175-82.
22. Saldiva RD, Silva LF, Saldiva PH. Rating anthropometric and food con-juice in children under five years residents em a municipality in the northeastern semi-arid region with partial ture cober family scholarship program children. Rev Nutr Camp 2010;23:221-9.
23. Yang Z, Huffman SL. Nutrition in pregnancy and early childhood and associations with obesity in developing countries. Matern Child Nutr 2013;9 Suppl 1:105-19.
24. Ricci KA, Girosi F, Tarr PI, Lim YW, Mason C, Miller M, *et al.* Reducing stunting among children: The potential contribution of diagnostics. Nature 2006 23;444 Suppl 1:29-38.
25. Were FN, Bwibo NO. Early growth of very low birth weight infants. East Afr Med J 2006;83:84-9.
26. Raj A, Saggurti N, Winter M, Labonte A, Decker MR, Balaiah D, *et al.* The effect of maternal child marriage on morbidity and mortality of children under 5 in India: Cross sectional study of a nationally representative sample. BMJ 2010;340:b4258.
27. Finlay JE, Özaltin E, Canning D. The association of maternal age with infant mortality, child anthropometric failure, diarrhoea and anaemia for first births: Evidence from 55 low-and middle-income countries. BMJ 2011;1:e000226.
28. Outes I, Porter C. Catching up from early nutritional deficits? Evidence from rural Ethiopia. Econ Hum Biol 2013;11:148-63.
29. Teranishi H, Nakagawa H, Marmot M. Social class difference in catch up growth in a national British cohort. Arch Dis Child 2001;84:218-21.
30. Aizawa R. Health problems of the low birth weight infants. In: Fujiwara M, Watanabe G, editors. Sougou Eisei Koushueisei. [A Textbook of Public Health]. Tokyo: Nankoudou; 1978. p. 942-8.