Original Paper

Status of Height in Children Aged 4 to 14 Years in Relation to Mid Parental Height- An Observational Study

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Abstract

Introduction: The adult height of a growing child largely depends on the heredity. The present height status of a child can be determined by mid parental height. This study is an initial step to determine the status of height in children between 4 years to 14 years in relation to mid parental height.

Objective: To assess the status of height in relation to parental height in children aged between 4 to 14 years and to assess other factors (birth order, number of younger siblings, gestational age at birth, birth weight, feeding in first six month of age, maternal age at child birth, maternal education, crowding, monthly family income and area of residence) that may influence height, other than parental height.

Materials and Methods: A cross-sectional observational study was conducted on 100 children of age between 4 years to 14 years attending outpatient department and inpatient department of Sher-E-Bangla Medical College Hospital, Barisal from 1st March 2011 to 31st August 2011. Data were collected through interviewing with pre-designed questionnaire and anthropometry.

Results: A total 100 children of 4 to 14 years of age were enrolled during the study period. Among them 46 were male and 54 were female. Among all the cases under study, 60 cases were appropriate in status of their height in relation to their parental height, whereas 20 cases were tall in status and another 20 cases were short in status in relation to their mid-parental height. Apparently, it seems both the tall and short cases were equal in number, but the mean of Z scores of all children under the study was -0.432 and median was -0.55 which indicates the overall loss of height. Higher maternal age, appropriate gestational age, higher birth weight, first birth order and higher maternal educational status came out to be having strong influence on higher height in relation to mid parental height while higher total family income had weaker influence.

Conclusion: Height status of our country is almost static in condition, but there is slight inclination towards being shorter in future. Though very apparent but male children are in slight shorter while female children are apparently taller in status, which may be due to early age of puberty in case of female children.

Key-words: Mid parental height, 4-14 years, Status of height.

Introduction

Growth in childhood is considered to be a sensitive indicator of children's health[1]. Height in childhood is a good predictor of height in adulthood[2]. Height is a classical example of an inherited human trait. More than a 100 years ago, Francis Galton used height data to study the resemblance between parents and offspring, concluding that ‘when dealing with the transmission of stature from parents to children, the average height of the two parents, is all we need to know about them’[3]. Genetic effects on height are well accepted[4,5]. The adult height of a child who grows up under favorable environmental circumstances is to a large extent dependent on heredity. It may thus be predicted from the height of parents, though with a considerable degree of uncertainty which arises from the various possible combinations of the many genes controlling stature, as well as from epigenetic and environmental effects and their interactions[2]. Numerous studies showed that height is one of the most heritable human phenotypes. Typically, the proportion of the sex and age-adjusted variance of height attributable to familial factors (heritability) is estimated as 80%. Most of this heritability may be owing to genetic factors because, for height, the non-genetic causes of sib resemblance are usually negligibly small[6].

Environmental influences have also been identified[7-10], with several factors, especially in early life, acting to delay growth. Depending on the severity and duration

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of the inhibitory factor, adult height may also be affected[1]. However, given the increases in height seen across many populations[11-13] the magnitude of genetic and environmental influences may have changed over time[14,15]. Parental height was most strongly associated with childhood height. Third or later-born and those with three or more siblings had deficits of 1–2 cm in both generations. Other factors, particularly indicators of socioeconomic position, showed weaker effects in the younger generation[16]. Because genetic factors are of great importance as determinants of growth and height potential, it is always worthwhile to assess a patient's stature relative to that of siblings and parents[17]. Mid Parental Heights (MPH) are widely used to help assess an individual child's growth[18]. The calculation of MPH has been a standard procedure for assessing individual children since it was first described by Tanner[19]. The MPH, which is the average of both parents' heights, plotted on the height centile chart at age 18 years after adjustment for sex, can be used as a crude prediction of that child's future adult height; the MPH expressed as a centile or standard deviation score is commonly used to assess whether a child's current height centile is consistent with genetic expectations[20]. Tanner's original paper suggested that the sex adjustment should be made by adding or subtracting 13 cm to/from one parent's height and plotting both on one chart, with the midpoint constituting the MPH and a child's adult height (Target range) would be expected to fall within 8.5 cm of the MPH[21,22]. The parental target height can be readily ascertained by calculating the mean parental height and adding or subtracting 6.5 cm from male or female children respectively[17,26]. This gives the height expected at 18 years of age and this can be plotted on the percentile chart to predict the child's height at the appropriate age. This can normally vary by two standard deviations (SD) each way[23]. The 2-SD range for this calculated parental target height is about ±10cm[24]. This measurement aids distinction between genetic and constitutional growth disturbances. This calculation is not appropriate if either natural parent is not of normal stature[23]. The technique is a valid, nonintrusive, inexpensive and simple method for predicting adult height in adolescent children, free of growth limiting diseases[25].

Materials and Methods

This cross-sectional observational study was undertaken with the objective to assess the status of height in children in relation to MPH with the following methodology at Out-Patient Department (OPD) and In-Patient Department (IPD) of Sher-e Bangla Medical college Hospital (SBMCH), Barisal, with a sample size of 100 during the period of March 2011 to August 2011. This study was done by Non-probability, convenient sampling from the population who fulfills the selection criteria. Variables were age (in months), sex, birth order, number of younger siblings, gestational age (GA) at birth, birth weight, feeding in first six months, maternal age at child birth and educational status, socio-economic status (person per room, monthly income, residence) child's height, "Z" score of child's height for age, maternal height and paternal height. All the children of age between 4 years to 14 years attending SBMCH within the study period were included and children or parents with a chronic illness, genetic disorders (down syndrome, turner syndrome), musculo-skeletal dysplasia, congenital heart disease, chronic lung disease and those on medication such as corticosteroids and children with eating disorders like anorexia nervosa were excluded from the study.

A semi-structured data collection sheet was designed, after necessary modification following pre-testing and this was used as data collection instrument. Enrollment was done just after registration and informed written consent was taken from the mother or the attendant. Child's details were taken from history, anthropometric examination of both child and parents and records of admissions. A stadiometer was used for measuring height and was recorded to the nearest 0.1 centimeter and then plotted in CDC growth chart for MPH. Data was analyzed with SPSS software (ver. 13.0).

Results

One hundred formed the study group.

- The mean of "Z" scores of all children was -0.432
- The median of "Z" scores of all children was -0.55.

This indicates to the overall height status in relation to MPH which is a bit shorter than their previous generation. In Table-II, among the tall children (20), in respect to MPH, 19(25.93%) and 06(13.04%) are male (p-0.0056).

Table-I: Distribution of status of height in relation to MPH as per age (n=100)

Age in month	Number (%)	Status of height			p value
		Appropriate (%)	Short (%)	Tall (%)	
48-83	44(44)	28 (63.63)	6 (13.63)	10 (22.72)	0.00034
84-119	22(22)	10 (45.45)	8 (36.36)	4 (18.18)	
120-143	18(18)	8 (44.44)	4 (22.22)	6 (27.27)	
144-168	16(16)	14 (87.5)	2 (12.5)	0 (0.0)	
Total	**100(100)**	**60 (60)**	**20 (20)**	**20 (20)**	

Table-II: Distribution of status of height in relation to MPH as per sex (n=100)

Sex	Number (%)	Status of height			p value
		Appropriate (%)	Short (%)	Tall (%)	
Male	46 (46)	28 (60.87%)	12 (26.09%)	06 (13.04%)	0.0056
Female	54 (54)	32(59.26%)	8 (14.81%)	14 (25.93%)	
Total	**100 (100)**	**60 (60%)**	**20 (20%)**	**20 (20%)**	

Table-III: Distribution of height in relation to MPH as per birth order (n=100)

Birth order	Number (%)	Status of height			p value
		Appropriate (%)	Short (%)	Tall (%)	
First	64 (66)	36 (56.25)	12 (18.75)	16 (25)	0.0013
Second	28 (28)	20 (71.43)	4 (14.29)	4 (14.29)	
Third or later	08(08)	04 (50)	4 (50)	0 (0)	
Total	**100(100)**	**60 (60)**	**20 (20)**	**20 (20)**	

Table-IV: Status of height in relation to MPH according to the GA of the child at birth (n=100)

GA at birth (weeks)	Number (%)	Status of height			p value
		Appropriate (%)	Short (%)	Tall (%)	
<38	16 (16)	10 (62.5)	6 (37.5)	0 (0.00)	0.0013
38-42	82 (82)	48 (58.54)	14 (17.07)	20 (24.39)	
>42	2 (2)	2 (100)	0(0.00)	0 (0.00)	
Total	**100 (100)**	**60 (60)**	**20 (20)**	**20 (20)**	

Table-V: Status of height in relation to MPH according to birth weight (n=100)

Birth weight (in kg)	Number (%)	Status of height			p value
		Appropriate (%)	Short (%)	Tall (%)	
<2.5	4 (4)	2 (50)	2 (50)	0 (0)	0.0013
2.5-4	62 (62)	36 (58.06)	12 (19.35)	14 (22.58)	
>4	2 (2)	0 (0)	2 (100)	0 (0)	
Not known	32 (32)	22 (68.75)	4 (12.5)	6 (18.75)	
Total	**100(100)**	**60 (60)**	**20 (20)**	**20 (20)**	

Table-VI: Status of height in relation to MPH according to feeding in first 6 months after birth (n=100)

Feeding in first 6 month after birth	Number (%)	Status of height			p value
		Appropriate (%)	Short (%)	Tall (%)	
Only breast milk	66 (66%)	36 (54.55%)	10 (15.15%)	20 (30.3%)	0.00034
Formula milk	6 (6%)	06 (100%)	0 (0%)	0 (0%)	
Both	24 (24%)	18 (66.67%)	6 (33.33%)	0 (0%)	
Others	4(4%)	0 (0%)	4 (100%)	0 (0%)	
Total	**100(100%)**	**60 (60%)**	**20 (20%)**	**20 (20%)**	

Table-VII: Status of height in relation to MPH according to maternal age at child birth (n=100)

Maternal age at child birth (years)	Number (%)	Status of height			p value
		Appropriate (%)	Short (%)	Tall (%)	
<20	10 (10)	08 (80%)	02 (20%)	00 (00%)	0.0001
20-25	34 (34)	16 (47.06%)	12 (35.29%)	06 (17.65%)	
25-30	34 (34)	20 (58.82%)	06 (17.65%)	08 (23.53%)	
30-35	20 (20)	14 (70%)	00 (00%)	06 (30%)	
>35	02 (02)	02 (100%)	00 (00%)	00 (00%)	
Total	**100(100)**	**60 (60%)**	**20 (20%)**	**20 (20%)**	

Table-VIII: Status of height in relation to MPH according to maternal education (n=100)

Maternal education	Number (%)	Status of height			p value
		Appropriate (%)	Short (%)	Tall (%)	
Illiterate	20 (20)	10 (50%)	08 (40%)	02 (10%)	
Primary	16 (16)	06 (37.5%)	06 (37.5%)	04 (25%)	0.0001
Secondary	24 (24)	16 (66.67%)	02 (8.33%)	06 (25%)	
Higher secondary	26 (26)	18 (69.23%)	04 (15.38%)	04 (15.38%)	
Graduate-University	14 (14)	10 (71.43%)	00(00%)	04 (28.57%)	
Total	**100(100)**	**60 (60%)**	**20 (20%)**	**20 (20%)**	

Table-IX: Status of height in relation to MPH according to person per room (n=100)

People per room	Number (%)	Status of height			p value
		Appropriate (%)	Short (%)	Tall (%)	
<1	2 (2)	02 (100)	00 (00)	00 (00)	0.00034
1-2	52 (52)	32 (61.34)	06 (11.54)	14 (26.92)	
2-3	24 (24)	16 (66.67)	02 (8.33)	06 (25)	
>3	22 (22)	10 (45.45)	12 (54.55)	00 (00)	
Total	100 (100)	60(60)	20 (20)	20 (20)	

Table-X: Status of height in relation to MPH as per residence (n=100)

Residence	Number (%)	Status of height			P value
		Appropriate (%)	Short (%)	Tall (%)	
Urban	52 (52)	32 (61.54)	06 (11.54)	14 (26.92)	0.013
Semi-urban	14 (14)	08 (57.14)	06 (42.86)	00 (00)	
Rural	34 (34)	20 (58.82)	08 (23.53)	06 (17.65)	
Total	100(100)	60 (60)	20 (20)	20 (20)	

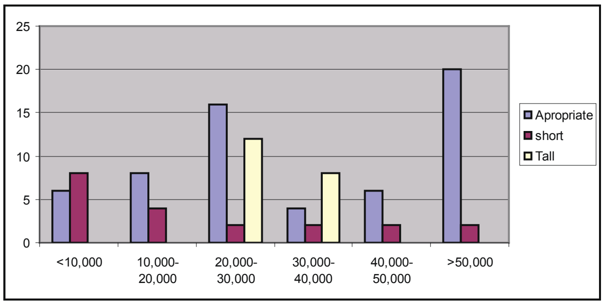

Chart-1: Status of height in relation to MPH according to monthly family income (n=100).

Discussion

Total 100 children of 4 to 14 years of age were enrolled, among them 46 cases were male and 54 were female. Sixty, 20 and 20 cases were appropriate, tall and short in status in relation to MPH respectively. Apparently, both the tall and short cases seemed to be equal, but the mean of "Z" scores of all children under the study was -0.432 and median was -0.55 indicating overall height is a bit shorter than their previous generation. Recent study in Taiwan shows increase in height between the two generations of Taiwanese were 1.49–3.19 cm for boys and 2.03–2.61 cm for girls. These increases lie between those reported for Chinese children in Hong Kong (4.2–4.8 cm) and children in Sweden (0.7– 1.0 cm)[26].

In a recent cross sectional study with 1544 children from daycare centers of Santo Andre, Brazil where height was classified according to the 2000 CDC. Stepwise Forward Regression method was used including age, gender, birth weight, breastfeeding duration, age of mother at birth and period of time they attended the daycare center. The results showed that children presented mean z scores of height above the median of the CDC reference. Girls were taller among both genders. The z scores tended to rise with age. A Pearson Coefficient of Correlation, 0.93 for Height was documented indicating positive association of age with height[27]. In this study regarding the status of height in relation to age in months, 60% cases were found to be appropriate in height and 20% were short and another 20% were tall in respect to their MPH. Here we see that after the age of 144 months (12 years) almost all (87.5%) height data became appropriate and the relationship between age and status of height in relation to MPH is significant.

Recent retrospective analysis indicates that adult height prediction slightly under-predicts female but often over-predicts male children's eventual height[17]. In the present study, among the male children, 26.09% were short and 13.04% were tall, in contrast, among female, 14.81% were short and 25.93% were tall in respect to their MPH. There is a significant relationship between sexual difference and the status of height in relation to MPH. This may be due to the fact that puberty of male children is about 2 years later than female[26,28,29]. The present study revealed the significant relationship between birth order and height in relation to MPH. This reflects that the trend of being short is prominent in third or later birth order and the trend of being tall is prominent in first birth order and that correlates well with other studies[16].

Sixteen percent were having less than 38 weeks GA at birth and of them 62.5% were appropriate in height, 37,5% were short and no one was tall in respect to their MPH. Eighty two cases were having 38-42 weeks GA at birth and of them 58.54% were appropriate in height and 17.07% were short and 24.39% were tall in respect to their MPH. 02% were having more than 42 weeks GA at birth and of them 100% were appropriate in height and there were no short or tall in respect to their MPH. This reflects the trend of being short in preterm children. This result also correlates with other studies[30]. This study reflects the trend of being short in children having LBW. Growth in utero is linked with adult risk of several chronic diseases. Another study in Department of Pediatrics, University of Bologna, Italy, which studied a total of 49 subjects born at term with birth weight below the 10th centile were consecutively examined for idiopathic short stature and found subjects with birth weight below the 10th centile remained as short adults with final height below target height[30]. This result is also consistent with current study.

This study reflects the importance of breast feeding in the first six months of life for attaining good height in adulthood. In comparison with a study conducted in Dhaka medical college, a strong correlation was found between infant and child's feeding index with length of a child[27]. This study reflects that the chance of being appropriate in height increases with maternal age at child birth. It was found also significant when compared to other study[31].

In our study, this significant relationship was found between maternal education and child's height in respect to MPH. One meta-analysis of data from 15 countries showed that children's height for age is closely linked to mother's education. In 6 of the 15 countries the coefficient for primary education is significant and positive, and in 13 countries coefficient for secondary education is significant and positive[31]. Another meta analysis in China found strong correlation between maternal education and child's height[30,32].

This study reflects the bad effect of more people per room. In MRC National Survey of Health and Development, University College, London, UK, found that low parental social class was associated with shorter adult stature in offspring in a national birth cohort. Since short adult stature is a risk factor for serious illness, particularly heart disease, origins of the observed class differences were sought in the childhood environment and in combined genetic and environmental factors represented by MPH and birth weight. In addition to social class the childhood environmental factors of birth order, number of surviving younger siblings, overcrowding and mother's education were found to be significant and independent predictors of adult height, even after adjusting for parental heights and birth weight, and had therefore a long-term intra-generational effect[30,33]. In this study, significant relationship was found between monthly family in come with status of height in respect to MPH. Shoeps et al also found relationship between lower income and decrement in height[29].

In present study, 52% cases were urban and of them 61.54% were appropriate in height, 11.54% were short and 26.92% were tall in respect to MPH. Fourteen percent cases were semi-urban and of them 57.14% were appropriate in height and 42.86% were short in respect to MPH. 34% were rural and of them 58.82% were appropriate in height, 23.53% were short and 17.65% were tall in respect to MPH. We found that most of the short children were from rural area.

Conclusion

Male children are in slight shorter while female children apparently are in taller status, which may be due to early age of puberty in case of female children. Higher maternal age, appropriate GA, higher birth weight, first birth order and higher maternal educational status came out to be having strong influence on higher height in relation to MPH while higher total family income has weaker influence.

References

1. Waterlow JC, Buzina R, Keller W et al. The presentation and use of height and weight data for comparing the nutritional status of groups of children under the age of 10 years. Bull WHO 1977; 55:489-8.

2. Tanner JM, Whitehouse RH, Marshall WA, et al. Prediction of adult height from height, bone age, and occurrence of menarche, at ages 4 to 16 with allowance for mid-parent height. Arch Dis Child 1975; 50:14-26.

3. Galton F: Regression towards mediocrity in hereditary stature. Journal of the anthropological institute 1886; 15:246–63.

4. Sinclair DDP. Human Growth after Birth. 6th ed. Oxford: Oxford Medical Publications1998:460.

5. Mueller WH. The genetics of size and shape in children and adults. In: Falkner F, Tanner JM (eds). Human Growth. New York: Plenum Press, 1986.

6. Visscher PM, Medland SE, Ferreira MA et al. Assumption-free estimation of heritability from genome-wide identity-by-descent sharing between full siblings. Plos Genet 2006; 2:e41.

7. Kuh DL, Wadsworth M. Parental height: Childhood environment and subsequent adult height in a national birth cohort. Int J Epidemiol 1989; 18:663–8.

8. Bobak M, Bohumir K, David AL et al. Socioeconomic factors and height of preschool children in the Czech Republic. Am J Public Healt 1994; 84:1167–70.

9. Cernerud L, Elfving J. Social inequality in height. A comparison between 10 years old Helsinki and Stockholm children. Scand J Soc Med 1995; 23:23–7.

10. Kromeyer K, Hauspie RC, Susanne C. Socioeconomic factors and growth during childhood and early adolescence in Jena children. Ann Hum Biol 1997; 24:343–53.

11. Takaishi M. Secular changes in growth of Japanese children. J Pediatr Endocrinol 1994; 7:163–73.

12. Hughes JM, Li L, Chinn S et al. Trends in growth in England and Scotland,1972 to 1994. Arch Dis Child 1997; 76:182–9.

13. Cole TJ. Secular trends in growth. ProcNutrSoc2000; 59:317–24.

14. Cernerud L. The association between height and some structural social variables: a study of 10 years old children in Stockholm during 40 years. Ann Hum Biol 1993; 20:469–76.

15. Prebeg Z. Changes in growth patterns in Zagreb school children related to socio-economic background over the period 1973–1991. Ann Hum Biol 1998; 25:425–39.

16. Leah Li and Chris Power, Influences on childhood height: comparing two generations in the 1958 British birth cohort International Journal of Epidemiology 2004; 33:1320–8.

17. Rosenfeld RG, Cohen P. Disorders of growth hormone or insulin like growth factor secretion. in: Sperling Paediatric Endocrinology, 3rd ed. Saunders Elsevier 2008; 8:254-334.

18. Charlotte M Wright, Tim D Cheetham, The strengths and limitations of parental heights as a predictor of attained height, Arch Dis Child1999; 81:257–60.

19. Tanner JM, Goldstein H, Whitehouse RH. Standards for children's height at ages 2–9 years allowing for height of parents. Arch Dis Child 1970; 45:755–62.

20. Charlotte M Wright, Tim D Cheetham. The strengths and limitations of parental heights as a predictor of attained height, Arch Dis Child 1999; 81:257–60.

21. Child Growth Foundation. Growth chart, birth-18 years. London: Harlow Printing, 1st ed, 1995, p409.

22. Buckler J, Tanner J. 10–20 years' height and weight. Welwyn Garden City: Castlemead 1996; 50:105-6.

23. GPNotebook. Mid parental percentile. (http://www.gpnotebook.co.uk/simplepage.cfm? ID=133824460).

24. Grimberg A, De leon D. The requisites in paediatrics, Disorders of growth, in Paediatric Endocrinology, 1st ed. Elsevier Mosby 2005: 8;127-67.

25. Sherar LB, Mirwald RL, Baxter-Jones AD et al. Prediction of adult height using maturity-based cumulative height velocity curves. J Pediatr 2005 Oct; 147(4):508-1.

26. Pen-Hua, Su Shuli, Jia-Yuh Chen. Estimating Final Height from Parental Heights and Sex in Taiwanese. Human Biology 2007; 79:283-92.

27. Khatoon T et al. Association between Infant and Childfeeding Index and Nutritional Status: Results from a Cross-sectional Study among Children Attending an Urban Hospital in Bangladesh. J HEALTH POPUL NUTR 2011 Aug; 29(4):349-56.

28. Patel L, Clayton PE. Normal and disordered growth in Brook's clinical paediatric endocrinology, 5th ed. Blackwall publisher 2006; 8:90-112.

29. Shoeps et al. Nutritional status of pre-school children from low income families. Nutrition Journal 2011; 10:43

30. Kuh D, Wadsworth M. Parental height: childhood environment and subsequent adult height in a national birth cohort. MRC National Survey of Health and Development, University College, London, UK 1989 Sep; 8(3):663-8.

31. Desai S, Alva S. Maternal education and child health: Is there a strong causal relationship? Demography 1998; 35(1):71-81.

32. Yuyu Chen, Hongbin Li. Mother's Education and Child Health: Is There a Nurturing Effect? JEL Classification I21; 14 February, 2006.

33. Zucchini S, Cacciari E, Balsamo A et al. Final height of short subjects of low birth weight with and without growth hormone treatment. Arch Dis Child 2001; 84:340–3.