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Original Article

Height trends in the population of Rabwah, district Chiniot, Pakistan and comparison with WHO standards

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Abstract
Human height is a quantitative trait with high heritability, controlled by many gene pairs. It is influenced by environmental factors such as nutrition, disease and lifestyle. A study was carried out to compare the height trends of the local population of Rabwah with WHO standards. A total of 4293 accurate observations (male=2084 female =2209) were recorded. The age group chosen for present study is 5-19 years which is the phase of growth and height increase. Heights of the parents and siblings up to 25 are also recorded for further analysis. The R- Programming and smoothing spline technique were applied to analyze the height trends of the collected data. The average height of male adults is found to be 172cm (67.71" ± 3.98) and for females it is159 cm (62.55" ± 3.06).Comparison of male and female height trend indicates that growth rate is almost the same up to 13 years, but it is higher for males after 13 years age. The female height trend revealed non-significant increase beyond 16 years, while, for males this trend increased until 19 years. According to mid-parental height plots, 73% male and 84% female data lies within ±3 inches range of mid-parental heights. The comparison of percentile curves of local height trend and WHO curves indicate that local height trends are significantly lower than the WHO standard. The 50th percentile curve of the local population was found in the range of 25th percentile curve of WHO standard.
Key Words: Height trends, mid-parental, WHO standards, Rabwah

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INTRODUCTION

The human height, a polygenic trait, is influenced by both genetic and environmental factors (Preece, 1996; Susanne, 1975).Average height is considered to be a measure of well-being and health of a population (Bolton-Smith, 2000; Komlos and Baur, 2004). Case and Paxson (2006) mentioned height as an indicator to cognitive development. Genetics play a major role in the determination of height although it is much less significant with regard to differences within a population (Lai, 2006). According to Lango *et al.* (2010) a genome-wide association (GWA) study has identified over 180 loci linked with human height comprising hundreds of genetic variations. One of the studies have suggested PHOG gene located in the sex chromosome X (pseudoautosomal region) to be significantly impacting body height (Nance *et al.,* 1998).

Although adult height is generally the result of his genetic makeup, however underlying medical conditions, overall health and pattern of nutrition can influence the final height attained (Lavin, 2009). The final body height achieved is attributed to a number of environmental factors influencing during pregnancy, infancy and adolescence (Butler and Goldstein, 1973). Moreover, diseases as well as psychosocial factors result in a slower growth rate (Malleson, 1991; Skuse *et al*., 1996). Studies have revealed that age of the mother also has some role in determining the height achieved, presenting a directly proportional relation with the child's height (Savage *et al.,* 2013).

Malnutrition together with chronic/acute under nutrition has played a role in causing stunted growth in different populations (De-Onis *et al.,* 2011). Hermanussen *et al.* (2015) studied the relationship between skeletal morphology and lifestyle and concluded that rapid changes, evident in the skeletal morphology and height are due to altered lifestyles. It was believed earlier that growth patterns are also influenced by ethnic groups. However, a study group (Multicentre Growth Reference) negated this

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belief by showing that variation in infant growth is higher within population groups as compared to groups of different countries (De-Onis *et al*., 2006). Height of adults has been found to vary from less than 60 cm (2 ft) to more than 260 cm (8 ft 6 in). Males are taller than females on average. Genetically expected height is generally determined by the method of corrected mid-parental height which is based on either addition or subtraction of 13 cm to/from one of the parents height and dividing the sum by two (Tanner *et al.,* 1970). Children that fail to meet the normal mid-parental height range are investigated by doctors for potential causes (Lavin, 2009). The relation of a child's height to his parents is also used to evaluate child's health in growth related therapies (Ranke and Lindberg, 1996; Kristrom *et al.,* 1995).

The present study is aimed at exploring and assessing the height trends of school-aged children of Rabwah and comparing it with WHO standards. Mid-parental methods are also used to analyze the attained heights of studied cohort.

MATERIALS AND METHODS

Data structure and survey forms

The present study was carried out during April, 2014 to April, 2015 on 4293 school-aged children. The data comprised 2084 males and 2209 females from 5 to 19 years. The students included in the study belonged to randomly located eight schools and two colleges of Rabwah, district Chiniot, Punjab, Pakistan.

The survey form was designed in Urdu language with a clearly stated set of instructions. The correct procedure and time for measuring and recording heights was provided in the forms. Data comprised information on students, their parents' heights and that of their siblings between 18-25 years of age. Survey forms were distributed among students for them to add the relevant information according to the given instructions. Forms were collected by responsible coaching staff of the organization under the Principal's supervision. A separate team of researchers was responsible for modeling the data for analysis. Age was rounded off to the nearest year. Inaccurate observations were discarded. The heights recorded in inches were converted to centimeters.

Mid-parental heights were calculated by the following formulae:

Male Mid-Parental height (cm) =Father's Height + Mother's Height +13/2

Female Mid-Parental height (cm) = Father's Height-13 + Mother's Height/2.

Statistical analysis

SPSS version 20 was used for data entry purpose and R programming language was used for data analysis. R programming, other than GUI (graphical user interface) of R language provides some special features of its CRAN package graphics which were used for fitting smoothing splines. Smoothing spline technique derived by Whittaker (1923) is a comprehensive method to analyze observed data values. It is a technique that studies trends as well as roughness of the data offering a mid-way between fitting linear regression and fitting a curve. Smoothing parameter was set at 0.5 which can have any value greater than zero.

RESULTS AND DISCUSSION

The results of the analysis showed that average adult height for boys' is 172 cm (67.71" ±3.98) and for girls is 159 cm (62.55"±3.06).The male to female stature ratio is found to be 1.08. The general height trend for both genders at all ages is distributed around the 50th percentile. In case of male children the variation in height at age 5 ranges from 77-122 cm. The height for males is steadily increases between the ages 5-16, gradually becomes less steep between 16-19 years (Fig. 1). The spread at age 5 for females varies from 79-123 cm (Fig. 2).

Comparison of male and female heights at 50th percentile.

The height of male and female subjects is relatively equal between the ages 5 to 9 years. It ranges from around 109 cm at age 5 to 130 cm at age 9. The average height of female subjects between 9-13 years is a little higher than that of male subjects. Female height trend shows no significant increase beyond 16 years. The height of male subjects increases considerably between 13-18 years as compared to that of female subjects. Male height spurt is longer and steeper than the female height spurt on the whole (Fig. 3). Puberty results in dramatic hormone driven changes accompanied by growth spurts. The onset of puberty for females is from 8-13 years while that of males is from 10-15 years (Soliman *et al*, 2014).

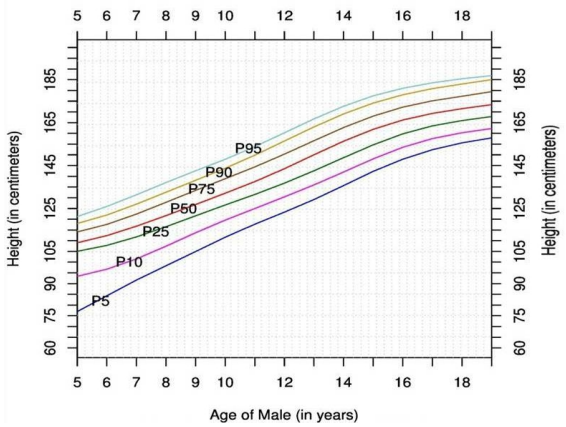

Figure 1: Height of males at 5th to 95th percentiles.

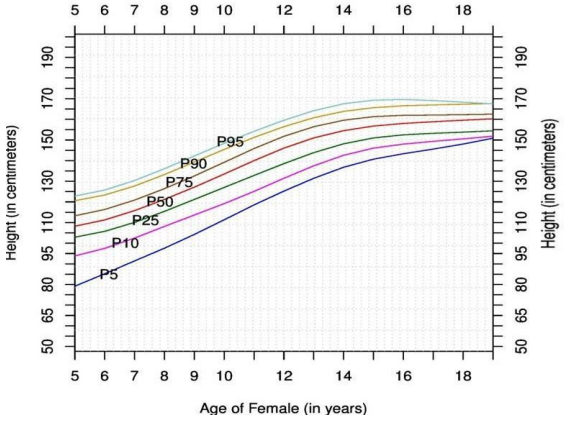

Figure 2: Height of females at 5th to 95th percentiles.

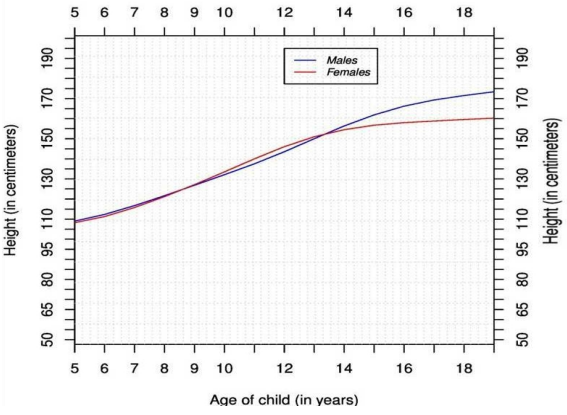

Figure 3: Comparison of male and female height indicating growth rate between 5-19 years at 50th percentile.

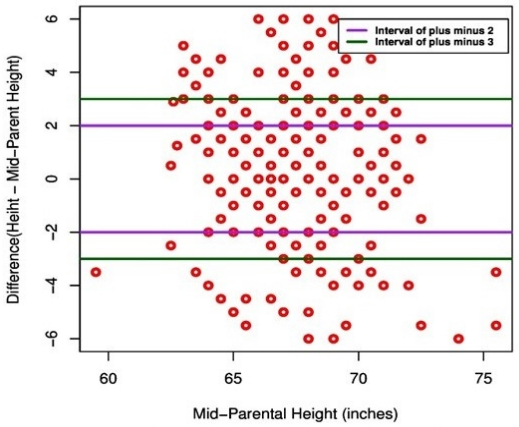

Figure 4: Comparison for males attained final height (18 to 25) with mid-parental height

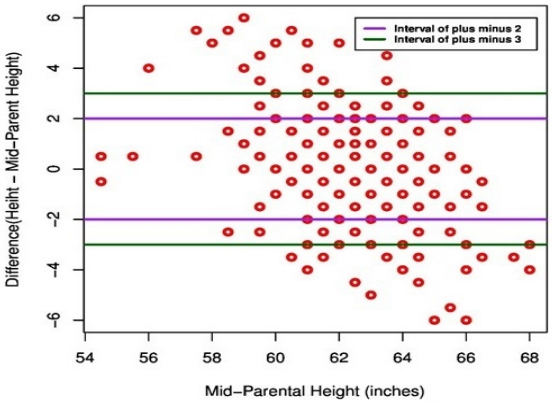

Figure 5: Comparison for females attained final height (18 to 25) with mid-parental height

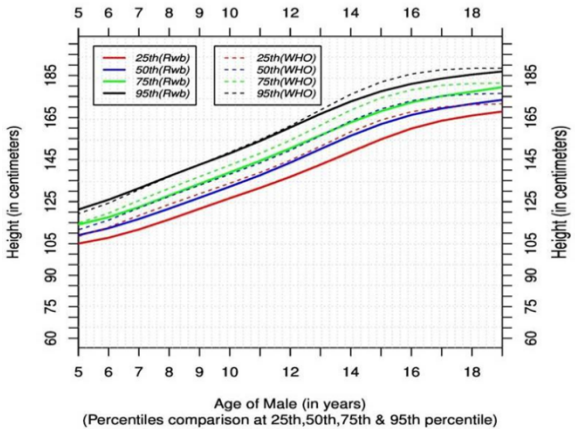

Figure 6: Comparison of male height with WHO 2007 reference standards.

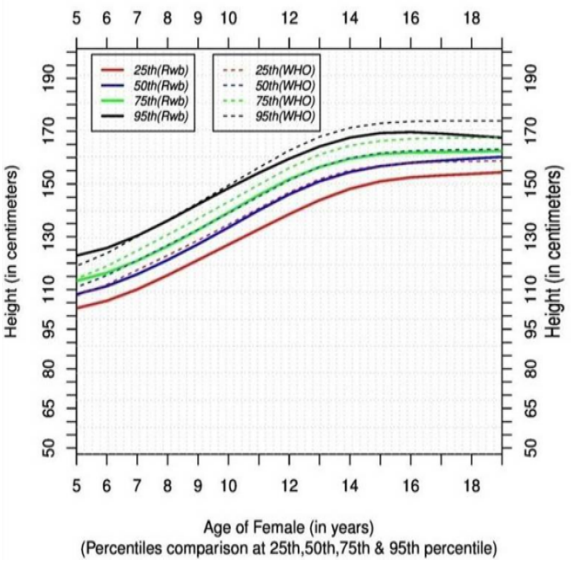

Figure 7: Comparison of female height with WHO 2007 reference standards

On average, male growth spurt lasts longer than females, eventually making them taller than females. This is supported by Tofani (1972) who presented the findings that earlier growth spurts are greater in magnitude and lesser in intensity while late growth spurts are lesser in magnitude but have greater intensity.

Mid-parental height analysis

For Mid-parental analysis data set consisted of heights of siblings between 18-25 years of age who have attained their final heights. The analysis for males shows that 73% data lies within ±3inches range of mid-parental height (Fig. 4), while 84% female data lies within ±3 inches range of mid-parental height (Fig. 5). Graphical view shows that expected height attained by subjects generally tend towards mid-parental height. As explained by Tanner *et al.* (1970), mid-parental height determines the expected height of a child as being almost equal to the average of parents' heights.

Based on the fact, a particular child can be compared to mid-parental height (mph) to check his growth pattern. This is in agreement with Wright and Cheetham (1999) who mentioned that children following normal growth patterns can be accessed through mid-parental heights. However, they also discussed the fact that mid-parental height could mislead in case of very tall or very short heights, because of the regression towards the mean (Galton, 1886).

Comparison of height trends with WHO standards

Male height comparison at 25th, 50th, 75th, and 95th percentiles

The male height increment for both Rabwah and WHO, has the steepest rates between ages 5-16 years on the whole. The rate of increase slows down between the ages 16-18 years before it becomes constant. The 50th percentile curve of the local population lies in the range of the 25th percentile curve of WHO standards (Fig. 6).

25th and 50th percentiles

The overall height of male subjects of Rabwah at every age is about 5cm less than that of the WHO recommendations.

75th percentile

At 5 years of age, the average height of male subjects of Rabwah is similar to WHO standards. However, as the age increases, the height of male subjects decreases to about 3-5 cm from the recommended height at all ages. However, at 19 years of age, the average height attained by male subjects becomes almost equal to the recommended height.

90th percentile

At 5 years of age, the average height of male is 1cm above the recommended height. At ages 8-12 years, it becomes equal to the recommended height. At ages 12-18 years, it is lower than that recommended by WHO but eventually becomes similar at 19 years.

Female height comparison at 25th, 50th, 75th, and 95th percentiles

The female height increment for both Rabwah and WHO, has the steepest rate between ages 7-13 years on the whole. The rate of increase slows down between the ages 12-18 years before it becomes constant (Fig. 7).

25th and 50th percentile

The overall height of female subjects of Rabwah is about 5 cm less than the WHO recommended height.

75th percentile

At 5 years of age, the average height of a female child of Rabwah is same as the WHO recommended height. However with increasing age, it decreases to about a 3-5 cm from WHO standards.

90th percentile

At age 5, the subjects of Rabwah are 4 cm taller than the WHO recommended height. At age 9, WHO and Rabwah follow the same pattern. At age 10 and above, the average height is less than that of WHO standards by 3-5 cm. There is a significant difference between the heights of school-aged children of Rabwah and the WHO standards. The 50th percentile of our male and female subjects was found to be at 25th percentile of WHO 2007 reference. (Fig. 6 & 7). The variations in our study could possibly be attributed to hereditary reasons and socioeconomic conditions of the area since they are considered to be one of the most common factors affecting height as described by Tanner (1978) and Bogin (1988). One similar study was carried out in Lahore, Pakistan based on data obtained from 12 randomly distributed schools of Lahore. The study group consisted of children between 5-12 years (Mushtaq *et al.,* 2012). However, the study concluded non-significant differences between WHO reference (WHO, 2007) standards and the observed height patterns of its subjects.

CONCLUSION

The variation in heights of the studied population suggests that further research with extensive surveys are required to develop standard height patterns for our country's population. Identification of standard patterns would serve as a guide to pediatrics and child health care programs. This research provides insights to further height-based studies in order to analyze the possible causes of deviation from the WHO standards.

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REFERENCES

BOGIN, B. 1988. Patterns of human growth. Cambridge, Cambridge University Press.

BOLTON-SMITH, C. 2000. Accuracy of the estimated prevalence of obesity from self-reported height and weight in an adult Scottish population. *J Epidemiol Community Health*. **54**(2):143–148.

BUTLER, N.R., AND GOLDSTEIN, H. 1973. Smoking in pregnancy and subsequent child development. *BMJ*. **4**:573–575.

CASE, A. AND PAXSON, C. 2006. Stature and status: height, ability, and labor market outcomes. *J. Polit. Econ*., **116**(3):499-532.

LAI, C.Q. 2006. How much of human height is genetic and how much is due to nutrition. Scientific American, Nature America, Inc. (http://www.scientificamerican.com/article/how-much-of-human-height/).

DE-ONIS, M., BLOSSNER, M. AND BORGHI, E. 2011. Prevalence and trends of stunting among pre-school children, 1990–2020. *Public Health Nutr*. **15**(1):142–148.

DE-ONIS, M., et al. 2006. WHO Child Growth Standards. *ActaPaediatr*. **95**:450.

GALTON, F. 1886. Regression towards mediocrity in hereditary stature. *J.R. Anthropol. Inst*., **15**:246–63.

HERMANUSSEN, M., SCHEFFLER, C., GROTH, D. AND ABMANN, C. 2015. Height and skeletal morphology in relation to modern life style. *J PhysiolAnthropol*., **34**:41.

HIMES, J.H., ROCHE, A.F., THISSEN, D. AND MOORE, W.M. 1985. Parent-SpecificAdjustments for Evaluation of Recumbent Length and Stature of Children. *Pediatr*. **75**(2):304-313.

KOMLOS, J. AND BAUR, M. 2004. From the tallest to (one of) the fattest: the enigmatic fate of the American population in the 20th century. *Econ. Hum. Biol*., **2**:57–74.

KRISTROM, B., KARLBERG, J. AND ALBERTSSON-WIKLAND, K. 1995. Swedish Pediatric Study Group for GH treatment. Prediction of the growth response of short prepubertal children treated with growth hormone. *ActaPadiatr*. **84**:51–57

LANGO, A.H. et al., 2010. Hundreds of variants clustered in genomic loci and biological pathways affect human height. *Nature*. **467**(7317):832–838.

LAVIN, N.M.D. 2009. Manual of Endocrinology and Metabolism. In: *Endocrinology and*

metabolism and diabetes (ed. L.W. Wilkins) (4th Edition). pp. 832.

MALLESON, P.N. 1991. Pain syndromes, disability, and chronic disease in childhood. *CurrOpinRheumatol*.**3**:860–866.

MUSHTAQ, M.U., GULL, S., MUSHTAQ, K., ABDULLAH, H.M., et al. 2012. Height, weight and BMI percentiles and nutritional status relative to the international growth references among Pakistani school-aged children. *BMC Pediatrics*. **12**:31.

NANCE, W.E., PANDYA, A., MAES, H., et al. 1998. The PHOG gene on Xpter-p22.32 appears to be GTL for stature in adolescent twins. *Twin Res*., **1**:103.

PREECE, M.A. 1996. The genetics contribution to stature. *Horm Res*., **45**(2):56–58.

RANKE, M.B. AND LINDBERG, A. 1996. Growth hormone treatment of short children born small for gestational age or with Silver-Russell syndrome: results from KIGS (Kabi International Growth Study), including the first report on final height. *ActaPadiatr Suppl*., **417**:18–26

SAVAGE, T., DERRAIK, J.G.B., MILES, H.L., MOAT, F., HOFMAN, P.L. AND CUTFIELD, W.S. 2013. Increasing maternal age is associated with taller stature and reduced abdominal fat in their children. *PLoS One*., **8**(3):e58869.

SOLIMAN, A., DE-SANCTIS, V. AND ELALAILY, R. 2014. Nutrition and pubertal development. *Indian J EndocrinolMetab*., **18**(1):39–47.

SKUSE, D., ALBANESE, A., STANHOPE, R., GILMOUR, J. AND VOSS, L. 1996. A new stress-related syndrome of growth failure and hyperphagia in children, associated with reversibility of growth hormone insufficiency. *Lancet*. **348**:353–358.

SUSANNE, C. 1975. Genetic and environmental influences on morphological characteristics. *Ann Hum Biol*., **2**:279–287.

TANNER, J.M., GOLDSTEIN, H. AND WHITEHOUSE, R.H. 1970. Standards for children's height at ages 2:9 years allowing for height of parents. *Arch Dis Child*.**45**:755–762.

TANNER, J.M. 1978. Fetus into man: Physical growth from conception to maturity. 3rd edition. Cambridge, MA: Harvard University press. p. 14.

TOFANI M. 1972. Mandibular growth at puberty. *Am J Orthod*. **62**:176-94.

WHITTAKER, E.T. 1923. On a new method of graduation". *Proc Edinb Math Soc*., **41**:63–75.

WORLD HEALTH ORGANIZATION. 2007. WHO Child Growth Standards. (http://www.who.int/growthref/en/)

WRIGHT, C.M. AND CHEETHAM, T.D. 1999. The strengths and limitations of parental heights as a predictor of attained height. *Arch Dis Child*. **81**:257–260.