Height Velocity Percentile Curves in Indian Children: Time to Move Beyond Standard Growth Charts

ALPESH GOYAL1 AND RAJESH KHADGAWAT2
From the Departments of 1,2Endocrinology and 3Metabolism, All India Institute of Medical Sciences (AIIMS), New Delhi, India.
2rajeshkhadgawat@hotmail.com

Growth assessment forms an important component of holistic evaluation of a child, as it provides information on his/her overall well-being. Growth may be assessed using single-point height estimates (cross-sectional data) or serial measurements of height (longitudinal data). Rate of change in height measured over a period of 6-12 months (height velocity) is a far more sensitive measure of growth than single time-specific height measures. For this reason, abnormal height velocity alone (<–2 SDS for 1 year or <–1.5 SDS for 2 years) even in absence of short stature (current height <–2 SDS) is considered as a criterion for evaluation of growth disorders, including acquired growth hormone deficiency [1]. Tracking an individual using height velocity percentile curves may help differentiate those with normal variant of growth and pubertal development such as constitutional delay of growth and puberty (who are expected to grow at a normal height velocity) from those with pathological short stature. Additionally, height velocity may be extremely helpful in showing early effectiveness of a medical intervention and predicting final stature (using height velocity and peak height velocity) [2].

Population-specific reference curves are needed for growth interpretation, due to variations in genetic and environmental factors affecting growth in different populations. Currently, the growth charts available for Indian children aged >5 years are based on cross-sectional data [3-5]. Height velocity charts are already available for few countries [6-8]; there is an urgent need to generate good quality height velocity data for our country. This demands longitudinal follow-up of years – involving a healthy, sufficiently large population, which is geographically and ethnically diverse – in order to capture the normal variability in height.

We have previously studied height velocity over 12 months period in apparently healthy school children aged 3-17 years from Delhi [9]. The data were derived from 5635 participants belonging to seven fee-paying schools in five zones of Delhi. Pubertal assessment was also performed for a subset of participants (n=1553) and data from study participants at pubertal onset (boys: testicular volume ≥4 mL, and girls: thelarche) were used to determine the 3rd, 50th and 97th percentiles for age at onset of puberty. The peak height velocity was attained in boys and girls at age of 12-12.9 years and 10-10.9 years, respectively; and was significantly higher in boys compared to girls. On studying the distribution of height velocity according to pubertal staging, we noted that maximum height velocity was attained in Tanner stage 3 in boys and in stage 2 among girls. The boys achieving late puberty (>97th centile) had higher height velocity compared to those with normal puberty (3rd–97th centile) or early puberty (<3rd centile), but no such relationship was observed among girls. This was the first large study from India evaluating height velocity data over 12 months among healthy school children from Northern India, which also looked at pubertal status at baseline in a subset of study participants, in order to account for the relationship between puberty and height velocity. However, this study had certain limitations. The data, although derived from a large population, was not representative of the population belonging to lower socioeconomic status or rural areas. This would call for a study with database derived from a more heterogeneous population, including children from different socioeconomic status, ethnicity and regions. The longitudinal follow-up was limited to one year only. Study with longer follow-up would have provided more information about height velocity. Finally, the pubertal assessment was only done at baseline; a longitudinal assessment could have resulted in more accurate determination of age of pubertal onset, and the relationship between puberty and height velocity.

In this issue of Indian Pediatrics, Khadilkar, et al. [10] have published a study on height velocity percentiles in healthy school children aged 5-17 years from Delhi and Pune. The study is based on seven year longitudinal
follow-up (2007-2013) of a cohort of 2949 children belonging to affluent class, including only individuals
with a minimum of three annual measurements in the final
analysis. Annual measurements were performed at similar
time of the year, and by same set of observers, to exclude
the seasonal and inter-observer bias. Authors have
reported age- and gender-specific smoothed percentiles
(3rd, 10th, 25th, 50th, 75th, 90th and 97th) for height velocity
using the lambda-mu-sigma (LMS) method. The peak
height velocity was attained at 10.5 years in girls (median
6.6 cm/year) and 13.5 years in boys (median 6.8 cm/year).
In their peak height velocity-centered analysis (including
subset of study participants who had data for two
preceding and succeeding years around the peak), peak
velocities were higher – 9.7 cm/year (10.8 years) in girls
and 10.3 cm/year (13.4 years) in boys.

The authors should be complemented for a well-
conducted study with data generated using sufficiently
long follow-up of seven years from two different cities in
Northern and Western India. The height velocity
percentile curves will serve as a useful addition to the
existing growth charts. The study, a useful complement to
pre-existing height velocity data derived from our study,
recruited children from affluent class only, thereby
limiting generalizability of results to economically
deprived and rural population. It is important to remember
that a significant proportion of children catered to by
pediatricians/endocrinologists in public hospitals belong
to the later group. Second, pubertal assessment was not
performed in the study participants; therefore, correlation
between peak height velocity and pubertal staging in this
group of study participants could not be derived.
Because the longitudinal data was sufficiently long, an
assessment of pubertal status at baseline and on follow-
up (even in a subset of study participants) could have
provided peak height velocity for pubertal stage and
enabled generation of separate percentile curves for early-,
delayed- and averagely-maturing children. However,
analysis of pubertal status is one of the most difficult tasks to be performed in population-based
studies – less acceptable to parents as well as school
authorities, and challenging to the investigators.

To conclude, height velocity is an extremely sensitive
marker of growth, which provides information about
tempo of growth in an individual. An assessment of
height velocity is extremely important in early diagnosis of
disordered growth, even before a diagnosis based on
the absolute cut-off becomes apparent. The generation of
height velocity percentile curves based on longitudinal
follow-up of healthy school children is a welcome
addition to existing growth reference curves for our
population. However, it may just be a beginning in the
right direction; good quality large-scale multicenter
longitudinal data of sufficiently long duration involving
ethnically and culturally diverse study population is
needed in the near future. Inclusion of children belonging
to economically weaker section of society and rural
background will aid in generalizability of the study
results. Additionally, assessment of pubertal status at
baseline and longitudinal follow-up will provide peak
height velocity for pubertal status and chronological age,
making the results more creditable. A well-conducted
study meeting above requirements will also help generate
separate percentile curves for adolescents with differing
timings of sexual maturity.

Funding: None; Competing interest: None stated.

REFERENCES

1. Consensus guidelines for the diagnosis and treatment of
growth hormone (GH) deficiency in childhood and
adolescence: Summary statement of the GH Research
2000;85:3990-3.
2. Sherar LB, Mirwald RL, Baxter-Jones AD, Thomis M.
Prediction of adult height using maturity-based cumulative
3. Agarwal DK, Agarwal KN, Upadhyay SK, Mittal R,
Prakash R, Rai S. Physical and sexual growth pattern of
affluent Indian children from 6-18 years of age. Indian
4. Khadilkar V, Yadav S, Agrawal KK, Tamboli S, Banerjee
M, Chetan A, et al. Revised IAP growth charts for height,
weight and body mass index for 5- to 18-year-old Indian
5. Khadilkar VV, Khadilkar AV, Cole TJ, Sayyad MG. Cross-
sectional growth curves for height, weight and body mass
6. Kelly A, Winer KK, Kalkwarf H, Oberfield SE, Lappe J,
Gilsanz V, et al. Age-based reference ranges for annual
2014;99:2104-12.
A longitudinal study of growth patterns in school children
in Taipei area I: Growth curve and height velocity curve. J
8. Gerver WJ, de Bruin R. Growth velocity: A presentation of
9. Dabas A, Khadgawat R, Gahlot M, Surana V, Mehan N,
Ramot R, et al. Height velocity in apparently healthy north
10. Khadilkar V, Khadilkar A, Arya A, Ekbote V, Kajale N,
Parthasarathy L, et al. Height velocity percentiles in Indian