Clinical standards for growth velocity in height of Belgian boys and girls, aged 2 to 18 years

The present paper presents the first clinical standards for growth velocity in height of Belgian boys and girls, based on purely longitudinal data. Growth charts are provided with centiles of height for age, along with the growth velocity curves of the typical early, average and late maturing child in the population.

These new growth velocity standards provide centile lines which allow to judge whether a child's growth velocity over a one-year interval lies within the limits of normal variation for his age, irrespective of his stage of maturation. They also provide information about variability in the individual patterns of growth velocity in the population and can, as such, also be used to evaluate the normality of a child's pattern in growth velocity over a longer period of time. Age at peak velocity occurred in 95% of the children within an age range of about 4 years.

The average age at peak height velocity at puberty was 14.0 years (S.D. = 1.0) in boys and 11.6 years (S.D. = 0.9) in girls. Peak height velocity was in the average 9.1 cm/year (S.D. = 1.4) in boys and 7.5 cm/year (S.D. = 1.1) in girls.

The representativity of these new standards with respect to the actual Belgian population was tested by comparison with recent cross-sectional data, collected on a large number of subjects. These new charts will find useful applications in longitudinal health screening surveys, and in clinical follow-up studies, where interest lies in the examination of a child's growth retardation in relation to some disease, or catch-up growth, as a response to subsequent medical treatment.

Key words: Growth velocity standards, longitudinal growth study, maturation.

Introduction

An individual child's growth curve of height for age does not perfectly match any of the centile lines in conventional cross-sectional standards. Especially during adolescence, we notice a considerably steeper slope in the growth pattern of an individual child than in the average pattern of height for age as shown by the means in cross-sectional standards. This phenomenon has been thoroughly discussed by Tanner et al. (1966a, b). Recent standards of height for age, allowing for the variability in the shape of individual growth curves, have been published by Tanner and Davies (1987) for the American, by Susanne et al., for the Polish and by Wachholder and Hauspie (1987) for the Belgian population. Such longitudinally-based charts consist of conventional centile lines, but also provide estimates of the growth pattern of the typical early, average and late maturing child in the population.

Although the above mentioned longitudinally-based distance charts already allow a much better evaluation of the individual shape of a child's growth curve, we still need a reference to determine how big or how small a child's change in growth pattern over a particular age interval may be, before we start considering it is abnormal. These sort of questions can only be answered by standards for growth velocity. Such standards are based on longitudinal data and usually provide centiles for whole-year increments in height at each age. They allow to check if a child's increase in height from one year to another lies within the limits of normal variation in the population, irrespective of his maturational
status. However, since these standards are generally also unconditional for the variation in tempo or maturation in the population, they suffer from the same phase-difference effect as the distance standards (Wachholder and Hauspie, 1987), and are as such still not apt to evaluate correctly a child's pattern in growth velocity over a longer period.

The present study deals with centiles of whole-year increments for height in Belgian boys and girls, together with curves, showing the variability in the true individual shape of the growth velocity curves of early, average and late maturing children. The methods used in this study are based on techniques recently used by Tanner and Davies (1985). The present growth velocity charts complete the longitudinally-based height for age (distance) standards for the Belgian population (Wachholder and Hauspie, 1987) and are particularly indispensible to judge whether a child's growth rate over time is abnormal. So, for the interpretation of individual patterns in growth velocity, we need reference data about the variability in the shape of the true individual growth velocity patterns in the population. They will find useful applications in longitudinal health screening surveys, where the aim is to verify if the increase in height from one year to another is within acceptable limits for his age, as well as in clinical follow-up studies, where interest lies in the examination of a child's growth retardation as a response to some disease, or catch-up growth, as a response to some intervention or medical treatment. The actual charts are based on the same data as the longitudinally-based distance charts for which the representativity for the Belgian population was shown (Wachholder and Hauspie, 1987).

Subjects and Methods

The data of the present study comes from the Belgian Growth Study of the Normal Child (Graffar, 1958), which was conducted between 1955 and 1975. Detailed description of the survey, socio-economic background of the subjects, and measuring techniques were given elsewhere (Falkner, 1961; Graffar, 1958; Graffar and Corbier, 1965; Wachholder and Hauspie, 1987).

The actual growth velocity charts were constructed on purely longitudinal data on height growth of 48 boys and 50 girls, measured at regular intervals from early childhood until adulthood. Growth velocity was actually calculated as the increase in size over a whole-year interval. Centile values were estimated from the mean yearly increments and standard deviations at each age, while the centile lines were obtained by fitting a mathematical model to the various sets of centile lines at each age.

The growth velocity curves of the typical early, average and late maturing child in the population were obtained as the mathematical first derivative (velocity) of the respective curves in the height for age standards.

Details about methodology and calculations are given in the Appendix section.

Results

The growth velocity charts are shown in Figure 1 for boys and in Figure 2 for girls. The height velocity centiles (yearly increments in cm/year) are given in Table 1 for boys and in Table 2 for girls. The ages correspond to the midpoints of the one-year intervals. So, the value of 4.7 cm/year for P50 in boys at age 10, for example, relates to the mean increase in height between age 9.5 and 10.5, as calculated over the 48 boys.

The centiles on these charts simply depict the distribution in yearly height increments