Comparison of Commonly Used Methods to Predict the Final Height in Constitutional Tall Stature

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What is already known on this topic?

The literature on predicting the adult height of young children with tall stature is scant.

What this study adds?

Proves that adult height can be predicted in prepubertal children with constitutional tall stature.

Abstract

Objective: To determine the accuracy of adult height prediction in children with constitutional tall stature.

Methods: The medical records of 138 non-syndromatic prepubertal and early pubertal children (52 male, 86 female) with a height of ≥90th percentile born between the years 1975 and 1988 were included in this study. Using the Bayley-Pinneau (BP) and Tanner-Whitehouse I (TWI) prediction methods, their height standard deviation score (SDS) at referral was compared with their height SDS at age 17 years when measured at the IDF conscription center.

Results: While remaining tall, the height SDS at age 17 years was lower than that at referral decreasing from 2.13 ± 1 to 1.65 ± 1.21 in boys and from 2.48 ± 1 to 2.15 ± 1 in girls.

Conclusion: The prediction by the BP and TWI methods can be useful for estimating adult height in constitutional tall stature even in the prepubertal and early pubertal period. However, the fallibility of these methods should be kept in mind during clinical practice. We think that this study will shed light on these issues.

Keywords: Tall stature, height prediction, growth, adult height, familiar tall stature

Introduction

The social impact of tall stature has caused controversial opinions. Tall stature may have advantages in adult life according to some authors (1); by others there are reports that tall children often suffer from social unattractiveness and may have difficulties in finding partners in their adult age. Additionally, it has also been reported that tall adolescent girls have a higher prevalence of depression (2,3,4,5).

Similar to the parents of children with growth retardation, also parents of children with early tall stature are concerned about their adult height (6). To answer their queries, a series of height prediction methods have been developed (7,8,9,10,11,12). The most frequently used methods are that of Bayley-Pinneau (BP) based on skeletal age (7) and that devised by Tanner and Whitehouse which includes mid-parental height in their formula (9).

The majority of height prediction studies were performed in untreated children of short stature of various etiologies (10,11,12,13,14,15,16,17) and in those treated by growth hormone in order to estimate the success of their treatment

(18,19). We found only 2 reports of height prediction for children diagnosed with constitutionally tall stature (20,21). Both parents of short and tall statured children are concerned whether their children will reach adult height within normal limits (5,22).

In the present study, we compared two methods of height prediction in a large group of prepubertal or early pubertal children with constitutional tall stature, with the actual height measured at age 17 years.

Subjects

The clinical data of children with constitutional tall stature (height > 90th percentile) referred between the years 1975-1998 was retrieved from the medical records of the Pediatric Endocrine Clinic at the Beilinson Hospital and Schneider Children Medical Center. Children with syndromic tall stature and endocrine disorders were excluded. One hundred seventy-three individuals (62 boys and 111 girls) fitted the diagnosis of constitutional tall stature. For 138 records (52 males, 86 females), measurements were available at the Israel Defense Forces (IDF) conscription center. All eligible Israeli adolescents, both boys and girls at age 17 years, a year before their conscription, undergo medical assessment in order to determine their medical fitness for military service.

Methods

The BP method (7) of adult height prediction was compared to that of Tanner-Whitehouse 1 (TWI) (9).

This study was approved by the Ethics Committees of the Rabin Medical Center and that of the IDF Medical Corps.

Statistical Analysis

The data were analyzed using BMDP software (23). Analysis of variance (ANOVA) and covariance with repeated measures was used to determine changes over time. The t-test was used to compare differences between groups. A p value of ≤0.05 was considered significant.

Results

Previous medical history was reported and height and weight parameters were measured. In this study, records of height and weight at age of 17 were obtained for those who were early constitutionally tall children i.e > 90th percentile.

The mean age at referral was 9.54 ± 3.6 years for boys and 8.86 ± 3.2 years for girls. The majority of boys and girls (n = 80) were prepubertal, while others had early stage puberty. The mean birth weight was $3,607 \pm 496$ gr for boys (n = 52) and $3,313 \pm 539$ gr for girls (n = 84). The mean birth lengths of 19 boys was 51.5 ± 3 cm and it was 51.3 ± 2.8 cm for 42 girls.

Table 1 presents height standard deviation score (SDS) and body mass index (BMI) at referral compared to that at age 17 years. It can be seen that in both boys and girls there is a decrease in height SDS, at the same time that BMI increased in both genders.

The comparisons between the predicted age at referral and the height SDS at age 17 by either the BP or TWI methods (Table 2) show that the TWI method, which includes mid-parental calculation, underestimates the adult height by a mean of 5 cm in both sexes, whereas the BP method provides closer results to the actual height in girls, but with an overestimation by a mean of 5 cm for boys.

Comparing the height SDS of the boys at age 17 years with that of their fathers and that of the girls with their mothers (Table 3), it is evident that boys and girls are taller by one height SDS than their parent.

Table 1. Comparison between height SDS and BMI at referral and at age 17 years

	Height SDS m ± SD		p	BMI m ± SD		p
	Referral	Age 17		Referral	Age 17	
Males (n = 52)	2.13 ± 1.00	1.65 ± 1.21	0.001	20.47 ± 3.75	25.1 ± 5.79	< 0.001
Females (n = 84)	2.48 ± 1.00	2.15 ± 1.05	0.005	18.47 ± 3.15	22.79 ± 3.85	< 0.001

SDS: standard deviation (SD) score, BMI: body mass index

Table 2. Comparison between the actual height at age 17 years and those predicted by the Bayley-Pinneau and Tanner-Whitehouse I

	Height at age 17 years (cm)	BP prediction (cm)	p	TW prediction (cm)	p
Males (n = 52)	185.9 ± 8.06	191.2 ± 6.35	0.001	180.1 ± 5.37	< 0.001
Females (n = 84)	173.6 ± 5.31	172.5 ± 5.12	0.035	168.6 ± 6.17	< 0.001

BP: Bayley and Pinneau, TW: Tanner Whitehouse I

Table 3. Comparison between the height SDS at age 17 years of the males with that of their fathers, and that of the females with that of their mothers

	Boys	Fathers	Δ SDS	p
Height SDS	1.65 ± 1.20	0.74 ± 1.17	0.93 ± 1.30	**< 0.001**
	Girls	Mothers	1.10 ± 1.31	**< 0.001**
	2.15 ± 1.05	1.30 ± 1.29		

Δ: delta, SDS: standard deviation (SD) score

Discussion

The prospective height of tall children is of great concern to parents both for boys as well as for girls. For boys, the hope is that they will remain tall, as tall men have been described as being more successful (1,2,3,4,5). For parents of tall girls, the hope is that they will not be too tall, so as to avoid social problems (4) often leading to requests to enhance puberty to limit adult height by pharmacologic intervention, which is a treatment with risks (24).

The number of follow-up studies of the growth of children with constitutional tall stature are rare. Dickerman et al. (25), in a retrospective study of 36 boys and 29 girls, found that their birth length was increased: 53.5 ± 1 cm for boys (norm: 50.5 ± 1.53) and 52 ± 2.3 cm for girls (norm: 49.8 ± 1.5 cm) followed by a progressive growth acceleration, with both sexes reaching at age 9 a mean height corresponding to 2.75 SD above the 50th percentile for age.

In our study comparing the height SDS heights at referral with those at age 17 years, we found that both sexes showed a decrease. Whereas the height SDS of the boys decreased to a normal percentile, that of the girls remained above the 90-97 height percentile.

Testing the adult height prediction using 2 of the mostly used methods, that of BP (7) and that of TWI (9), the first based on skeletal age, and the second incorporating mid-parental height in the calculation, we found the BP method (7) was closer to the actual height, whereas the TW1 underestimated the actual height. Even Tanner et al. (10) in a later study and Wright and Cheetham (12) found that it was unwise to make an allowance for parental height. This is supported by our findings showing that both boys and girls ended up taller than their parents.

A study by de Waal et al. (21) using another method for the prediction of adult height of pubertal children with constitutional tall stature also found that the BP predication method was preferable (7). The limitation of our study was the use of only two prediction methods.

Study Limitations

Compared to studies on the prediction of height in short children, publications on the early prediction of tall children are scant.

Conclusion

The prediction by the BP and TWI methods can be useful for estimating adult height in constitutional tall stature even in the prepubertal and early pubertal period. However, the fallibility of these two methods should be kept in mind during clinical practice. We think that this study will shed light on these issues.

Ethics

Ethics Committee Approval: This study was approved by the Ethics Committees of the Rabin Medical Center and that of the IDF Medical Corps (0572 – 20RMC – 07.03.2020).

Informed Consent: Retrospective study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: Zvi Laron, Design: Zvi Laron, Data Collection or Processing: Alma Kamar Matias, Analysis or Interpretation: Evgenia Muginshtein-Simkovitch, Lilos Pearl, Literature Search: Alma Kamar Matias, Writing: Alma Kamar Matias, Gilad Twig, Zvi Laron.

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