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Original Article

Target height prediction in Indonesian children: a population-based and clinically relevant model

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Abstract

Background The traditional calculation of target height (TH) overlooks two important factors: the assortative mating correlation, which reflects the tendency for people of similar height to partner, and the parental-offspring correlation, which measures the strength of the relationship between parents' and children's heights. A more accurate model is needed for the Indonesian population.

Objective To develop a target height (TH) prediction model for Indonesian children and to compare its performance with traditional formulas.

Methods This retrospective study used nationally representative data from the *Indonesia Family Life Survey* (IFLS). Adult height data from the IFLS-5 (2014) for 2,506 subjects and the corresponding parental height data from the IFLS-3 (2000) were analyzed. We used a new model, namely estimated target height (eTH), which combined the Hermanussen-Cole and van Dommelen methods, to estimate each participant's TH. This new model was compared to traditional models which used Tanner (TTH) and modified Tanner (mTH) formulas.

Results The new eTH model yielded the following formulas: TH (boys)=0.36 × father's height + 0.43 × mother's height + 42.77; and TH (girls)=0.30 × father's height + 0.36 × mother's height + 50.47. Correlations with the observed adult height were highest for the new model (r=0.528 for boys; r=0.534 for girls), compared to traditional models.

Conclusion This study provides a locally validated model for TH estimation in Indonesian children that demonstrates improved clinical applicability over traditional formulas. **[Paediatr Indones. 2025;65:416-21; DOI: https://doi.org/10.14238/pi65.5.2025.416-21]**.

Keywords: *target height; growth prediction; Indonesia; Hermanussen–Cole method; child growth modeling*

Target height (TH) is a widely used clinical indicator to evaluate whether a child's growth aligns with their genetic potential. It also serves as a reference point for determining the appropriateness of therapeutic interventions in children with short stature. Traditionally, TH has been calculated using the mid-parental height method, most commonly via the Tanner formula (TTH), in which a sex-specific adjustment is applied to the average parental height.[1,2]

In Indonesia, a modified version of the TTH (mTH) is often applied in clinical practice. In this formula, a 6.5-cm addition for boys and a 6.5-cm subtraction for girls is used, depending on the child's sex, along with a ±8.5 cm range for interpreting normal growth expectations.[3] However, increasing evidence suggests that the mTH may underestimate actual adult height, particularly in Asian populations.[4-7]

Foundational work by Hermanussen and Cole introduced a revised model that incorporates two key correlations: parental-offspring resemblance

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and assortative mating. This model expresses TH in terms of standard deviation scores (SDS) and offers improved predictive power.[8] Despite the model's theoretical strength, the use of SDS is often seen as impractical in routine clinical settings, where estimates in centimeters are preferred. Hughes et al.9 emphasized this limitation, which prompted the development of conversion techniques.

Van Dommelen *et al*.[10] proposed a stepwise approach to convert TH SDS to centimetric values to allow for broader clinical implementation. However, this approach has not yet been evaluated or calibrated for Indonesian children. The absence of localized TH prediction models limits the precision of pediatric growth assessments in the Indonesian context.

The aim of our study was, thus, to construct and validate a TH prediction model for Indonesian children by applying the Hermanussen-Cole (HC) method[8] and the van Dommelen conversion framework.[10] We also compared the predictive performance of the new model against traditional TTH and mTH formulas to evaluate its clinical relevance and accuracy in the local population.[1-3]

Methods

In this study, we utilized data from the *Indonesia Family Life Survey* (IFLS), which is a nationally representative, longitudinal household survey conducted by the *RAND Corporation* in collaboration with Universitas Indonesia and Universitas Gadjah Mada.[11] The IFLS data are freely available from the Institute of Demography, Faculty of Economics and Business, Universitas Indonesia for IFLS-1 and IFLS-2, which were conducted in 1993 and 1997, respectively;[12] and a from private Indonesian research agency, *Surveymeter*, for IFLS-3, IFLS-4, and IFLS-5, which were conducted in 2000, 2007, and 2014, respectively.[13-15] The IFLS surveys and their procedures have been reviewed and approved by an institutional review board (IRB) in the United States (*RAND Human Subjects Protection Committee*). In Indonesia, the survey protocols have been cleared by the IRB of Universitas Gadjah Mada for IFLS-3, IFLS-4, and IFLS-5 and Universitas Indonesia for IFLS-1 and IFLS-2.[16] All methods were carried out in accordance with relevant guidelines and regulations. All participants in the IFLS survey had given written informed consent prior to data collection.[17] Stratified multistage sampling design across 13 provinces was employed in the IFLS to cover approximately 83% of the Indonesian population. The dataset is publicly available and was accessed in October 2019.[11-15] Data from IFLS 5 (2014) were used to predict the adult height of subjects aged 19-25 years, while the corresponding parental height data, which were collected during the participants' childhoods, were extracted retrospectively from IFLS 3 (2000). This approach helped minimize potential bias due to stature shrinkage in older adults. Data were processed and analyzed from January to March 2025.

The final sample included 2,506 individuals (1,195 males and 1,311 females) who had complete records of their adult height and the heights of both parents. Subjects were aged between 19 and 25 years at the time of the IFLS-5 measurement, which reflected the attainment of their full adult height. The paternal and maternal heights were drawn from their IFLS-3 records to avoid age-related bias.

The TH was estimated using three different approaches: the HC-van Dommelen method (new model or eTH formula), the original TTH formula, and the mTH formula. The new model (eTH, estimated Target Height) incorporated both the parent–offspring correlation (r=0.57) and the assortative mating correlation (r=0.27) as follows:[8]

eTH SDS in centimeters =

$$\text{TH SDS} \times r(P,O) \times \sqrt{[2/(1+r(P,P)]} + \text{error}$$

[eTH=estimated target height; r(P,O)=parent-offspring correlation; r(P,P)=assortative mating correlation; TH SDS=(TH - mean height)/ standard deviation]

Conversion from the TH SDS to a centimeter-based TH (eTH) was conducted by following the procedure outlined by van Dommelen *et al*.,[10] in which population-specific height means and standard deviations were used. The new model (eTH) calculated the actual mean height of subjects, hence the possibility of a secular trend would be considered.

In comparison, TTH was calculated using the formula (father's height + mother's height)/2 +

6.5 cm in males and (father's height + mother's height)/2 − 6.5 cm in females.[1,2] In mTH, a sex-specific adjustment based on the observed final height differences was applied: +6.15 cm for boys and −6.15 cm for girls.[3] Based on the two formulas (TTH and mTH), an actual mean height of subjects was not included, hence the secular trend could not be considered.

Descriptive statistics were calculated for all the relevant anthropometric variables. Pearson's correlation was used to examine the correlation between actual adult height and each of the TH estimates (eTH, TTH, and mTH) as well as individual parental heights. Linear regression models were applied to determine the variances in adult height explained by each formula. The mean difference between the predicted TH and actual adult height was also calculated. Statistical analyses were performed using *STATA/SE 16.1 software* (*StataCorp LLC*, College Station, Texas, USA).

Results

Table 1 provides a summary of baseline anthropometric characteristics of subjects. Mean adult height was 165.4 (SD 6.2) cm for males and 152.9 (SD 5.2) cm for females. The observed mean intergenerational height difference between father and son was 4.1 cm, while the difference between mother and daughter was 2.7 cm, which indicated a secular increase in height across generations.

The eTH formulas derived from IFLS data were as follows:

- Males: eTH in centimeters (cm) = 0.36 × father's height in cm + 0.43 × mother's height in cm + 42.77
- Females: eTH in cm = 0.30 × father's height in cm + 0.36 × mother's height in cm + 50.47

Using this model, the 95% confidence interval (95%CI) for the TH estimates corresponded to ±1.64 SDS, which was equivalent to approximately ±10.2 cm in males and ±8.5 cm in females.

Table 2 displays the correlation coefficients between subjects' adult heights, the TH estimates (eTH, TTH, and mTH), and the parental heights. The highest correlations were observed between the final adult heights and the estimated THs derived from the new formula (eTH). These correlations were marginally higher than those observed using the TTH and mTH formulas.

Compared to the TTH and mTH approach, mean difference between estimated and observed final heights was the smallest using the new eTH model (**Table 3**). In contrast, adult height was overestimated by 3 to 3.6 cm using the TTH and mTH formulas. We then performed subgroup analysis to test the internal consistency of eTH, with subjects split into those who lived in urban and rural areas. The mean difference in urban subjects was 0.30 (5.24) cm in males and 0.27 (4.35) cm in females. In rural subjects, the mean difference was -1.15 (4.42) cm in males and -0.55 (5.24) cm in females. Linear regression models showed that the new eTH model accounted for 27.8% of the height variance in males and 28.5% in females, and that these variances were slightly higher than those of the TTH and mTH formulas (27.4% each).

Discussion

In this study, we present a novel, population-specific approach to estimating TH in Indonesian children

Table 1. Anthropometric characteristics of the study population

Variables	Males (n=1,195)	Females (n=1,311)	Total (N=2,506)
Median age (range), years	22 (19-25)	22 (19-25)	22 (19-25)
Mean final height (SD), cm	165.4 (6.2)	152.9 (5.2)	158.8 (8.4)
Mean father's height (SD), cm	161.3 (6.2)	161.3 (6.2)	161.3 (6.2)
Mean mother's height (SD), cm	150.2 (5.3)	150.3 (5.2)	150.2 (5.2)
Mean FH – MH (SD), cm	11.1 (7.5)	11.0 (7.4)	11.0 (7.4)
Mean male-female height gap	-	-	12.5 (0.2)

FH=father's height; MH=mother's height

based on the HC model,[8] which was operationalized through the van Dommelen conversion framework.[10] The newly derived formula accounts for assortative mating and parent-offspring height correlations to enhance both biological plausibility and statistical robustness. By expressing the results in centimeters, the model bridges the gap between advanced statistical modeling and routine clinical practice, where centimeter-based metrics are more intuitive for interpretation.

A key strength of this study was the use of nationally representative data from the IFLS, which provided a demographically diverse sample. The resulting model, which we call estimated target height (eTH), showed superior performance when compared with conventional methods, such as the TTH formula and its modified version.[1-3] The new model (eTH formula) yielded the strongest correlation with the observed adult heights in both the males (r=0.528) and females (r=0.534), thereby slightly outperforming the TTH and mTH methods, with correlations hovering around 0.52. These findings suggest the model's improved predictive power, particularly for female subjects, which is a known limitation of earlier Asian population models.[7]

Our results affirmed prior critiques of the limitations of the TTH model, particularly in non-Western settings. Previous studies in Korea and India have revealed the consistent underestimation of final adult height when using the TTH formula.[6,7]

Table 2. Coefficient correlation of the subjects' final heights with the parental heights and TH estimates

Correlation	Males	Females
Father's height	0.379	0.300
Mother's height	0.500	0.459
Estimated TH (eTH)	0.528	0.534
Tanner TH (TTH)	0.524	0.527
Modified TH (mTH)	0.524	0.527

TH=target height

For instance, a study found significant discrepancies between the observed and Tanner-predicted adult heights in Korean adolescents,[6] while another study reported similar findings in Asian Indian populations, particularly among girls.[7] In contrast, our Indonesian-specific model demonstrated more balanced accuracy across sexes, with narrower 95% confidence intervals (±10.2 cm for boys, ±8.5 cm for girls) than those reported in Australian and Dutch studies.[9,10] Our new model showed greater accuracy in males than females (**Table 3**), with a discrepancy between estimated and observed adulg height of only -0.02 cm in males, compared to -1.17 cm in females. A more pronounced secular trend in males may explain this difference.

Notably, our model achieved similar performance in explaining the variance in both sexes: 27.8% in males and 28.5% in females. In earlier studies, this variance often differed markedly by sex; for example, in an Indian study, the TH explained 29.7% of the variance in females, but only 16.7% in males.[7] The improved balance in our findings likely reflects the benefits of incorporating the correlations into the model, as originally advocated by Hermanussen and Cole.[8]

The observed intergenerational height increases of 4.1 cm in boys and 2.7 cm in girls underscore an ongoing secular trend and align with previous findings in the Javanese population.[18] Similar secular gains have been observed across various low- and middle-income countries, which suggests environmental improvements in nutrition, healthcare, and education. However, such trends may confound static TH prediction models and potentially lead to the misclassification of normal growth acceleration as pathological. While our model does not explicitly adjust for secular trends, its retrospective design (using childhood-era parental data) helps mitigate this bias, as advised in prior literature.[9]

This study offers the first validated TH prediction model for the Indonesian pediatric population that

Table 3. Comparison of TH formulas: accuracy and explained variance

Formula	Mean difference (SD), cm		Explained variance, %	
	Males	Females	Males	Females
eTH (new)	–0.02 (0.15)	–1.17 (0.12)	27.8	28.5
Tanner TH (TTH)	3.00 (5.41)	3.65 (4.70)	27.4	27.7
Modified TH (mTH)	3.36 (5.41)	3.30 (4.70)	27.4	27.7

incorporates population-specific references and genetic theory. Unlike previous models derived from Western or East Asian data, our formula reflects local anthropometric distributions and growth dynamics, which improves its clinical relevance.

The precision and reliability of our method hold particular utility in evaluating children with growth concerns. Compared to the TTH model, which consistently overestimated height by approximately 3 cm in our sample, the eTH method yielded a near-zero mean prediction error, especially in males, and lower SD. This enhances its potential for the early identification of pathological growth deviations.

By applying this model to the IFLS cohort, our study provides a replicable framework for future updates as secular trends evolve. This flexibility is critical for ensuring long-term clinical applicability in a rapidly changing epidemiological and socioeconomic landscape. The present model offers clear advantages in both clinical interpretation and methodological rigor. Its derivation from a large, nationally representative sample enhances external validity. The reduced mean error, high correlation with final height, and operational simplicity strengthen the case for its adoption in routine pediatric evaluations in Indonesia.

This study had some limitations. Although we attempted to reduce bias by using earlier height data from IFLS-3, residual shrinkage-related inaccuracies may have persisted. Additionally, the dataset reflects conditions up to 2014 and thus may not have captured more recent shifts in child growth norms. The timing and duration of puberty, which are known to influence final height, were not included in the current model.[5] Incorporating these variables in future iterations of the model could further improve its predictive accuracy. Although eTH was the more accurate formula, using absolute values in cm in the final calculation may reduce the accuracy, as this cannot account for secular trends. Nonetheless, the consistency of the results within a large, representative national dataset enhances the model's internal validity.

We found that the correlation between male adult height and mother's height was almost as high as that between male adult height and target height derived from both parents; further explanation is needed for this finding. A previous study has proposed a formula for estimation of adult height when the father's height is unknown.[10] Further studies are needed to estimate target height based on mother's height only. In our study, the correlation of assortative mating and parent-offspring height were based on Dutch data. Future studies should investigate such associations in the Indonesian population.

Our results present a refined and population-specific model for TH prediction in Indonesian children and offer improved clinical utility and predictive accuracy over traditional formulas. By incorporating genetic correlations through the HC method and using population-relevant conversion steps, the resulting equations better reflect actual adult height outcomes across sexes. These findings affirm the value of recalibrating global pediatric tools using local anthropometric data. The new TH estimation model has the potential to enhance clinical decision-making in pediatric endocrinology across Indonesia and could serve as a template for similar adaptations in other low- and middle-income countries.

Conflict of interest

None declared.

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