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Mixed dentition space analysis for Indonesian Javanese children

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Abstract The purposes of this study were to determine the applicability of Moyers and Tanaka-Johnston prediction methods for Indonesian Javanese children, and to develop new regression equations for predicting the size of the canine-premolar segment based on the normative standard of mesio-distal crown diameters of the permanent teeth in Indonesian children. Two hundred and eighty five sets of dental casts of the permanent dentition were obtained from Indonesian Javanese children in Yogyakarta, Indonesia during 2000–2001. There were 143 males and 142 females aged 11.1 to 14.9 years. The mesio-distal crown diameters were measured with calipers to an accuracy of 0.05 mm. The statistical analyses were performed using computer software (SPSS 9.0 for Windows). This study confirmed that the use of Moyers and Tanaka-Johnston prediction methods for mixed dentition analysis among Indonesian Javanese children were unsuitable. Both methods underestimated the size of canine-premolar segments, with exception of the Tanaka-Johnston method in females. The combination of maxillary first molars and mandibular lateral incisors ($\Sigma\ \underline{6}\ \overline{2|2}\ \underline{6}$) showed relatively higher correlation with the actual size of $\Sigma\ \overline{3\ 4\ 5}$. The development of new linear regression equations with predictor $\Sigma\ \underline{6}\ \overline{2|2}\ \underline{6}$ for predicting the size of the canine-premolar segment was based on the normative standard of mesio-distal crown diameters of permanent teeth in Indonesian Javanese children. The newly developed regression equations are more accurate than the regression equation that uses predictor $\Sigma\ \overline{2\ 1|1\ 2}$ for mixed dentition analysis among Indonesian Javanese.

Key words
Indonesian Javanese,
Mesio-distal crown diameter,
Mixed dentition analysis,
Regression equation

Introduction

The period of late primary dentition or early mixed dentition is a critical period for the prevention or interception of any developing malocclusion[1]. Moreover, treatment of a malocclusion in the period of active growth is more advantageous, because of the opportunities for occlusal guidance, interception of the malocclusion or removal of etiological factors[1–3].

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One of the important considerations during the period of mixed dentition is the discrepancy between available space and required space for unerupted permanent canine, first and second premolars. For determining an accurate occlusal guidance or orthodontic treatment plan, some prediction methods for estimating the size of the unerupted canine-premolar segment have been established. Among these, the Moyers[4] and Tanaka-Johnston[5] methods are the most widely used, although other methods[6–9], using radiography, are suggested to be more accurate[6–9]. Moyers and Tanaka-Johnston methods are straight forward, providing a high degree of accuracy, without the need for special equipment or radiation exposure[4,10–14].

Significant differences in tooth size exist among different ethnic populations[10,15,16]. Therefore, an accurate prediction method for one ethnic population may be less accurate for others. In Indonesia, the Moyers and Tanaka-Johnston methods are the most widely used and both of these methods take the sum of the mesio-distal crown diameters of mandibular central and lateral incisors ($\Sigma\,\overline{2\ 1|1\ 2}$) as the predictor variable. Studies in other ethnic populations showed a fairly high coefficient of correlation between $\Sigma\,\overline{2\ 1|1\ 2}$ and the sum of the mesio-distal crown diameters of canine, first and second premolars (Σ 3 4 5), *e.g.* in the Hong Kong Chinese the coefficient of correlation ranged from 0.65 to 0.79[11], in American Negroes, 0.63 to 0.71[12], in Syrians, 0.67 to 0.70[13], in American Chinese, 0.64 to 0.66[14], and in Japanese, 0.65 to 0.76[17]. However, in our study on the mesio-distal crown diameters of permanent dentition in Indonesian Javanese children, the correlation magnitude between $\Sigma\,\overline{2\ 1|1\ 2}$ and Σ 3 4 5 was fairly low, ranging from 0.56 to 0.66. Another combination of tooth group may be able to improve the correlation magnitude, as well as the accuracy.

The purposes of this study were to determine the applicability of Moyers and Tanaka-Johnston prediction methods for Indonesian Javanese children, to develop new regression equations for predicting the size of the canine-premolar segment, and to get the prediction tables for clinical use based on the normative standard of mesio-distal crown diameters of permanent teeth in Indonesian Javanese children.

Materials and Methods

Two hundred and eighty five Indonesian Javanese children, of which 143 were males, aged 11.1–14.9 years (mean 12.4 ± 1.0) and 142 were females, aged 11.6–14.9 years (mean 12.4 ± 0.9) were included in this study. Informed consent was obtained from the parents and children. The subjects were selected from 16 junior high schools and 5 elementary schools (3,832 children) in Yogyakarta, Indonesia during the years 2000 to 2001. The criteria of subjects were as follows: no apparent facial disharmony; all permanent teeth except the third molars erupted and assessed to be morphologically normal; acceptable occlusion, such as the Angle Class I first molar and canine relationship, anterior crowding, or spacing within 2 mm; and no history of orthodontic treatment.

Alginate impressions of the maxillary and mandibular arches were obtained and poured in super hard stone plaster. The mesio-distal crown diameter was measured with calipers with an accuracy of 0.05 mm (Mitutoyo YS-33, Yamaura Co., Japan) inserted from the buccal or labial side, parallel to the long axis of the tooth on the anatomic contact points[18]. When the measurement could not be taken precisely because of malformation, caries, restorations or plaster defects, these teeth were excluded. The mesio-distal crown diameters of all the dental casts were measured by one investigator (SK). Each tooth was measured twice on different occasions, the second measurement being taken 6–8 months after the first, and the average of the two readings was taken as the diameter for the individual tooth. If the first and second measurements differed by more than 0.20 mm, a third measurement was taken, and the two closest values were averaged as suggested by Bishara *et al.*[16]

When applying the Moyers prediction method, the value of the 75th percentile of probability was used, as protection against under predicting of the true size[4]. For Tanaka-Johnston prediction method, half of the width of mandibular incisors ($1/2\ \Sigma\,\overline{2\ 1|1\ 2}$) plus 11.0 for the maxillary canine-premolar segment and $1/2\ \Sigma\,\overline{2\ 1|1\ 2} + 10.5$ for the mandibular canine-premolar segment were used[5].

Descriptive statistics, including the mean, standard deviation, minimum and maximum values, were calculated for the sum of the tooth group as the predictor variable, and the size of Σ 3 4 5 as the predicted variable as well as the actual size of Σ 3 4 5. Pearson's coefficient of correlation (r) between the sum of the tooth group as the predictor variable and the actual size of Σ 3 4 5 was calculated. Simple linear regression equations were developed from the combination of tooth group showing the greatest r-value as the predictor variable. Analysis of variance (ANOVA) was performed as a means of examining the significance of the regression equation. The statistical analyses were performed using computer software (SPSS 9.0 for Windows).

Results

Descriptive statistics of the actual size and predicted size derived from the Moyers and Tanaka-Johnston methods of Σ 3 4 5 are presented in Table 1. The

Table 1 Descriptive statistics of the actual size and predicted size derived from the Moyers and T/J methods of Σ345 (mm)

Σ 3 4 5	Sex	Maxillary segment			Mandibular segment		
		Mean	S.D.	Range	Mean	S.D.	Range
Actual size	M	23.05	0.97	20.75–25.77	22.22	0.97	20.02–24.70
	F	22.34	0.93	19.31–24.88	21.44	0.92	18.93–24.25
Moyers	M	22.14	0.61	20.90–24.40	21.97	0.55	20.90–24.10
	F	21.23	0.34	20.40–22.20	21.17	0.59	19.60–22.80
T/J	M	22.61	0.61	21.33–24.88	22.11	0.61	20.83–24.38
	F	22.32	0.58	20.71–23.87	21.82	0.58	20.21–23.37

T/J: Tanaka-Johnston; Maxillary segment: $\Sigma\,\underline{3\ 4\ 5}$; Mandibular segment: $\Sigma\,\overline{3\ 4\ 5}$

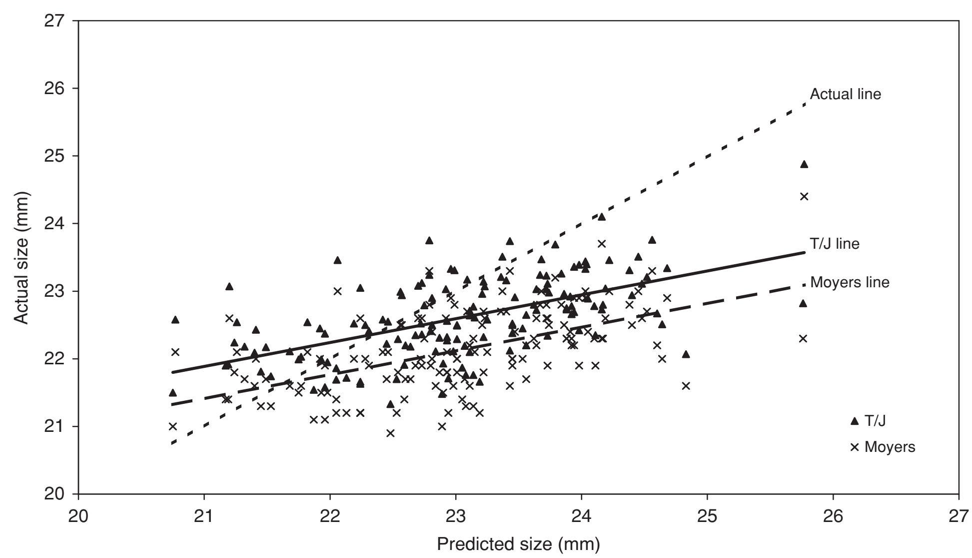

Fig. 1 Predicted size derived from the Moyers and T/J methods vs. the actual size of $\Sigma\,\underline{3\ 4\ 5}$ in males

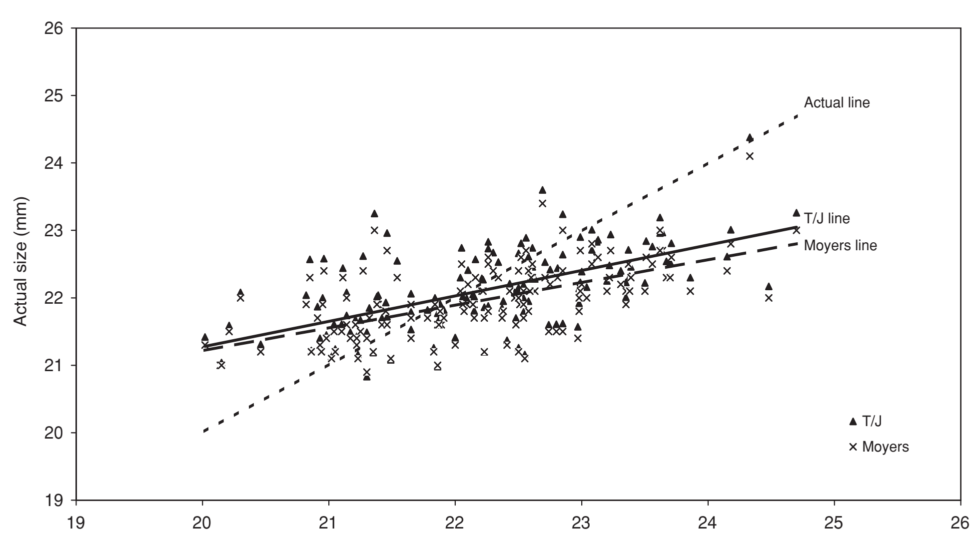

Fig. 2 Predicted size derived from the Moyers and T/J methods vs. the actual size of $\Sigma\,\overline{3\ 4\ 5}$ in males

relationships between the predicted size of $\Sigma 3\,4\,5$ derived from Moyers and Tanaka-Johnston methods and the actual size of $\Sigma 3\,4\,5$ are presented in Figures 1–4. The predictions for females were more precise than those obtained for males, using both Moyers and Tanaka-Johnston methods. For males, both methods underestimated the predicted size of $\Sigma 3\,4\,5$ in both the maxillary and mandibular segments. For females, the Tanaka-Johnston method provided a good prediction with regard to the maxillary segment, but showed an overestimation with regard to the mandibular segment, while Moyers method showed an underestimation in both segments.

The coefficient of correlation (r) between the sum of tooth group, $\Sigma\,\overline{2\,1|1\,2}$, $\Sigma\,\overline{6\,2|2\,6}$, $\Sigma\,\underline{6}\,\overline{2|2}\,\underline{6}$, $\Sigma\,\overline{6}\,\underline{1|1}\,\overline{6}$, $\Sigma\,\underline{6\,1|1\,6}$, and the actual size of $\Sigma 3\,4\,5$ derived from this study are presented in Table 2. The values of the coefficient of correlation of maxillary first molars and mandibular lateral incisors ($\Sigma\,\underline{6}\,\overline{2|2}\,\underline{6}$) were comparatively higher than the $\Sigma\,\overline{2\,1|1\,2}$, $\Sigma\,\overline{6\,2|2\,6}$, $\Sigma\,\overline{6}\,\underline{1|1}\,\overline{6}$ and $\Sigma\,\underline{6\,1|1\,6}$ in the maxillary and mandibular segments for males and females.

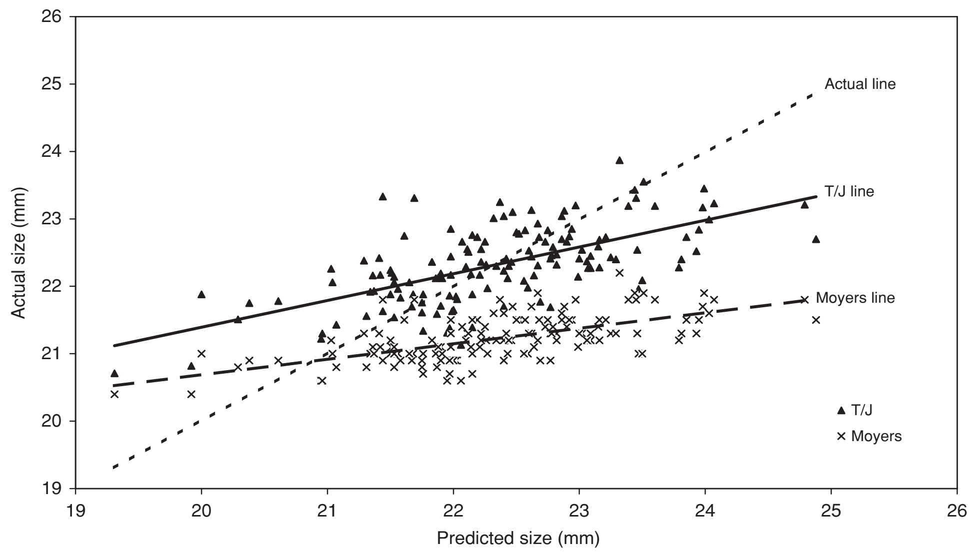

Fig. 3 Predicted size derived from the Moyers and T/J methods vs. the actual size of $\Sigma\,\underline{3\,4\,5}$ in females

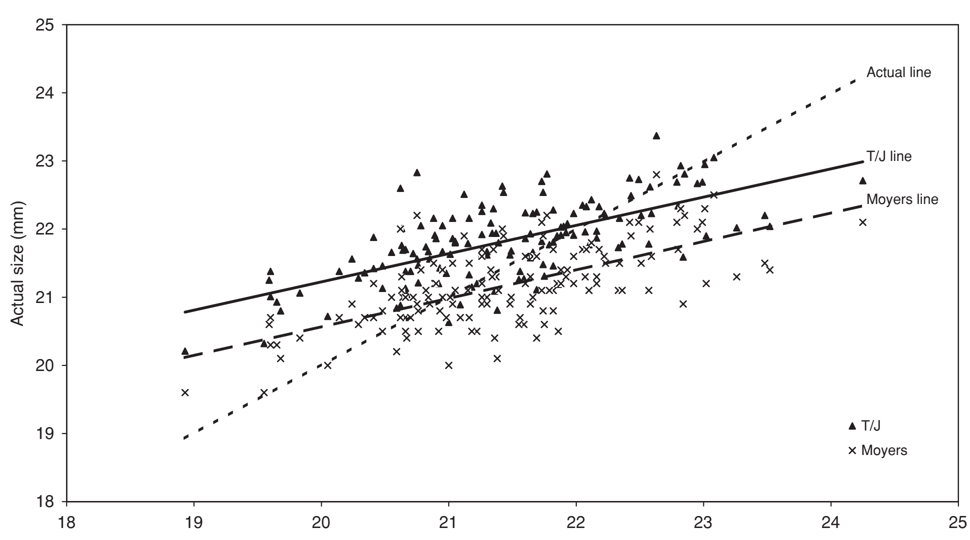

Fig. 4 Predicted size derived from the Moyers and T/J methods vs. the actual size of $\Sigma\,\overline{3\,4\,5}$ in females

Table 3 shows the descriptive statistics of the simple linear regression equations for prediction of the size of the canine-premolar segment using $\Sigma\,\underline{6}\,\overline{2\vert 2}\,\underline{6}$ or $\Sigma\,\overline{2\ 1\vert 1\ 2}$ as predictor variables. Both of the regression equations using $\Sigma\,\underline{6}\,\overline{2\vert 2}\,\underline{6}$ or $\Sigma\,\overline{2\ 1\vert 1\ 2}$ were statistically highly significant ($P<0.001$), but the regression equations using predictor $\Sigma\,\underline{6}\,\overline{2\vert 2}\,\underline{6}$ were higher in the coefficient of correlation (r) values (Table 2), as well as in the coefficient of determinant (R^2) values, and smaller in the standard error of estimation (SEE) than the regression equations using predictor $\Sigma\,\overline{2\ 1\vert 1\ 2}$. The prediction for females was consistently better than the prediction for males with larger R^2 and smaller SEE values (Table 3). The SEE values of both regression equations were smaller than the standard deviation (SD) of the actual size of Σ3 4 5 (Tables 1 and 3).

Table 2 Coefficient of correlation (r) between the sum of tooth group and the actual size of Σ3 4 5

Tooth group	Maxillary segment		Mandibular segment	
	M	F	M	F
$\Sigma\,\overline{2\ 1\vert 1\ 2}$	0.56	0.63	0.60	0.66
$\Sigma\,\overline{6\ 2\vert 2\ 6}$	0.63	0.68	0.68	0.73
$\Sigma\,\underline{6}\,\overline{2\vert 2}\,\underline{6}$	0.67	0.70	0.69	0.70
$\Sigma\,\overline{6}\,\underline{1\vert 1}\,\overline{6}$	0.66	0.66	0.67	0.71
$\Sigma\,\underline{6\ 1\vert 1\ 6}$	0.70	0.67	0.67	0.68

Maxillary segment: $\Sigma\,\underline{3\ 4\ 5}$; Mandibular segment: $\Sigma\,\overline{3\ 4\ 5}$

Table 3 Descriptive statistics of the simple regression equations for prediction of the size of canine-premolar segment

Predictor	Segment	Sex	Intercept	Slope	R^2 (%)	SEE	F
$\Sigma\,\underline{6}\,\overline{2\vert 2}\,\underline{6}$	Maxilla	M	6.16	0.50	45.3	0.72	116.68***
		F	6.65	0.47	49.0	0.66	134.47***
	Mandible	M	4.96	0.51	47.5	0.71	127.38***
		F	5.81	0.47	49.2	0.65	137.81***
$\Sigma\,\overline{2\ 1\vert 1\ 2}$	Maxilla	M	12.58	0.45	31.8	0.81	65.71***
		F	10.86	0.51	40.2	0.72	94.27***
	Mandible	M	11.07	0.48	36.2	0.78	80.08***
		F	9.69	0.52	43.1	0.62	105.85***

R^2: coefficient of determinant; SEE: standard error of estimation; F: ANOVA ***$P<0.001$

Table 4 The absolute size difference between the actual size and predicted sizes of Σ3 4 5 (mm)

Predictor	Sex	Maxilla		Mandible	
		Mean ± S.D.	Range	Mean ± S.D.	Range
$\Sigma\,\underline{6}\,\overline{2\vert 2}\,\underline{6}$	M	0.56 ± 0.44	0.00–1.85	0.57 ± 0.40	0.02–2.09
	F	0.52 ± 0.36	0.00–1.62	0.52 ± 0.36	0.00–1.80
$\Sigma\,\overline{2\ 1\vert 1\ 2}$	M	0.62 ± 0.48	0.02–2.52	0.60 ± 0.47	0.00–2.21
	F	0.55 ± 0.43	0.00–2.00	0.55 ± 0.40	0.00–1.86

The absolute size difference between the actual size and predicted sizes of $\Sigma 3\,4\,5$ using both prediction equations are presented in Table 4. The mean value of the difference was larger in the prediction using the predictor variable $\Sigma\,\overline{2\,1|1\,2}$ than $\Sigma\,\underline{6}\,\overline{2|2}\,\underline{6}$ in both segments for males and females. This mean value of the difference was also consistently larger in males than in females.

The relation between the predicted size of $\Sigma 3\,4\,5$ derived from this study using the predictor variables $\Sigma\,\underline{6}\,\overline{2|2}\,\underline{6}$ and $\Sigma\,\overline{2\,1|1\,2}$ and the actual size of $\Sigma 3\,4\,5$ are presented in Figures 5 to 8. The prediction variable $\Sigma\,\underline{6}\,\overline{2|2}\,\underline{6}$ was more accurate than $\Sigma\,\overline{2\,1|1\,2}$ as a predictor variable in a simple linear regression equation for prediction of the size of $\Sigma 3\,4\,5$.

The addition of a half of the standard deviation of the sum of the mesio-distal crown diameters of the canine, first and second premolars are useful for clinical use as protection against underestimation of the true size. By this addition, the prediction equation shows the probability of 67% of the population. Therefore, the equations for clinical use are as follows:

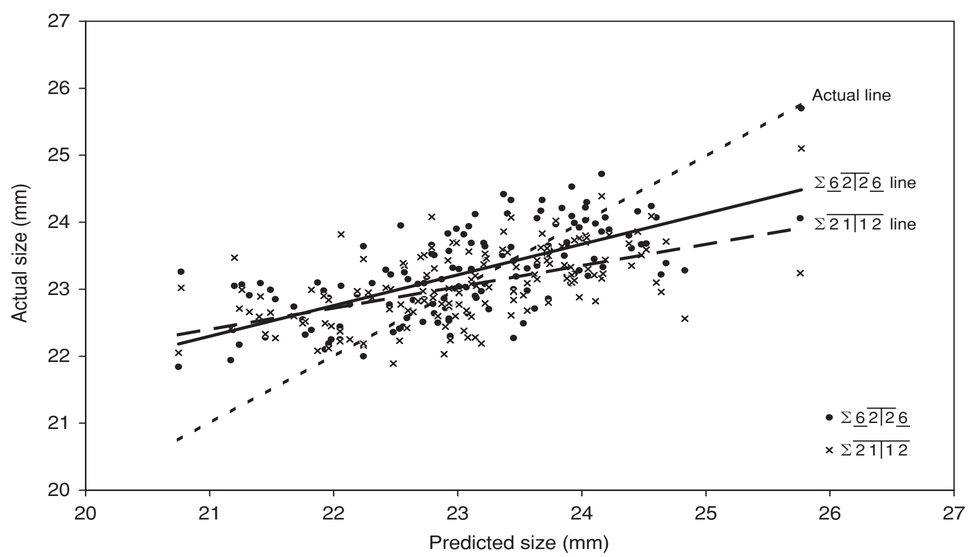

Fig. 5 Predicted size derived from this study vs. the actual size of $\Sigma\,\underline{3\,4\,5}$ in males

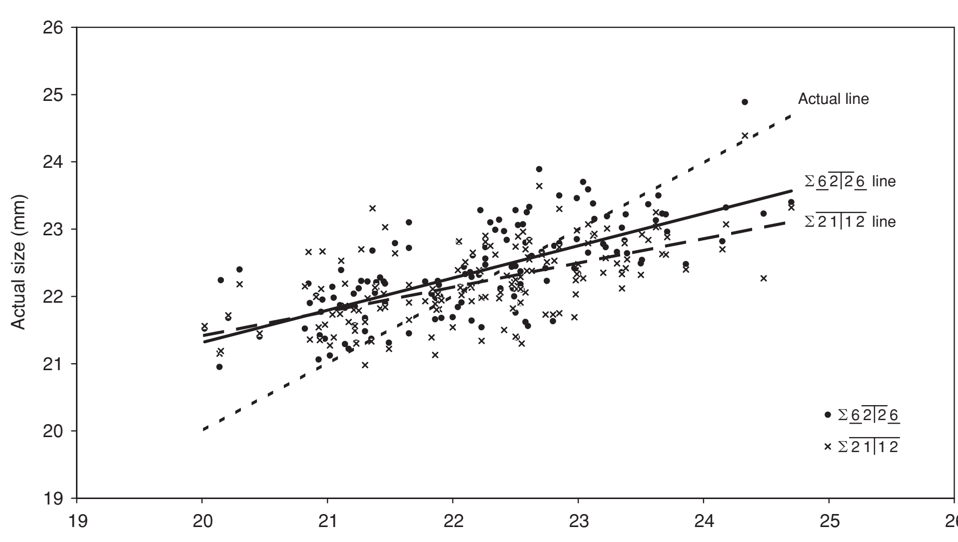

Fig. 6 Predicted size derived from this study vs. the actual size of $\Sigma\,\overline{3\,4\,5}$ in males

Maxillary segment for males
$y = 0.50x + 6.16 + 0.49$
Mandibular segment for males
$y = 0.51x + 4.96 + 0.49$
Maxillary segment for females
$y = 0.47x + 6.65 + 0.46$
Mandibular segment for females
$y = 0.47x + 5.81 + 0.46$
where x is $\Sigma\,\underline{6}\,\overline{2|2}\,\underline{6}$ and y is Σ3 4 5.

The descriptive statistics of the predicted size derived from the newly developed regression equations are presented in Table 5.

Table 5 Descriptive statistics of the predictor variable $\Sigma\,\underline{6}\,\overline{2|2}\,\underline{6}$ and predicted size of Σ3 4 5 (mm)

Tooth group	Sex	Mean	S.D.	Range
$\Sigma\,\underline{6}\,\overline{2|2}\,\underline{6}$	M	34.16	1.32	31.36–39.07
	F	33.33	1.37	28.79–36.84
$\Sigma\,\underline{3\ 4\ 5}$	M	23.24	0.66	21.84–25.70
	F	22.32	0.65	20.18–23.96
$\Sigma\,\overline{3\ 4\ 5}$	M	22.38	0.67	20.95–24.89
	F	21.48	0.65	19.34–23.12

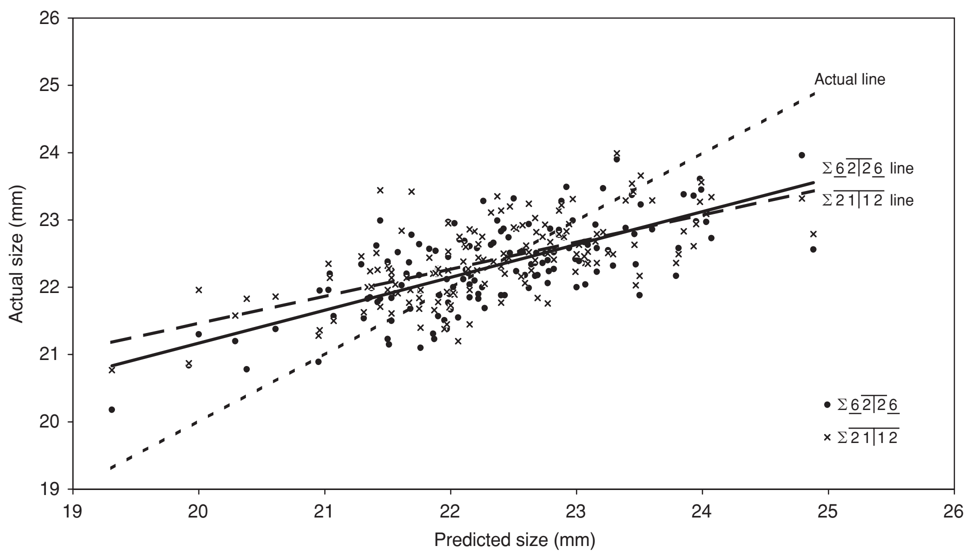

Fig. 7 Predicted size derived from this study vs. the actual size of $\Sigma\,\underline{3\ 4\ 5}$ in females

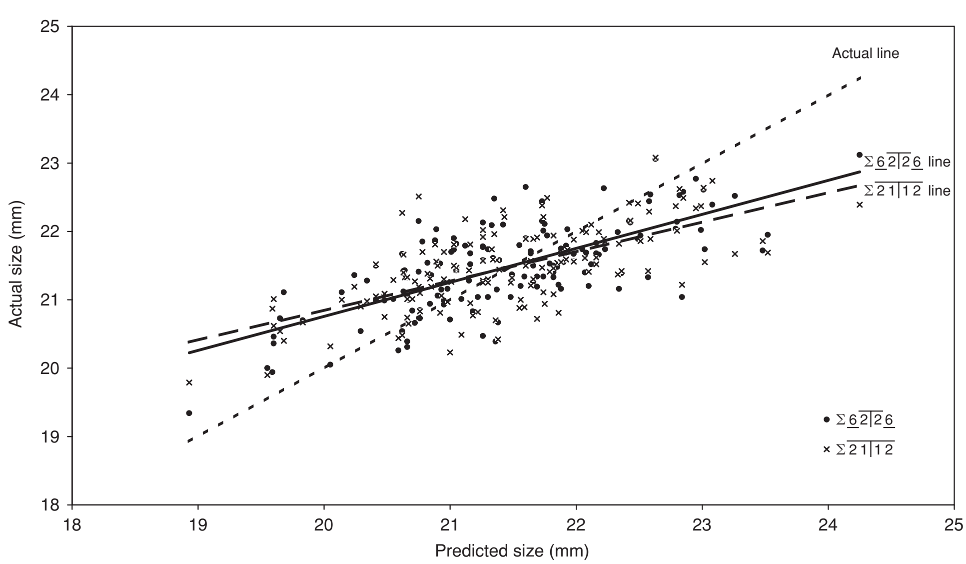

Fig. 8 Predicted size derived from this study vs. the actual size of $\Sigma\,\overline{3\ 4\ 5}$ in females

Probability tables derived from the new regression equations are shown in Tables 6 and 7.

Discussion

Some studies were performed to investigate the correlation between primary teeth and their successor permanent teeth. The prediction of unerupted permanent teeth can be done as early as possible in the primary dentition. However, longitudinal studies[19–21] have failed to find reasonably high coefficient of correlation values. Therefore, no

Table 6 Probability for predicting the sizes of unerupted canine and premolars in males

Maxillary canine and premolars																		
Σ 62|26	31.0	31.5	32.0	32.5	33.0	33.5	34.0	34.5	35.0	35.5	36.0	36.5	37.0	37.5	38.0	38.5	39.0	39.5
84%	22.4	22.6	22.9	23.1	23.4	23.6	23.9	24.1	24.4	24.6	24.9	25.1	25.4	25.6	25.9	26.1	26.4	26.6
75%	22.2	22.5	22.7	23.0	23.2	23.5	23.7	24.0	24.2	24.5	24.7	25.0	25.2	25.5	25.7	26.0	26.2	26.5
67%	22.0	22.3	22.5	22.8	23.0	23.3	23.5	23.8	24.0	24.3	24.5	24.8	25.0	25.3	25.5	25.8	26.0	26.3
50%	21.7	21.9	22.2	22.4	22.7	22.9	23.2	23.4	23.7	23.9	24.2	24.4	24.7	24.9	25.2	25.4	25.7	25.9
33%	21.3	21.6	21.8	22.1	22.3	22.6	22.8	23.1	23.3	23.6	23.8	24.1	24.3	24.6	24.8	25.1	25.3	25.6
25%	21.1	21.4	21.6	21.9	22.1	22.4	22.6	22.9	23.1	23.4	23.6	23.9	24.1	24.4	24.6	24.9	25.1	25.4
17%	20.9	21.2	21.4	21.7	21.9	22.2	22.4	22.7	22.9	23.2	23.4	23.7	23.9	24.2	24.4	24.7	24.9	25.2

Mandibular canine and premolars																		
Σ 62|26	31.0	31.5	32.0	32.5	33.0	33.5	34.0	34.5	35.0	35.5	36.0	36.5	37.0	37.5	38.0	38.5	39.0	39.5
84%	21.5	21.7	22.0	22.2	22.5	22.8	23.0	23.3	23.5	23.8	24.0	24.3	24.5	24.8	25.1	25.3	25.6	25.8
75%	21.3	21.6	21.8	22.1	22.3	22.6	22.8	23.1	23.3	23.6	23.9	24.1	24.4	24.6	24.9	25.1	25.4	25.6
67%	21.1	21.4	21.6	21.9	22.2	22.4	22.7	22.9	23.2	23.4	23.7	23.9	24.2	24.4	24.7	25.0	25.2	25.5
50%	20.8	21.0	21.3	21.5	21.8	22.0	22.3	22.6	22.8	23.1	23.3	23.6	23.8	24.1	24.3	24.6	24.9	25.1
33%	20.4	20.7	20.9	21.2	21.4	21.7	22.0	22.2	22.5	22.7	23.0	23.2	23.5	23.7	24.0	24.2	24.5	24.8
25%	20.2	20.5	20.8	21.0	21.3	21.5	21.8	22.0	22.3	22.5	22.8	23.0	23.3	23.6	23.8	24.1	24.3	24.6
17%	20.1	20.3	20.6	20.8	21.1	21.3	21.6	21.8	22.1	22.4	22.6	22.9	23.1	23.4	23.6	23.9	24.1	24.4

Table 7 Probability for predicting the sizes of unerupted canine and premolars in females

Maxillary canine and premolars																		
Σ 62|26	28.5	29.0	29.5	30.0	30.5	31.0	31.5	32.0	32.5	33.0	33.5	34.0	34.5	35.0	35.5	36.0	36.5	37.0
84%	20.7	20.9	21.2	21.4	21.6	21.9	22.1	22.4	22.6	22.8	23.1	23.3	23.5	23.8	24.0	24.2	24.5	24.7
75%	20.5	20.8	21.0	21.3	21.5	21.7	22.0	22.2	22.4	22.7	22.9	23.1	23.4	23.6	23.8	24.1	24.3	24.5
67%	20.4	20.6	20.8	21.1	21.3	21.6	21.8	22.0	22.3	22.5	22.7	23.0	23.2	23.4	23.7	23.9	24.1	24.4
50%	20.0	20.3	20.5	20.8	21.0	21.2	21.5	21.7	21.9	22.2	22.4	22.6	22.9	23.1	23.3	23.6	23.8	24.0
33%	19.7	20.0	20.2	20.4	20.7	20.9	21.1	21.4	21.6	21.8	22.1	22.3	22.5	22.8	23.0	23.2	23.5	23.7
25%	19.6	19.8	20.0	20.3	20.5	20.7	21.0	21.2	21.4	21.7	21.9	22.1	22.4	22.6	22.8	23.1	23.3	23.6
17%	19.4	19.6	19.9	20.1	20.3	20.6	20.8	21.0	21.3	21.5	21.7	22.0	22.2	22.4	22.7	22.9	23.1	23.4

Mandibular canine and premolars																		
Σ 62|26	28.5	29.0	29.5	30.0	30.5	31.0	31.5	32.0	32.5	33.0	33.5	34.0	34.5	35.0	35.5	36.0	36.5	37.0
84%	19.9	20.1	20.3	20.6	20.8	21.0	21.3	21.5	21.7	22.0	22.2	22.4	22.7	22.9	23.1	23.4	23.6	23.9
75%	19.7	19.9	20.2	20.4	20.6	20.9	21.1	21.3	21.6	21.8	22.0	22.3	22.5	22.8	23.0	23.2	23.5	23.7
67%	19.5	19.8	20.0	20.2	20.5	20.7	20.9	21.2	21.4	21.7	21.9	22.1	22.4	22.6	22.8	23.1	23.3	23.5
50%	19.2	19.4	19.7	19.9	20.1	20.4	20.6	20.9	21.1	21.3	21.6	21.8	22.0	22.3	22.5	22.7	23.0	23.2
33%	18.9	19.1	19.4	19.6	19.8	20.1	20.3	20.5	20.8	21.0	21.2	21.5	21.7	21.9	22.2	22.4	22.6	22.9
25%	18.7	19.0	19.2	19.4	19.7	19.9	20.1	20.4	20.6	20.8	21.1	21.3	21.5	21.8	22.0	22.2	22.5	22.7
17%	18.6	18.8	19.0	19.3	19.5	19.7	20.0	20.2	20.4	20.7	20.9	21.1	21.4	21.6	21.8	22.1	22.3	22.6

accurate prediction of the mesio-distal crown diameter of the permanent teeth can be made on the basis of a measurement of the predecessor primary teeth[19]. Since a close correlative relationship between tooth groups in the permanent dentition was found; prediction of unerupted permanent teeth can be done in the early mixed dentition, after the eruption of the first permanent molars and the mandibular central and lateral incisors. These teeth act as a corridor for the canine and premolars that will erupt[1].

An accurate prediction method is important for determining occlusal guidance and orthodontic treatment. This study confirmed that the use of Moyers and Tanaka-Johnston prediction methods for mixed dentition analysis among Indonesian Javanese children was unsuitable. Development of these methods was based on the sizes of the permanent teeth of American white people, whose permanent teeth are smaller than these of Indonesian Javanese. Tooth size differences among races are an important variable that must be concerned in a prediction equation[9,11–14,22,23]. In addition, the coefficient of correlation between Σ 2 1|1 2 and Σ3 4 5 was fairly low in Indonesian Javanese children (Table 2). Although the prediction was performed at the 75th percentile probability level, an underestimation of the sizes of Σ3 4 5 still occurred, with the exception of the Tanaka-Johnston prediction in females. The overestimation in the mandibular segment of the females might have occurred because of the lack of separation between males and females in the Tanaka-Johnston method.

New simple linear regression equations for predicting the size of Σ3 4 5 were developed based on the normative standard of mesio-distal crown diameters of permanent teeth in Indonesian Javanese children. The combination of maxillary first molars and mandibular lateral incisors (Σ 6 2|2 6) showed a higher correlation with the actual size of Σ3 4 5 in the maxillary and mandibular segments for males and females (Table 2). Our previous study showed that maxillary first molars were the most stable among the other tooth elements, i.e. the smallest value of coefficient of variance (CV). The size of the maxillary first molar also showed a good correlation with the size of Σ3 4 5. Conversely, mandibular central incisors rated as the second most unstable teeth after the maxillary lateral incisors. These findings disagreed with previous studies in other ethnic groups[4,5,11,12,24), that Σ 2 1|1 2 was the most reliable predictor, as was Σ 6 1|1 6 among Syrians[13]. The findings of the present study suggest that the predictions were more precise in the mandibular segment than in the maxillary segment, and in females than in males (Table 3). These findings disagreed with those from the studies in Hong Kong Chinese[11], Syrian[13], and American White populations[25].

The coefficient of correlation (r) and standard error of estimation (SEE), and the newly developed regression equations (Tables 2 and 3) were more accurate than the Tanaka-Johnston equations ($r=0.63$, and $SEE=0.86$ in the maxillary segment and $r=0.65$, and $SEE=0.85$ in the mandibular segment, respectively). This study confirmed that Σ 6 2|2 6 was more reliable as a predictor variable in a simple linear regression equation for prediction of the size of Σ3 4 5 for Indonesian Javanese children. Moreover, the prediction equations, developed on the basis of a normative standard for the Javanese children, were more suitable than the prediction equations developed from other ethnic groups.

The addition of half of the standard deviation of the sum of the mesio-distal crown diameters of the canine, first and second premolars are useful for clinical use as a protection against underestimation of the true size. Using this correction, the prediction equation shows the probability of 67% of the population. However, the choice of percentile levels of the probability in the clinical application varied depending on the experience of each clinician. Some clinicians prefer the prediction to be an overestimation rather than an underestimation. Moyers[4] and Tanaka-Johnston[5] suggested the 75th percentile for protect against underestimation, while Staley and co-workers[9] recommend the 84th percentile or the addition of one standard error of estimation (1 SEE). However, Kaplan and co-workers[26] recommend under prediction so as to avoid unnecessary extraction of teeth.

Probability tables derived from the new regression equations in this study are more convenient for clinical use than the regression equations.

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