# Evaluation of the reliability of mixed dentition analysis on a sample population from the Northeastern part of Karnataka, India: A comparative study.

**Dhanu G[1] , G Anitha[2] , Havale R [3], SP Shrutha[4]**

*1.MDS, Professor and Head,2.Post graduate student, 3.MDS, Professor,4.MDS, Reader,*
*Department of Pedodontics and Preventive Dentistry, AME's Dental College and Hospital, Raichur*

**ABSTRACT**

**BACKGROUND:** Most of the universally accepted and currently used mixed dentition analyses arebased on the data derived from studies northwestern European descent. However, the reliability of these methods when applied to different ethnic populations is questionable.

**OBJECTIVES:** To evaluate the applicability of Moyers (50th and 75th percentile) and Tanaka and Johnston (TJ) mixed dentition analysis in a sample of children from north eastern part of Karnataka, India.

**MATERIALS AND METHODS:** Study models were prepared from a sample of 100 patients (50 males and 50 females) in the age range of 13 to 15 years. The mesiodistal dimension of the teeth was measured using a digital Vernier calipers. Moyer's and Tanaka - Johnston's mixed dentition arch analysis were calculated. The actual values of permanent canine and premolars on the casts were compared with the predicted values from TJ and Moyers analysis. ANOVA test, Pearson's coefficient tests and simple regression analyses were used.

**RESULTS:** Overestimated values were noticed in males and females forboth arches with TJ equation at Moyers 75th percentile; at Moyers 50th percentile (50/100) underestimated values were observed in both the arches.

**Conclusion:** The values showed significant deviation from TJ and Moyers both at 50 and 75 percentile, its applicability to the present population is limited. Hence, new regression equations were derived.

**KEYWORDS:** Mixed dentition analysis, Tanaka Johnston analysis, Moyers analysis.

## Introduction

Malocclusion is one of the significant issues confronted during mixed dentition stage, particularly during dentofacial development and traverses from the sixth to twelfth year of life (1, 2). A majority of these malocclusions develop because of arch length-tooth size discrepancies (3). Early diagnosis and intervention of developing malocclusions can have both short and long term benefits while accomplishing the objective of occlusal harmony, function and dentofacial aesthetics (4).

Mixed dentition arch analysis is a vital part of early diagnosis and treatment planning. Space analysis frames an imperative criteria by figuring out if the treatment plan will include serial extraction, space maintenance, space regaining or by only periodic observation of the patient (5).

There are three essential methodologies that have been utilized to estimate the combined mesiodistal width of unerupted canine and premolars in mixed dentition stage:

(a) Measurement of the unerupted teeth on radiographs (b) Use of regression equations (c) Combination of regression equation and radiographs (6)

Of all the mixed dentition analysis, the regression equations based on already erupted permanent teeth are utilized most broadly, particularly the Moyers probability charts and Tanaka-Johnston equations since these can be done with least systemic error, have high usability, are less time consuming and require the least armamentarium. Besides, the first and third approach of mixed dentition analysis utilized radiographs as recommended by numerous authors (7, 8, 9, 10, 11) and convey significant accuracy. Yet, they are time

**Corresponding Author:**
**Dhanu G,** MDS
Professor and Head, Department of Pedodontics and Preventive Dentistry,
AME's Dental College and Hospital, Raichur
Email: drdhanu74@yahoo.co.in

consuming, technique sensitive, prone to distortions of the picture and error of rotated tooth in their crypts. So these are not reliable accurate methods either (12).

Tanaka and Johnston's analysis utilizes the sum of mesiodistal width of the mandibular central and lateral incisors to create regression equations for predicting the sizes of the unerupted canines and premolars. They established that the mesiodistal widths could bepredicted by dividing the width of the mandibular incisors and adding 10.5 mm for the mandibular teeth and 11.0 mm for the maxillary teeth (13).Moyer's analysis utilizes the whole of the widths of the mandibular incisors to predict the sum of both the mandibular and maxillary canines and premolars at different probability levels (5–95%) (14)

Both Tanaka-Johnson and Moyer's method for space analysis was developed for people of North European descent. It is sensible to question its use in different populations since tooth size varies among ethnicities (15). This is the rationale behind attempting the comparison of reliability of the two methods in a sample of children of North Eastern part of Karnataka, India.

**Aims and Objectives**

To evaluate the reliability and applicability of Moyer's $50^{th}$ and $75^{th}$ percentile from probability tables and Tanaka and Johnston's regression equations for the prediction of unerupted permanent canines and premolars of both dental arches in a sample of children belonging to the North Eastern part of Karnataka, Indiain order to derive new regression equations if required, for this specific population.

**Materials and Methods**

The study was carried out in the Department of Pedodontics and Preventive Dentistry of AME's Dental College and Hospital, Raichur. The sample for the study consisted of 100 children (50 boys and 50 girls) each within the age group of 13–15 yrs who were native to the North Eastern part of Karnataka India based on demographic data and native history.

*Inclusion Criteria*

- Children with complete eruption of permanent mandibular incisors, permanent mandibular and maxillary canines and premolars.
- Children with a maximum age of 15 years to preclude any discrepancies based on significant proximal wear.

Exclusion criteria

- Presence of any dental anomalies Teeth with clinical evidence of hypoplasia or hypocalcif ication
- Teeth with proximal caries, proximal wear or fractures Subjects with history of orthodontic therapy.

*Methodology*

Alginate impressions were obtained using standard procedures for material mixing as per manufacturer instructions & dental casts of high quality, without any distortion, were obtained with dental stone (Type III). Mesiodistal crown dimensions were measured using the electronic digital caliper (Baker SDN 10, India) which is calibrated to the nearest of 0.01 mm, according to the method described by Jensen et al (16) in which the caliper was held at the greatest mesiodistal diameter of tooth, perpendicular to the long axis and parallel to the occlusal surface of the tooth. Tanaka and Johnston and Moyer's prediction methods at 50th and 75th percentile were applied to the present cluster sample.

*Statistical analysis*

Statistical analysis was performed using SPSS version 21.0 (IBM, Chicago, USA). Descriptive statistics including the mean, standard deviation, and minimum and maximum values were calculated for the actual tooth size as well as predictive tooth size and comparison of the actual widths with the predicted widths by Tanaka Johnston and Moyer's method ($75^{th}$ percentile) and Moyer's method ($50^{th}$ percentile) using ANOVA test. Pearson's coefficient tests were used to evaluate the correlations between the groups of teeth and simple regression analyses were made to develop

possible regression equations for the present sample.

**Results**

*I.Comparisons of tooth sizes between right and left sides:*

No significant differences were present

*II. Comparisons between males and females:*

Preliminary examination indicated that predictive differences between the genders were statistically not significant for both the prediction methods in maxilla and mandible. Hence, the predicting regression equations for the present sample were not calculated separately for males and females.

*III.Comparison of the actual width of canines and premolars with the predicted width by Tanaka Johnston method, Moyer's method (75$^{th}$ percentile) &Moyer's method (50$^{th}$ percentile) using ANOVA test are shown in Graph 1 and 2.*

These findings demonstrated that the differences between the predicted width of the canine and premolars by Tanaka Johnston and Moyers method and actual widths were highly significant in the statistical sense, as indicated by ANOVA tests with F value=13.396 & P value=<0.001 in the maxilla and F value=12.498 & P value=<0.001 in the mandible. Tanaka Johnston approach and Moyer's probability at 75% slightly over assessed the tooth size of the unerupted canine and premolars in maxilla and mandible. Moyers probability at 50% level under assessed the tooth size of the unerupted canine and premolars in both mandible and maxilla.

*IV. Correlation coefficient (r) between the predicted and actual teeth size :*

There were statistically significant correlations between the actual and predicted tooth size obtained by both Tanaka Johnston approach and Moyers 75% & 50% confidence level, and r value were:

Tanaka Johnston prediction method were:

- r=0.673 for mandibular teeth
- r= 0.589 for maxillary teeth.

Moyers 75% level were:

- r= 0.681 for mandibular teeth.
- r= 0.626 for maxillary teeth.

Moyers 50% level were:

- r= 0.626 for mandibular teeth.
- r= 0.618 for maxillary teeth.

In general the 'r' values are higher for the Moyers 75% prediction compared to Tanaka Johnston and Moyers 50% prediction method.

*VI. Simple linear regression analysis:*

Following the guidelines for statistical analysis as described in the methodology and upon analysis of data, regression equations were developed separately for the maxilla and the mandible

Y = a + b (X) where,

- X= independent variable (sum of mandibular incisors measurements)
- Y = dependent variable (sum of canine and premolars).

For mandibular teeth,

- Y = 1.760 + 0.880 (X)

For maxillary teeth,

- Y = 7.875+0.620 (X)

*Graphs 3 (a,b,c) & 4(a,b,c)* represent the scatter plots of the data showing the presence of outlier values, the linearity of the relationship around the regression line.

**Discussion**

Mixed dentition arch analysis frames a basic part of early orthodontic intervention (5). Understanding the significance of diagnosing the tooth size and arch length errors at an early stage, numerous investigators have developed criteria for predicted the size of uneruptedpermanent teeth. These include Ballard and Wylie (1947); Hixon and Old Father (1958); Bull (1959); Moyers (1973, 1988); Tanaka and Johnston (1974); Staley and Hoag (1978); and Ingervall and Lennnartson (1978) and these were developed on the basis of three criteria in particular and presented through a regression

equation, radiograph and combination. (17, 18, 19, 2010. In the present study, the generally used non-radiographic method which uses simple regression equations i.e, Tanaka and Johnson (1974) Moyers (1976) was chosen because the results of the radiographic technique rely on the nature of the X-ray film available and the technique and position of the crypts (21, 22). In the present study, mesiodistal measurement of the teeth were done indirectly on the casts using digital calipers since the errors were less and it is quick, simple and accurate (23).

Statistically significant differences were observed between the actual values and those predicted by Tanaka and Johnston method. Tanaka and Johnston's prediction in the maxillary arch overestimated the combined mesiodistal width of permanent canine and premolars by 0.73mm when compared to the actual values. These results are in agreement with the studies done by Sonahitaet al. (24),Goyel et al. (6), Sonawane et al (25) and Shobha et al (2). However, underestimated values in females were noticed by Abu Alhaija and Qudeimat too (26).

In the mandibular arch, using Tanaka and Johnston prediction, overestimated values were observed by 0.89mm. These results are in harmony with the studies by Shobha et al (2), Chandna et al. (27), Sonawane et al. (25), Buwembo et al. (28) and Sonahita et al. (24). Contrary to this, underestimated values were detected by Abu Alhaija and Qudeimat (26).

With Moyers' prediction at the 50th percentile in the maxillary arch, underestimation of 0.49mm was observed, which is similar to the studies done by Abu Alhaija and Qudeimat.(26) and Nik Tahare et al. (29). On the contrary, studies done by Memon and Fida. (30) and Shobha et al (2) showed no difference between the actual values and predicted values in males.

At the 75th percentile of Moyers' prediction in the maxillary arch, an overestimation of 0.14 mm was observed. Results were similar to the work done by Sonawane et al.(25),Durgekar and Naik. (31). On the other hand, underestimated values were found by Hammad and Abdellatif (32), Philipet al (33), and Chandnaet al (27). On the contrary, Nik Tahereet al (29),Memon and Fida (30), and Buwemboet al (28) found its applicability for predicting values.

At the 75th percentile of Moyers' prediction in the mandibular arch, an overestimation of 0.67 mm was observed. These results are consistent with the study done by Shobha et al (2) andChandnaet al (27). On the contrary, underestimated values were reported by Hammad and Abdellatif (32).

In the present population, under and over assessed values were observed when Tanaka and Johnston and Moyer's prediction methods were applied, which could be due to variety in racial, ethnic, sample size and secular patterns. In this manner reiterating the fact that one prediction method may not be applicable universally (34, 35, 36). However, the exact etiology is not known for variations in tooth size among various racial groups although nutrition and environment along with genetics play an imperative role during development of tooth (37, 38).

## Conclusion

The most commonly used Tanaka and Johnston and Moyer's prediction methods were not exact when applied to the present sample since they tend to over/under-estimate the actual measurements. Tanaka and Johnston and Moyer's (75th percentile) overestimated the values whereas Moyer's ($50^{th}$ percentile) underestimated the actual values. The new derived regression equations were more promising in predicting the mesiodistal widths of canines and premolars

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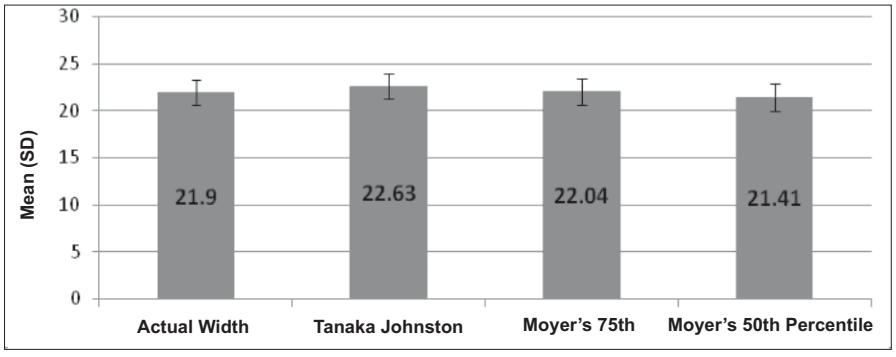
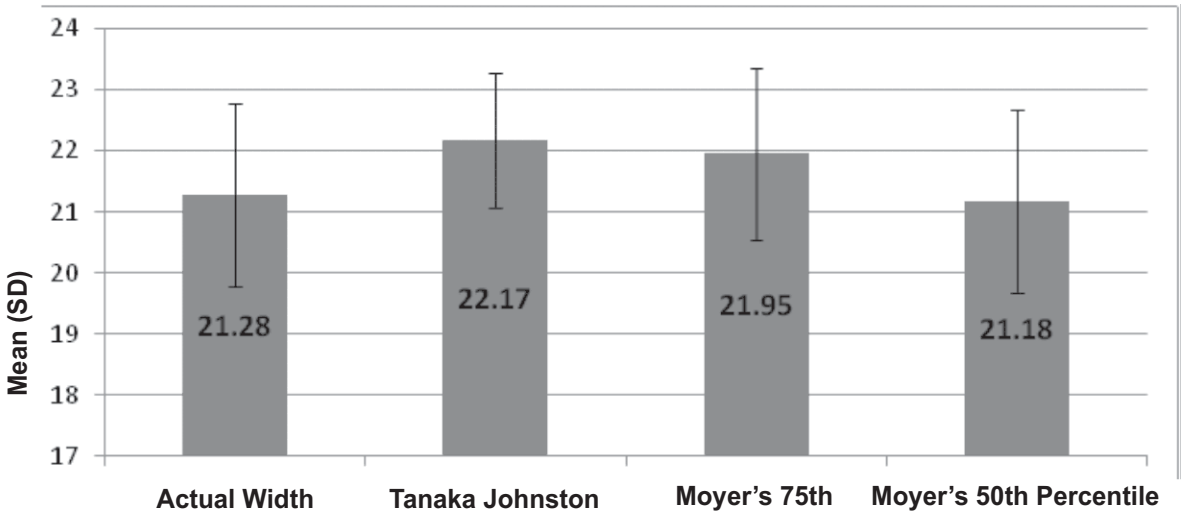
**Graphs and Legends:**

**Graph 1. Comparison of the actual width of upper canines and premolars with the predicted width by Tanaka Johnston method, Moyer's method (75th percentile) & Moyer's method (50th percentile) using ANOVA test.**

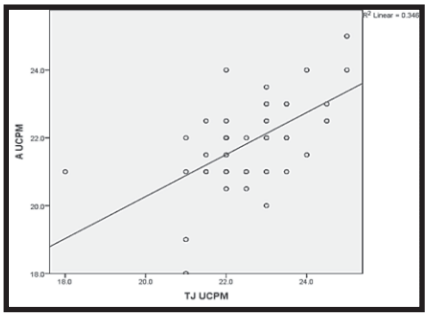


**Graph 2: Comparison of the actual width of lower canines and premolars with the predicted width by Tanaka Johnston method, Moyer's method (75th percentile) & Moyer's method (50th percentile) using ANOVA test.**



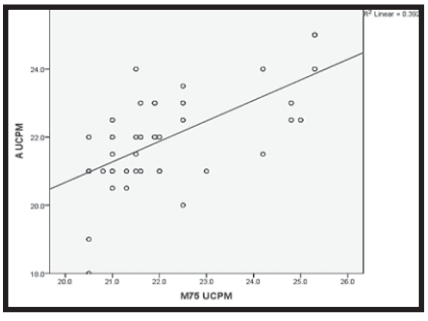

**Graph 3: Correlation between actual width of upper canines and premolars with the predicted width by Tanaka Johnston method, Moyer's method (75th percentile) & Moyer's method (50th percentile)**

**3 a)**



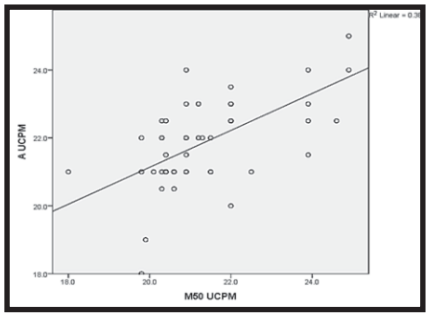

[A UCPM = actual width of canine and premolars; TJ UCPM= Tanaka & Johnston's prediction of upper canine and premolars]

**3 b)**




[A UCPM = actual width of canine and premolars; M75 UCPM= Moyer's 75th percentile prediction of upper canine and premolars.

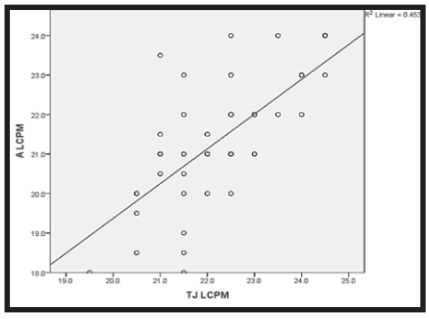
**3 c)**




[A UCPM = actual width of canine and premolars; M50 UCPM= Moyer's 50th percentile prediction of upper canine and premolars]

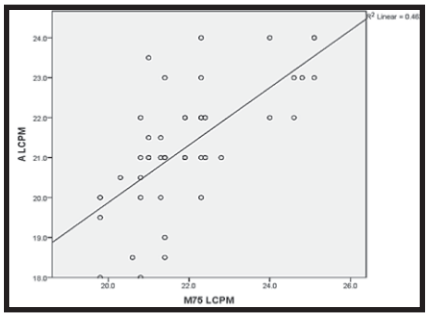
## Graph 4: Correlation between actual width of lower canines and premolars with the predicted width by Tanaka Johnston method, Moyer's method (75th percentile) & Moyer's method (50th percentile)

**4 a)**



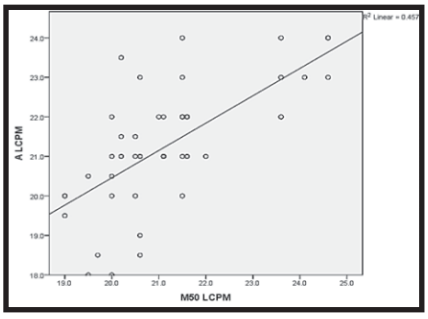

[A LCPM = actual width of lower canine and premolars; TJ LCPM= Tanaka & Johnston's prediction of lower canine and premolars]

**4 b)**




[A LCPM = actual width of lower canine and premolars; M75 LCPM= Moyer's 50th percentile prediction of lower canine and premolars]

**4 c)**




[A LCPM = actual width of lower canine and premolars; M50 LCPM= Moyer's 50th percentile prediction of lower canine and premolars].