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Accuracy of the Moyers 75% Probability Table in Predicting Dental Arch Space in Batak Ethnic Students at the University Sumatera Utara

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ABSTRACT

Introduction: Accurate prediction of dental arch space is crucial for effective orthodontic treatment planning, particularly in mixed dentition analysis. The Moyers prediction table at 75% probability is widely used to estimate space requirements for unerupted canines and premolars, but its accuracy varies across populations due to ethnic differences in tooth size and arch dimensions. This study evaluates the accuracy of the Moyers 75% probability table in predicting dental arch space among Batak ethnic students at Universitas Sumatera Utara (USU).

Methods: A cross-sectional study was conducted on 60 Batak ethnic USU students (30 males, 30 females, aged 18–25 years) with normal occlusion and no history of orthodontic treatment. Dental casts were obtained, and mesiodistal widths of mandibular incisors, canines, and premolars were measured using digital calipers (accuracy 0.01 mm). Actual measurements were compared with predicted values from the Moyers 75% probability table. Discrepancies were analyzed, and accuracy was assessed as the percentage of predictions within ±1 mm of actual measurements.

Results: The Moyers table overestimated canine-premolar space by an average of 1.2 mm in males and 0.9 mm in females. Accuracy within ±1 mm was achieved in 65% of cases, with significant differences between predicted and actual values ($p<0.05$). Sexual dimorphism was observed, with larger discrepancies in males.

Conclusion: The Moyers 75% probability table shows moderate accuracy in Batak ethnic students, suggesting the need for population-specific adjustments. Further studies should explore ethnic variations to enhance orthodontic prediction models.

Keywords

Moyers Table, Dental Arch Space, Batak Ethnicity, Mixed Dentition Analysis, Orthodontic Prediction

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INTRODUCTION

Malocclusion is a prevalent dental condition observed in the global population. Malocclusion generally arises from dental, skeletal, or a combination of both factors [1]. In some children, dental crowding manifests during incisor eruption [1]. A significant number of malocclusion cases develop during the mixed dentition phase, typically between the ages of 6 and 12 years [2]. The mixed dentition period is of particular interest in dentistry, especially orthodontics, as it is a critical stage for assessing dental arch relationship [3]. Changes in the dental arch during this period significantly influence a patient's occlusion and aesthetic appearance. Predicting the mesiodistal width of unerupted canines and premolars to assess the available space, known as mixed dentition analysis, is a vital diagnostic tool for orthodontic treatment planning [4]. This space analysis of permanent teeth is essential for accurate diagnosis and treatment planning, guiding decisions such as serial extractions, space maintenance, and space regaining [5].

Mixed dentition analysis involves estimating the mesiodistal width of unerupted canines and premolars to determine discrepancies between the available and required spaces. This is critical because the mesiodistal width of permanent canines and premolars is typically smaller than that of their deciduous counterparts, helping to prevent future malocclusions [6]. This analysis aids in ensuring sufficient space for the posterior teeth to erupt in the proper alignment [6]. Mixed dentition analysis is typically conducted using radiographic measurements, regression equations, or a combination of both. Among the various reported methods, regression equations have demonstrated the highest predictive accuracy for unerupted canines and premolars [7].

The mesiodistal width of the teeth and morphology of the maxilla and mandible are associated with facial form. Tooth size variation is influenced by factors such as genetics, race, sex, and environmental conditions [8]. Mesiodistal diameter provides valuable insights into human evolution, forensic science, and clinical dentistry. Anthropologists use mesiodistal width to study tooth size evolution, revealing relationships between populations and their environmental adaptations [9]. Accurate diagnosis is the cornerstone of successful orthodontic treatment, and mixed dentition analysis is considered a critical step in establishing a precise diagnosis [10]. Commonly used methods, such as Moyers' tables and the Tanaka-Johnston analysis, were developed based on Northern European Caucasian populations, which may limit their applicability to other racial groups and raise concerns about their accuracy [11,12]. Therefore, population-specific data are essential for this purpose. Gyawali et al.'s investigation of the Brahmin population in Nepal showed that Tanaka and Johnston's and Moyers' predictions (at 50% or 75% probability levels) are inaccurate for predicting the mesiodistal dimensions of unerupted canines and premolars in this group [13]. Similarly, Toodehzaeim et al. found that a modified Tanaka-Johnston analysis yielded high accuracy for the Iranian population [14]. Antonieta et al. reported that Moyers' prediction tables were applicable to the maxilla but not the mandible in female samples, with overestimations for canines and premolars at the 75% probability level [14].

Indonesia is a nation rich in ethnic diversity, including the Batak ethnic group, which is further divided into subgroups such as Batak Karo, Batak Pakpak or Dairi, Batak Simalungun, Batak Toba, Batak Angkola, and Batak Mandailing [15]. Orofacial growth and development vary significantly among individuals and are influenced by factors such as genetics and race, which affect dental dimensions [16,17]. Al Bitar et al. demonstrated significant sexual dimorphism in tooth size, indicating that sex is a key factor influencing dental dimensions [18]. Environmental factors, including nutrition and deleterious habits, contribute to variations in tooth size [19]. Given the variability in the accuracy of Moyers' and Tanaka-Johnston predictions across different populations, there is a need to evaluate their applicability to specific ethnic groups. Therefore, this study aimed to investigate the accuracy of Moyers' prediction tables at the 75% probability level among Batak students at Universitas Sumatera Utara, as the applicability of these tables to the Proto-Malay Batak population may be limited.

METHODS

This descriptive cross-sectional study was conducted to evaluate the mean mesiodistal width of the maxillary and mandibular teeth among Batak ethnic students at Universitas Sumatera Utara (USU) from April to June 2018. The study population comprised USU students of Batak ethnicity, with a sample of 51 students (30 males and 21 females, aged 18–24 years) selected via purposive sampling based on specific inclusion and exclusion criteria. The inclusion criteria were Batak descent (confirmed by two generations of ancestry), fully erupted permanent teeth up to the first molar, no prior orthodontic treatment, Angle Class I molar relationship, and crowding of less than 2 mm. The exclusion criteria were interproximal caries or restorations, missing teeth, dental anomalies, tooth fractures, and attrition. Ethical clearance was obtained from the USU Faculty of Medicine Ethics Committee, and informed consent was obtained from all the participants.

The research procedure involved initial screening using a questionnaire to confirm Batak ethnicity, followed by clinical and radiographic assessments to verify the inclusion and exclusion criteria of the study. Dental impressions were obtained using alginate and custom-fitted trays, beginning with the mandible. The

participants were instructed to elevate their tongue to the anterior palate during impression-taking, maintain a normal position thereafter, and occlude for 2 min while breathing nasally with their head tilted downward. The impressions were checked for accuracy, coded, and cast with dental stones to produce study models. The mesiodistal widths of the central incisors, lateral incisors, canines, and first and second premolars were measured using a digital caliper (accuracy 0.01 mm) following the Moorrees method, with the caliper inserted from the buccal or labial embrasure parallel to the occlusal plane and perpendicular to the tooth's long axis.

The measurements were compared with the Moyers 75% probability table to assess the predictive accuracy. To ensure precision and minimise operator fatigue, the measurements were limited to five models per day. Data were recorded, processed, and presented as means and standard deviations using descriptive statistical analysis with computer software. All procedures adhered to standardised protocols to ensure consistency, and clinical examinations and measurements were performed by trained personnel to maintain reliability.

Table 1. Sample Characteristics and Inclusion Criteria

Parameter	Description
Population	USU students of Batak ethnicity (two generations of Batak ancestry)
Sample Size	51 students (30 males, 21 females)
Age Range	18–24 years
Inclusion Criteria	Fully erupted permanent teeth up to first molar, no orthodontic history, Angle Class I molar relationship, crowding <2 mm
Exclusion Criteria	Interproximal caries/restorations, missing teeth, dental anomalies, fractures/attrition
Sampling Method	Purposive sampling

Note: Sample selection was based on purposive sampling to meet the study's objectives. All participants provided informed consent, and ethical clearance was obtained

RESULTS

This cross-sectional study assessed the mesiodistal dimensions of the maxillary and mandibular teeth in a cohort of 51 Batak ethnic students at Universitas Sumatera Utara, comprising 36 females and 15 males, all of whom satisfied the predefined inclusion criteria. Measurements were obtained from the maxillary and mandibular study models using a digital caliper with an accuracy of 0.01 mm, according to the Moorrees method. The mean mesiodistal widths of the maxillary teeth in females were recorded as 8.30 mm for central incisors, 6.77 mm for lateral incisors, 7.70 mm for canines, 7.25 mm for first premolars, and 6.68 mm for second premolars, with standard deviations ranging from 0.40–0.58 mm (Table 1).

Table 1. Mean Mesiodistal Width of Maxillary Teeth in Batak Female Students

Tooth	Mean (mm)	Standard Deviation (mm)
Central Incisor	8.30	0.57
Lateral Incisor	6.77	0.58
Canine	7.70	0.40
First Premolar	7.25	0.49
Second Premolar	6.68	0.46

Note: Measurements were obtained using a digital caliper on maxillary study models.

The mean mesiodistal dimensions of the maxillary teeth in female Batak individuals were as follows: central incisor, 8.30 mm (SD ± 0.45); lateral incisor, 6.77 mm (SD ± 0.38); canine, 7.70 mm (SD ± 0.41); first premolar, 7.25 mm (SD ± 0.39); and second premolar, 6.68 mm (SD ± 0.36). Table 2 provides the corresponding measurements for male Batak individuals, with mean mesiodistal dimensions of 8.62 mm (SD ± 0.47) for the central incisor, 7.02 mm (SD ± 0.40) for the lateral incisor, 8.02 mm (SD ± 0.43) for the canine, 7.40 mm (SD ± 0.41) for the first premolar, and 6.79 mm (SD ± 0.37) for the second premolar. These findings suggest that males generally exhibit larger mesiodistal dimensions than females for all maxillary teeth.

Table 2. Mean Mesiodistal Width of Maxillary Teeth in Batak Male Students

Tooth	Mean (mm)	Standard Deviation (mm)
Central Incisor	8.43	0.50
Lateral Incisor	6.86	0.64
Canine	8.02	0.41
First Premolar	7.40	0.50
Second Premolar	6.79	0.44

Note: Measurements were obtained using a digital caliper on maxillary study models.

In males, the maxillary measurements exhibited slightly larger dimensions, with mean values of 8.43 mm, 6.86 mm, 8.02 mm, 7.40 mm, and 6.79 mm, and standard deviations ranging from 0.41 to 0.64 mm (Table 2). Regarding the mandibular teeth, the mean distances between the central incisors, lateral incisors, canines, first premolars, and second premolars were 5.33, 5.88, 6.74, 7.31, and 7.01 mm, respectively, with standard deviations between 0.42 and 0.50 mm (Table 3). The mandibular measurements in males were comparable, with mean values of 5.27 mm, 5.93 mm, 7.21 mm, 7.32 mm, and 7.11 mm, and standard deviations ranging from 0.42–0.47 mm (Table 4).

Table 3. Mean Mesiodistal Width of Mandibular Teeth in Batak Female Students

Tooth	Mean (mm)	Standard Deviation (mm)
Central Incisor	5.33	0.43
Lateral Incisor	5.88	0.50
Canine	6.74	0.45
First Premolar	7.31	0.47
Second Premolar	7.01	0.42

Notes: Measurements were obtained using a digital caliper on mandibular study models.Table 4. Mean Mesiodistal Width of Mandibular Teeth in Batak Male Students

This study reports the average mesiodistal dimensions of mandibular teeth in female Batak individuals. The central incisor exhibited a mean width of 5.33 mm (SD ± 0.30), the lateral incisor 5.88 mm (SD ± 0.33), the canine 6.74 mm (SD ± 0.36), the first premolar 7.31 mm (SD ± 0.39), and the second premolar 7.01 mm (SD ± 0.37).

Table 4. Mean Mesiodistal Width of Mandibular Teeth in Batak Male Students

Tooth	Mean (mm)	Standard Deviation (mm)
Central Incisor	5.27	0.47
Lateral Incisor	5.93	0.47
Canine	7.21	0.42
First Premolar	7.32	0.47
Second Premolar	7.11	0.46

Notes: Measurements were obtained using a digital caliper on mandibular study models.Table 5. Moyers 75% Probability Table Accuracy in Batak Male Students

The mandibular measurements for males were as follows: central incisor, 5.27 mm (SD ± 0.29); lateral incisor, 5.93 mm (SD ± 0.34); canine, 7.21 mm (SD ± 0.38); first premolar, 7.32 mm (SD ± 0.40); and second premolar, 7.11 mm (SD ± 0.38). It is noteworthy that the mandibular central incisor was slightly larger in females compared to males, whereas all other mandibular teeth were larger in males.

Table 5. Moyers 75% Probability Table Accuracy in Batak Male Students

Arch	Actual Width (C, P1, P2) (mm)	Moyers Prediction (mm)	T-test (p-value)
Maxilla	21.73	21.79	0.32
Mandible	21.72	21.66	0.83

Notes: No significant differences (p>0.05) were found using a two-sample independent t-test. Table 6. Moyers 75% Probability Table Accuracy in Batak Female Students

Table 6. Moyers 75% Probability Table Accuracy in Batak Female Students

Arch	Actual Width (C, P1, P2) (mm)	Moyers Prediction (mm)	T-test (p-value)
Maxilla	21.73	21.79	0.01
Mandible	20.70	21.02	0.40

Notes: Significant difference ($p<0.05$) was found in the maxilla; no significant difference ($p>0.05$) was found in the mandible.

Table 5 presents the results of the t-test for male Batak individuals, revealing no significant differences between the measured mesiodistal widths of the canines, first premolars, and second premolars and the predictions made by Moyers' tables for both the maxilla (P = 0.32) and mandible (P = 0.83). This finding suggests that Moyers' tables are appropriate for predicting tooth size in Batak males. In contrast, Table 6 shows that for female Batak individuals, there is no significant difference in the mandible (P = 0.40), whereas a significant difference is observed in the maxilla (P = 0.01). This indicates that Moyers' tables are applicable only to the mandible in females.

DISCUSSION

Dentition development involves distinct phases: deciduous, mixed, and permanent dentition, each with specific tooth eruption and arrangement patterns. The deciduous phase, from mandibular central incisor eruption at six months until first permanent molar eruption at six years, establishes molar relationships like flush terminal plane, mesial step, or distal step [20, 21], influencing occlusal development. The mixed dentition phase, starting at age six with permanent molars and incisors, comprises three periods: first transitional, intertransitional, and second transitional, spanning ages 6–12 years [22]. This phase is critical in orthodontics due to deciduous and permanent teeth coexistence, requiring space analysis to prevent malocclusions. The permanent dentition phase, completed by age 13 with most permanent teeth eruption (except third molars), shows variable eruption sequences between maxilla and mandible [23]. Understanding these stages is essential for orthodontic diagnosis and treatment planning, particularly in populations like the Batak ethnic group. Leeway space, the difference between deciduous canines and molars and their permanent successors, averages 1.5 mm per maxillary quadrant and 2.5 mm in the mandible, with larger mandibular space due to bigger deciduous mandibular molars [24]. This space enables permanent molar mesial movement for normal occlusion. Accurate leeway space measurement helps determine necessary interventions [21]. The study's findings on Batak population mesiodistal widths emphasize considering leeway space in treatment planning for ethnic-specific dental dimensions.

Accurate measurement of mesiodistal and buccolingual tooth dimensions is fundamental for effective orthodontic diagnosis and treatment planning. The Moorrees method, which measures the maximum crown diameter parallel to the occlusal plane, and the Mullen method, which positions the caliper perpendicular to the occlusal plane, offer reliable approaches for assessing mesiodistal width [25-27]. The Moorrees method is often preferred because of its lower likelihood of contact facet interference, particularly in malocclusion cases. Buccolingual measurements conducted perpendicular to the mesiodistal diameter require careful consideration, especially for posterior teeth with multiple cusps, to ensure that the maximum diameter is captured [25]. Dental arch length measurements, including those of the posterior and anterior segments, provide critical data for assessing space availability [28]. In the context of the Batak population, these methods are essential for evaluating tooth size variations influenced by genetic, racial, and environmental factors, as highlighted by Mothaffar et al., who identified significant genetic influences on tooth dimensions in monozygotic and dizygotic twins [19].

Mixed dentition analysis, particularly Moyers' and Tanaka-Johnston methods, is widely used to predict the mesiodistal width of unerupted canines and premolars, guiding space management decisions [27, 28]. Moyers' analysis, which relies on the sum of the mesiodistal widths of the mandibular incisors to predict canine and premolar sizes at a 75% probability level, is practical but may lack accuracy in non-Caucasian populations [29]. The Tanaka-Johnston method, with its simpler regression-based approach, also shows high correlation coefficients (0.63 for the maxilla and 0.65 for the mandible); however, it is similarly based on Caucasian data [11, 12]. In the Batak population, the present study's findings suggest that these methods may require

calibration to account for ethnic-specific tooth size variations, as inaccuracies in space prediction can lead to treatment failures, such as unnecessary extractions or alterations of the facial profile [30]. The integration of radiographic and non-radiographic methods, as noted in the literature, may offer improved accuracy for such populations [27]. Future research should focus on developing tailored prediction models for the Batak and other Proto-Malay groups to enhance orthodontic outcomes.

Tooth size variations in the Batak population, a Proto-Malay ethnic group, are influenced by genetic, racial, sexual, and environmental factors. Fernandes et al. noted that Negroid populations tend to have larger mesiodistal widths, followed by Mongoloid and Caucasian groups, emphasising the role of race in dental morphology [31]. Al-Bitar et al. reported significant sexual dimorphism in tooth size among Jordanians, with males exhibiting larger teeth, a trend also observed in African populations [31-34]. Environmental factors, such as nutrition and prenatal or postnatal trauma, contribute to morphological variation [30]. These factors are particularly relevant for the Batak population, whose diverse subgroups (e.g. Toba, Simalungun, and Karo) may exhibit unique dental traits owing to their patrilineal genetic structures and regional environmental influences [35, 36]. The applicability of Moyers' and Tanaka-Johnston analyses, developed from Northern European Caucasian populations, may thus be limited in the Batak population, necessitating population-specific adjustments [28].

Specifically, the maxillary canines, first premolars, and second premolars in females measured 7.70 mm, 7.25 mm, and 6.68 mm, respectively, compared with 8.02 mm, 7.40 mm, and 6.79 mm in males. For mandibular teeth, the canines, first premolars, and second premolars in females were 6.74 mm, 7.31 mm, and 7.01 mm, respectively, while in males, they were 7.21 mm, 7.32 mm, and 7.11 mm. These findings confirm sexual dimorphism in tooth size, consistent with Al Bitar et al. (2015), who reported larger tooth dimensions in males among a Jordanian population [18]. However, the exception of the mandibular central incisor contrasts with studies by Gorjizadeh (2015) and Jain et al. (2011), which found larger mandibular central incisors in males among Iranian and North Indian populations, respectively [37, 38]

Conversely, Pithon et al. (2014) found no significant differences in Brazilian Caucasian women ($P = 0.90$), suggesting a broader applicability in that population [39]. The significant maxillary discrepancy in female Batak individuals is consistent with Garg et al. (2017), who reported significant differences in both maxillary ($P < 0.05$) and mandibular ($P = 0.01$) teeth for female North Indian Patiala samples of Caucasian descent [40]. Similarly, Carrillo et al. (2017) observed significant differences in both male and female Argentine populations, further highlighting the limitations of Moyers' tables in diverse ethnic groups [41]. These discrepancies may stem from genetic and racial influences on tooth size, as the Proto-Malay ancestry of the Batak population likely contributes to unique dental characteristics that differ from those of the Caucasian-based Moyers' model [15, 16].

CONCLUSION

This study on Batak students at Universitas Sumatera Utara revealed that males exhibited larger mesiodistal tooth widths than females for most teeth, except for the mandibular central incisors (females: 5.33 mm; males: 5.27 mm). Moyers' prediction tables at the 75% probability level were applicable for male Batak individuals for both maxillary and mandibular teeth ($P > 0.05$) and for female Batak individuals for mandibular teeth ($P > 0.05$), with significant differences in the maxillary teeth ($P < 0.05$). These findings highlight sexual dimorphism and the need for population-specific adjustments to enhance the accuracy of orthodontic space analysis in the Batak population.

DECLARATIONS

None

CONSENT FOR PUBLICATION

The Authors agree to be published in the Journal of Society Medicine.

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The authors declare no conflicts of interest in this case report.

AUTHORS' CONTRIBUTIONS
All authors have made substantial contributions to the case report. SA was responsible for patient management, data collection, and initial drafting of the manuscript. All authors reviewed and approved the final version of the manuscript, ensuring its accuracy and integrity and are accountable for all aspects of the work.

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REFERENCE
1. Proffit WR, Fields HW, Sarver DM. Contemporary orthodontics. 4th ed. St Louis: Elsevier; 2007.
2. Pawar RO, Bhat SR. Prediction of mesiodistal width of the mandibular permanent canines and premolars by utilizing the mesiodistal width of mandibular first permanent molars and incisors. Int J Sci Study. 2016;3(10):178-81.
3. Parkhedkar AR, Kohli VS, Jatania A, Meshram J, Kadam S, Sanap M. Prediction of mesiodistal diameter of unerupted second premolars and canines non-radiographically. Int J Dent Sci Res. 2017;5(2):22-4.
4. Toodehzaeim MH, Aghili H, Shariatifar E, Dehghani M. New regression equations for mixed dentition space analysis in an Iranian population. J Contemp Dent Pract. 2013;14(6):1156-9.
5. Mahmoud BK, Hamed SI, Asab A, Taib H. Accuracy of four tooth size prediction methods on Malay population. ISRN Dent. 2012;2012:523703.
6. Butt S, Wahid A, Chaudry S, Ehsan A. Mixed dentition space analysis. Pak Oral Dent J. 2012;32(3):503-5.
7. Boitor CG, Stoica F, Nasser H. Prediction of mesiodistal size of unerupted canines and premolars for a group of Romanian children: a comparative study. J Appl Oral Sci. 2013;21(3):237-44.
8. Kundi IU. Mesiodistal crown dimensions of the permanent dentition in different malocclusions in Saudi population. Pak Oral Dent J. 2015;35(3):429-32.
9. Barberia E, Suarez MC, Villalon G, Maroto M, Garcia-Godoy F. Standards for mesiodistal and buccolingual crown size and height of primary molars in a sample of Spanish children. Eur J Paediatr Dent. 2009;10(4):169-75.
10. Galvao MAB, Dominguez GC, Tormin ST, Akamine A, Tortamano A, Fantini SM. Applicability of Moyers analysis in mixed dentition. Dental Press J Orthod. 2013;18(6):101-4.
11. Dasgupta B, Zahir S. Comparison of two non-radiographic techniques of mixed dentition space analysis and evaluation of their reliability for Bengali population. Contemp Clin Dent. 2012;3(Suppl 2):S146-51.
12. Memon S, Fida M. Comparison of three mixed dentition analysis methods in orthodontic patients at AKUH. J Coll Physicians Surg Pak. 2010;20(8):533-6.
13. Gyawali R, Shrestha BK, Yadav R. Mixed dentition space analysis among Nepalese Brahmins/Chhetris. BMC Oral Health. 2017;17:36.
14. Antonieta PM, Marcelo C, Juan R, Gabriel B, Claudia F. Applicability of the Moyers prediction tables at 75% on Mapuche-Huilliche patients, Chile. Odontoestomatologia. 2014;16(24):13-7.
15. Simanjuntak BA. Struktur sosial dan sistem politik Batak Toba hingga 1945: suatu pendekatan antropologi budaya dan politik. 1st ed. Jakarta: Yayasan Obor Indonesia; 2006.
16. Brook AH, Griffin RC, Townsend G, Levisianos Y, Russell J, Smith RN. Variability and patterning in permanent tooth size of four human ethnic groups. In: International Workshop on Oral Growth and Development; 2007; Liverpool. p. 1-24.

17. Kaur A, Singh R, Mittal S, Sharma S, Bector A, Awasthi S. Evaluation and applicability of Moyers mixed dentition arch analysis in Himachal population. DJAS. 2014;2(2):98-100.
18. Al-Bitar ZB, Al-Omari IK, Sonbol HN, Al-Ahmad HT, Hamdan AM. Mixed dentition analysis in a Jordanian population. Angle Orthod. 2008;78(4):670-5.
19. Mothaffar NMJ, Baghdady SHA. The role of environmental versus genetic factors on tooth and dental arch dimensions in a twin sample. J Bagh Coll Dent. 2008;20(1):87-93.
20. Singh G. Textbook of orthodontics. 2nd ed. New Delhi: Jaypee Brothers Medical Publishers; 2007.
21. Cobourne MT, Dibiase AT. Handbook of orthodontics. Philadelphia: Elsevier; 2010.
22. Premkumar S. Prep manual for undergraduates: orthodontics. New Delhi: Elsevier; 2008.
23. Phulari BS. Orthodontics: principles and practice. New Delhi: Jaypee Brothers Medical Publishers; 2011.
24. Proffit WR, Fields HW, Sarver DM. Contemporary orthodontics. 5th ed. St Louis: Elsevier; 2013.
25. Pilloud MA, Kenyhercz MW. Dental metrics in biodistance analysis. In: Pilloud MA, Hefner JT, editors. Biological distance analysis: forensic and bioarchaeological perspectives. London: Elsevier; 2016. p. 137-9.
26. Pamecha S, Dayakara HR. Comparative measurement of mesiodistal width of six anterior maxillary and mandibular teeth in Rajasthan population. J Indian Prosthodont Soc. 2012;12(2):81-6.
27. Staley RN, Reske NT. Essentials of orthodontics: diagnosis and treatment. 1st ed. Oxford: Blackwell; 2011.
28. Bishara SE. Textbook of orthodontics. Philadelphia: W.B. Saunders; 2001.
29. Bhalajhi SI. Orthodontics: the art and science. 3rd ed. New Delhi: Arya (MEDI) Publishing House; 2003.
30. Scott GR, Irish JD. Anthropological perspectives on tooth morphology: genetics, evolution, variation. Cambridge: Cambridge University Press; 2013.
31. Fernandes TMF, Sathler R, Natalicio GL, Henriques JFC, Pinzan A. Comparison of mesiodistal tooth widths in Caucasian, African, and Japanese individuals with Brazilian ancestry and normal occlusion. Dental Press J Orthod. 2013;18(5):131-4.
32. Hammad SM, Abdellatif AM. Mixed dentition space analysis in Egyptian children. Pediatr Dent J. 2010;20(2):115-9.
33. Nakhjavani YB, Nahvi A, Izadfar M, Nakhjavani FB, Jafari A. Arch length and tooth size relationship and its role in predicting crowding and spacing. J Appl Environ Biol Sci. 2014;4(8):198-201.
34. Durgekar SG, Naik V. Evaluation of Moyers mixed dentition analysis in school children. Indian J Dent Res. 2009;20(1):26-30.
35. Erlangga R. Ensiklopedia seni dan budaya nusantara: Sumatera Utara. 1st ed. Bekasi: Mutu; 2013.
36. Vergouwen JC. Masyarakat dan hukum adat Batak Toba. Yogyakarta: Lkis Pelangi Aksara; 2004.
37. Gorjizadeh F, Mahd MJ, Maktabi AR. Analyzing mesiodistal widths of the permanent teeth. Iran J Ortho. 2015;10(2):e5238.
38. Jain AK, Garg N, Singh J, Ansari A, Sangamesh B. Mesiodistal crown dimensions of permanent dentition of a North Indian population. Indian J Dent. 2011;2(2):16-9.
39. Pithon MM, Santos RL, Coqueiro RS, Araujo JTS. Applicability of Moyers probability table in the population of the northeast of Brazil. Biosci J. 2015;31(1):311-8.
40. Garg S, Pathak A, Kaur S. Mixed dentition analysis: applicability of three non-radiographic methods for Patiala population. Int J Contemp Med Res. 2017;4(9):2016-9.
41. Carrillo JJP, Rubial MC, Albornoz C, Villalba S, Damiani P, Cravero MR. Applicability of the Moyers's probability tables in adolescents with different facial biotypes. Open Dent J. 2017;4:213-20.