AGE ESTIMATION USING ORTHOPANTOMOGRAMS AND DEMIRJIAN METHOD AMONG CHILDREN ATTENDING DENTAL CLINICS IN WESTERN KENYA

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ABSTRACT

Background: Various methods have been used to estimate age in different populations among them being Demirjian which has widely been utilized. However, in Kenya, there is hardly any approved method that can be used to achieve this purpose, hence the need to determine the available methods for estimating the age of children in Western Kenya. Therefore, this study aimed at estimating radiological age using Demirjian method among children attending dental clinics in Western Kenya. **Methods:** The study adopted a cross-sectional descriptive design and used Yamane Taro (1967) formulae to find a sample size of 171 panoramic radiographs of children aged between 5-17 years which were examined in order to determine the tooth maturity stages (A-H) for the first seven mandibular teeth on the left side. Each maturity stage was then assigned a corresponding maturity score as per Demirjian conversion tables for boys and girls, summed up and converted into dental age. Descriptive statistics such as mean, standard deviation, standard error of mean was presented in tables and graphs while inferential statistics such as linear regression was used to measure the deviation and test of significance. **Results:** The overall mean dental age was 8.16 ± 2.7 with a standard error of mean of 0.211. The female and male mean dental age deviated from the chronological age at ±2.22 years and ±1.68 years respectively at 95% Confidence interval. **Conclusion:** In conclusion, the study revealed an underestimation of the dental age from chronological age using Demirjian method among children of African origin.

Keywords: Chronological age, Dental age, Demirjian method
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INTRODUCTION

The biodata of an individual entails their age that is not only necessary for the living but for the deceased. Authentic documents such as certificate of birth, national identity cards or passports can be used to verify an individual's age. Nevertheless, in some circumstances where an individual's age can't be established, age estimation must be authenticated (Jayaraman, 2013). In this regard, it is important to understand that Chronological age (CA), also known as actual age, is obtained from the birth certificate of a newborn child while Dental age (DA) or estimated age is obtained by looking at the growth and development of individual' teeth (Yunus & Wardhani, 2016). Age estimation is normally applied in diverse fields such as forensic medicine, odontology, anthropology and archeological studies(Liversidge *et al.*, 2015; Ritz-Timme *et al.*, 2000; Senn & Weems, 2013). In the field of dentistry, the age of a patient and the maturity status of their tooth enables the dentists to plan for orthodontic and pedodontics management of various tooth conditions (Marwaha *et al.*, 2008; Panchbhai, 2011). Dentists often rely on observation of eruption patterns and the use of chronological tables which have been developed using foreign populations which may not have maturity rates similar to the local population (Hassanali & Odhiambo, 1982; Litt, 1996; Lwande *et al.*, 1985).

Within the dental clinic, tooth maturity stage and estimated age can be ascertained when assessing growth and development among paediatric patients. This is important in planning for treatment. Teeth maturity plays a major role in decision-making of when to extract teeth or commence orthodontic treatment. In addition, some maturity indicators like bone and sexual growth can be integrated with age for detecting paediatric hormonal problems and maturity anomalies(Marwaha *et al.*, 2008; Willems *et al.,* 2001) Therefore, this study aimed at estimating age among children in Western Kenya who did not possess age verification documents such as birth certificates, passports and identity cards in Western Kenya.

MATERIALS AND METHODS

This was a cross-sectional retrospective study conducted in a dental clinic and approved by different authorities (MSC/SM/ 00011/020, MUSERC/01149/22, and NACOSTI/P/22/2240) and concerned ethical committees. The study adopted a cross-sectional descriptive design and used Yamane Taro (1967) to obtain a sample of 171 panoramic radiographs from a total of 300 radiographs. The purposive sampling method was used to select the sample radiographs. The inclusion criteria included; radiographs with quality diagnostic images, no missing teeth on the mandibular segment, and those with available information on the date of birth and date of panoramic imaging. The radiographs that had missing biodata, and those with pathologies and cysts on teeth dentition were excluded. The panoramic radiographs were then examined by looking at the morphological appearance of the teeth and staged(A-H) according to Demirjian tooth staging technique. The technique was applied on the seven mandibular left teeth and each maturity stage was accorded maturity scores, summed up, and converted to dental age according to the Demirjian conversion tables for boys and girls. The data was then put into an Excel sheet and uploaded into the statistical package for social sciences (SPSS) version 26.0. Descriptive statistics such as mean, standard deviation, standard error of mean was utilized and presented in tables and graphs while inferential statistics such as linear regression was used to measure the deviation and statistical significance.

RESULTS

Using Demirjian method, the mean dental age was 8.16± 2.7 with a standard error of the mean of 0.211 in the total respondents (Table 1.1).

In females, the mean dental age was 7.09± 3.096 with a standard error of mean of 0.353 while in males it was 9.03±2.087 with a standard error of mean of 0.2(Table 1.2).
The distribution of frequency of dental age estimation errors is illustrated in figure 1.1 using Demirjian method. The probability of underestimation of chronological age was therefore high in females than in males. However, the cumulative error for age estimation for both sexes was less than ± 1.683 years (Figure 1.1).

Using the regression analysis test for linearity, the mean difference between chronological age and estimated age was plotted against the age frequency distribution to determine how wide the deviation is from the chronological age (standard error of mean). Among females, the deviation from chronological age was ±2.22 years at 95% confidence interval (CI), while in males, the deviation was ±1.68. This means that the females had a wider margin of error during age estimation than males (Table 1.3).

Table 1.1: Mean Dental age of the total respondents using Demirjian method

Dental Age Demirjian							
Age cohort	N	Mean	Std. D	SEM	Min	Max	Variance
5-6.99	25	5.56	1.960	.392	2	9	3.840
7-8.99	47	6.85	1.853	.270	2	11	3.434
9-10.99	49	8.04	1.755	.251	6	14	3.082
11-12.99	29	9.21	1.114	.207	9	13	1.241
13-14.99	12	12.33	2.309	.667	10	17	5.333
15-17.99	9	13.89	1.364	.455	12	16	1.861
Total	171	8.16	2.758	.211	2	17	7.604

Table 1.2: Difference in age estimation using Demirjian method among sexes

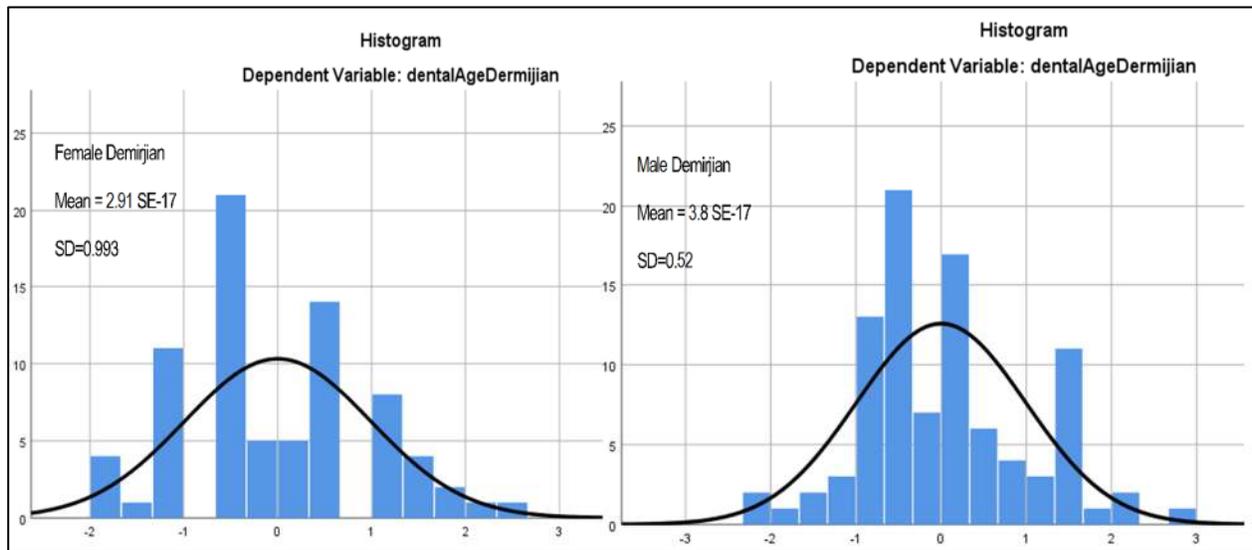|	Female Demirjian				Male Demirjian			
Age cohort	N	Mean	SD	SEM	N	Mean	SD	SEM
5- 6.99	13	4.08	1.441	.400	12	7.17	.835	.241
7- 8.99	21	5.90	2.189	.478	26	7.62	1.061	.208
9 -10.99	23	7.04	1.745	.364	26	8.92	1.230	.241
11-12.99	13	8.46	1.127	.312	16	9.81	.655	.164
13 -14.99	3	13.33	3.786	2.186	9	12.00	1.803	.601
15 -17.99	4	14.25	.957	.479	5	13.60	1.673	.748
Total	77	7.09	3.096	.353	94	9.03	2.087	.215

Figure 1.1 Histogram illustrating error in Dental age estimation in boys and girls using Demirjian method.

Table 1.3: Linear regression test for relationship between chronological age and Dental age in males and females

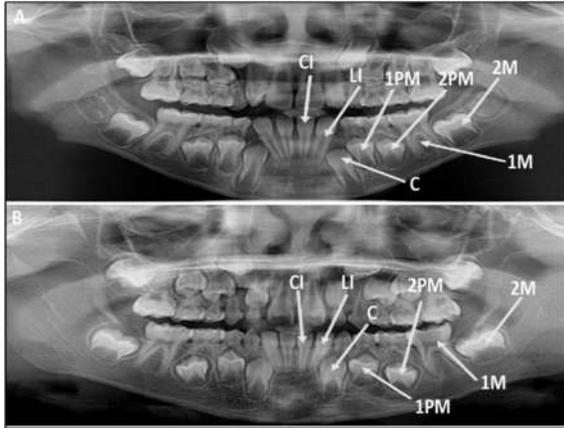|	FEMALES			MALES		
Predicted models	Minimum	Maximum	Std. Deviation	Minimum	Maximum	Std. Deviation
Predicted Value	.76	11.53	**2.223**	6.30	13.68	**1.683**
Residual	-3.346	3.499	**1.535**	-2.831	3.628	**1.233**
Std. Predicted Value	-1.968	2.878	**1.000**	-1.624	2.759	**1.000**
Std. Residual	-2.166	2.265	**.993**	-2.284	2.927	**.995**

Figure 1.2. A & B- Digital Orthopantomogram images of a 10-year-old male and female child whose Dental ages were estimated at 9 and 8 years respectively using Demirjian method. CI-Central incisor, LI -Lateral incisors, C- Canines, 1PM- First Premolar, 2PM- Second Premolar, 1M -First Molar, 2PM- Second Molar.

The seven mandibular left permanent teeth were assessed and staged(A-H) according to their developmental maturity on the digital orthopantomograms (Figure 1.2 & 1.3) Maturity scores were then given for each

tooth according to the Demirjian conversion tables for boys and girls. The scores were then summed up and converted to dental age.

Figure 1.3. Demirjian stages of tooth development(A-H)
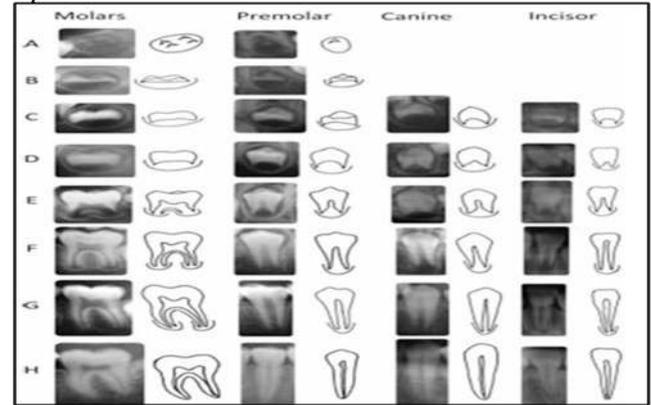
Adopted from the assessment and interpretation of Demirjian dental maturity stages by Hellen M. Liversidge.

DISCUSSION

Demirjian scoring system of age estimation has a wide application in ascertaining maturity scores of teeth. The maturity scores are obtained by first staging(A-H) the seven teeth on the left mandible and according them maturity scores according to the Demirjian conversion tables for boys and girls. The scores are then summed up and converted into dental age. Therefore, to determine the precise age, population specific standards need to be developed (Esan *et al.*, 2017).In the present study, the dental age was underestimated using Demirjian method for this age cohort. The overall mean difference between the estimated dental age and the chronological age was 8.16 ±2.7 with a standard error of 0.211 years (Table 1.1). There was an overall underestimation in all the age cohorts with a mean age difference of 7.09±3.096 in females and 9.03±2.087 in males (Table 1.2). In the entire sample population, the difference in the estimated dental age varied from 0.957-3.78 in females and 0.655-1.803

in males. The greatest underestimation of dental age in females and males was found both in the 13-14.99-year-old age cohort (Table 1.2). This revealed an advanced dental maturity in the older age groups at puberty stage as opposed to the younger age group). Similarly, varying degrees of underestimation was reported by (Mani *et al.*, 2008) in children of pubertal age group (13-15 year -old females) and (14-15-year-old males). (Mani *et al.*, 2008) also reported faster dental maturation attributed to para-pubertal speed fluctuation. Among females, the deviation from chronological age was ±2.22 years at 95% CI while in males the deviation was ±1.68(Table 1.3). This depicted that the females had a wider margin of error during age estimation as opposed to males. Diverse literature has also reported that females are generally ahead in tooth formation and emergence as compared to males (Demirjian & Levesque, 1980); (Upadhyay *et al.*, 2016). In the contrary, (Rai, 2008) reported high accuracy of age

estimation using Demirjian on Indian children aged 7.5-16 years .In accordance with the results of the present study, (Tunc & Koyuturk, 2008) reported a more advanced dental maturity in Northern Turkish children aged 4-12 years since the mean difference between dental and chronological ages of boys and girls varied from 0.36 to 1.43 years and 0.50 to 1.44 years respectively. Similarly, the study of (Galic *et al.,* 2010) on Bosnia-Herzegovina children revealed more advanced dental maturity scores when compared to the Demirjian sample. (Qudeimat & Behbehani, 2009) tested the applicability of the Demirjian method in Kuwait and concluded that Kuwait children had a delay in dental maturity when compared to the present study. The same findings were concluded in the study done by (Cruz-Landeira *et al.*, 2010). In that study, the Demirjian method revealed an inaccurate age estimation on Spanish and Venezuelan children with delayed dental maturity compared to the French-Canadian population. Chronological and estimated dental age differences in the present and previous studies could be attributed to numerous factors such as; the method of execution, the sample structure (age, sex, ethnicity, nationality and social status), examiners' subjectivity and the statistic approach used in obtaining the results (Bagic, 2008). Moreover, there could be a difference in the present-day comparisons due to positive secular trends. In summary, therefore, the study results revealed an underestimation of age in both females and males using Demirjian method.

CONCLUSION
The current study findings suggested an overall underestimation of the dental age in both females and males however, females had the highest probability of age underestimation with a wider margin of error.

Consent
No consent was needed

Conflict of interest
No conflict of interest

REFERENCES

1. Cruz-Landeira, A., Linares-Argote, J., Martínez-Rodríguez, M., Rodríguez-Calvo, M. S., Otero, X. L., & Concheiro, L. (2010). Dental age estimation in Spanish and Venezuelan children. Comparison of Demirjian and Chaillet's scores. *International journal of legal medicine*, *124*, 105-112.
2. Demirjian, A., & Levesque, G.-Y. (1980). Sexual differences in dental development and prediction of emergence. *Journal of dental research*, *59*(7), 1110-1122.
3. Esan, T. A., Yengopal, V., & Schepartz, L. A. (2017). The Demirjian versus the Willems method for dental age estimation in different populations: A meta-analysis of published studies. *PLoS ONE*, *12*(11), e0186682.
4. Galic, I., Nakas, E., Prohic, S., Selimovic, E., Obradovic, B., & Petrovecki, M. (2010). Dental age estimation among children aged 5-14 years using the Demirjian method in Bosnia-Herzegovina/Odredivanje dentalne dobi postupkom prema Demirjianu kod djece od 5 do 14 godina u Bosni i Hercegovini. *Acta Stomatologica Croatica*, *44*(1), 17-26.
5. Hassanali, J., & Odhiambo, J. W. (1982). Estimation of calendar age from eruption times of permanent teeth in Kenyan Africans and Asians. *Annals of human biology*, *9*(2), 175-177.
6. Jayaraman, J. (2013). Dental Age Assessment: an ethical solution for age dispute problems in India. *JIDA: Journal of Indian Dental Association*, *7*(4).
7. Litt, M. D. (1996). A model of pain and anxiety associated with acute stressors: distress in dental procedures. *Behaviour research and therapy*, *34*(5-6), 459-476.

8. Liversidge, H. M., Buckberry, J., & Marquez-Grant, N. (2015). Age estimation. *Annals of human biology*, *42*(4), 299-301.
9. Lwande, W., Hassanali, A., Njoroge, P., Bentley, M., Delle Monache, F., & Jondiko, J. (1985). A new 6a-hydroxypterocarpan with insect antifeedant and antifungal properties from the roots of Tephrosia hildebrandtii Vatke. *International Journal of Tropical Insect Science*, *6*(4), 537-541.
10. Mani, S. A., Naing, L., John, J., & Samsudin, A. R. (2008). Comparison of two methods of dental age estimation in 7–15-year-old Malays. *International Journal of Paediatric Dentistry*, *18*(5), 380-388.
11. Marwaha, R., Tandon, N., Desai, A., Kanwar, R., Grewal, K., Aggarwal, R., Sastry, A., Singh, S., Ganguly, S., & Mani, K. (2008). Reference range of thyroid hormones in normal Indian school-age children. *Clinical Endocrinology*, *68*(3), 369-374.
12. Qudeimat, M. A., & Behbehani, F. (2009). Dental age assessment for Kuwaiti children using Demirjian's method. *Annals of human biology*, *36*(6), 695-704.
13. Rai, B. (2008). Dental Age Assessment of 7, 5 to 16 Year-old Indian Children Using Demirjian's Method. *Adv Med Dent Sci*, *2*(3), 53-55.
14. Ritz-Timme, S., Cattaneo, C., Collins, M., Waite, E., Schütz, H., Kaatsch, H.-J., & Borrman, H. (2000). Age estimation: the state of the art in relation to the specific demands of forensic practise. *International journal of legal medicine*, *113*, 129-136.
15. Senn, D. R., & Weems, R. A. (2013). *Manual of forensic odontology*. CRC press.
16. Tunc, E. S., & Koyuturk, A. E. (2008). Dental age assessment using Demirjian's method on northern Turkish children. *Forensic science international*, *175*(1), 23-26.
17. Upadhyay, S., Shrestha, R., Shrestha, D., & Poudyal, S. (2016). Permanent teeth emergence time and sequence in children of Kavre District, Nepal. *Kathmandu Univ Med J*, *55*(3), 269-273.
18. Willems, G., Van Olmen, A., Carels, C., & Spiessens, B. (2001). Dental age estimation in Belgian children: Demirjian's technique revisited. *Journal of forensic sciences*, *46*(4), 893-895.
19. Yunus, B., & Wardhani, Y. (2016). Differences chronological age and dental age using Demirjian method based upon a study radiology using radiography panoramic at the Dental Hospital Hasanuddin University. *Journal of Dentomaxillofacial Science*, *1*(2), 103-108.