Comparison of Demirjian's Method and Willems Method for Estimation of Dental Age in Bengaluru Population

[1]Boraiah Shivakumar, Associate Professor, Department of Forensic Odontology, Government Dental College and Research Institute, Bengaluru, India.

[2]Vina Vaswani, Professor, Department of Forensic Medicine & Toxicology, Yenepoya Medical College, Yenepoya, Mangalore, India.

[3]Leena Pramod, Assistant Professor, Department of Forensic Medicine & Toxicology, Yenepoya Medical College, Yenepoya, Mangalore, India.

[4]Sheethal, BDS, MPH, Dental Square Clinic, Whitefield, Bengaluru, India.

[5]Balagangadharaswamy Shobha, PhD Research Scholar, Department of Microbiology and Biotechnology, Bangalore University, Bengaluru, India.

[6]Boraiah Niveditha, BDS, MDS, Dental Square Clinic, White field, Bengaluru, India.

[7]Manju Prasad, Associate Professor, Departments of Orthodontics, Vydehi Institute of Dental Sciences, Bengaluru, India.

Corresponding Author: Boraiah Shivakumar, Associate Professor, Department of Forensic Odontology, Government Dental College and Research Institute, Bengaluru, India.

Citation of this Article: Boraiah Shivakumar, Vina Vaswani, Leena Pramod, Sheethal, Balagangadharaswamy Shobha, Boraiah Niveditha, Manju Prasad, "Comparison of Demirjian's Method and Willems Method for Estimation of Dental Age in Bengaluru Population", IJDSIR- February - 2022, Vol. – 5, Issue - 1, P. No. 197 – 208.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Dental growth show a much higher correlation with the successive age of young people compared to the development of other organs. Age restrictions are very important and helpful in identifying and planning treatment. Age estimation can be done by measuring intervertebral discs, ribs, pubic symphysis, and dental age. Demirjian's method has emerged as a widely researched and widely used method for measuring the dental age of children and adolescents as simple and reliable. The present study is focused on comparison and evaluation of the accuracy of the Demirjian's and Willems techniques for estimating dental age in children from the Bangalore population. Where a total of 230 subjects were involved with 107 females and 123 males belonging to age group 9-14 years. The study participants were taken and analyzed using Demirjian's method and Willems method. The score obtained from both methods was compared to the chronological age of the individual and the most accurate method was determined. The statistical analysis was performed. Each category was provided with maturity points in

Demirjian's technique and the Points assigned to each section have seven teeth analyzed. In the Willems method, each stage was assigned a maturity score. The sum of the maturity points obtained was used to determine the dental age directly. The gap between the date of birth and the date of a panoramic radiograph was used to calculate the chronological age. We may infer from our research that Willems technique provides a more accurate estimate of chronological order than Demirjian's method.

Keywords: chronological age, Demirjian, dental age, Willems.

Introduction

Dental growth in humans begins in the intrauterine period and continues into adulthood [1]. Teeth development show a much higher correlation with the successive age of young people compared to the development of other organs. Age plays a role in immigration issues, especially if birth data is missing or questionable, and help identify and plan treatment for children and adolescents [2]. Chronological age is the actual amount of time an individual has been alive and it does not change, regardless of lifestyle and environmental factors. Biological age, also known as physiological age, considers many lifestyle factors and is estimated based on the degree of maturation of various tissue systems.

Age estimation can be done by measuring intervertebral discs, ribs, pubic symphysis, and dental age. Tooth decay as an indicator of physiologic maturity has received a great deal of attention and interest, due to its association with research into growth disorders and clinical orthodontics [3]. In addition, dental development control measures are independent of somatic and/or sexual growth, as there is no significant correlation between tooth growth and other signs of maturity [4].

Age estimation has become a standard procedure in the migration process given that the chronological age of an individual is intrinsically related to defining his/her legal status [5]. In many cases, children are at risk of not having access to benefits granted for children from the state or central government as they are unable to prove their real age thereby being treated as adults.

"Uncertainty in age-appropriate processes may produce even worse consequences for anonymous young people facing criminal charges" [6]. However, negative age perceptions may expose children to the increased risk of discrimination, abuse, violation of their rights, and imprisonment as a major consequence [7]. When considering an asylum application in many countries the issue of age arises from the beginning of the application process and the legal process. Age equity should be regarded as an effective, human-centered, and impartial process [7]. To measure dental age using radiographs to check chronological order to deal with cases involving refugees and cheating in youth sports competitions [8,9,10]. Also, when international adoption is considered children and adolescents with an unknown date of birth the assessment of dental age is one of the most reliable methods to determine chronological age [2,11].

Dental age is an essential component especially for diagnosis and the evaluation of treatment outcome children who are being treated for endocrinological disorders that affect development [12]. Techniques based on dental development are appropriate in determining the age of children because growing teeth are more genetically regulated and less susceptible to other tissues due to endocrine diseases and environmental damage [13,14,15]. Human skeletal development is strongly influenced by nutrition and environmental factors, while dental development is mainly influenced by genes [16].

Demirjian's method [12] was first proposed more than 40 years ago that has emerged as a widely researched and widely used method for measuring the dental age of children and adolescents as simple and reliable. Demirjian's method involves comparing each tooth with each of the ten stages of growth, each of which is marked by points by determining the sequence of stages of growth according to the degree of permanent tooth calcification. The Dental age is calculated by taking the sum of the developmental stage scores of the eight teeth of interest and the total maturity score is obtained, followed by substitution in the Indian formula [12]. Willems et al. applied Demirjian's method to estimate the age of a sample of the Belgian Caucasian population and adapted the dental age conversion table to the sample, resulting in a more accurate estimation [17,18].

A meta-analysis showed that Demirjian's method averagely overestimated the age of girls and boys [19]. On the other hand, Studies were done using the Willems method in Egypt, Malaysia, Serbia, France, China, Macedonia, and India reported considerable accuracy in the estimation of the chronological age of individuals in their populations [20]. The present study is focused on comparison and evaluation of the accuracy of the Demirjian's and Willems techniques for estimating dental age in children from the Bangalore population.

Material and Methods

The study was conducted using the radiographic records of candidates belonging to age 9 – 14 years from the Department of Forensic Odontology, Government Dental College and Research Institute, Bengaluru for age verification, as a prerequisite to participate in state and national level sports tournaments. The eligibility criteria included healthy individuals. Orthopantomograph (OPG) of the study participants was taken and analyzed using Demirjian's method and Willems method. The score obtained from both methods was compared to the chronological age of the individual and the most accurate method was determined.

Panoramic radiographs were analyzed by one specialist who was unaware of the patient's chronological years in the study. Using Demirjian's method and the Willems method dental age was examined.

The gap between the date of birth and the date of a panoramic radiograph was used to calculate the chronological age.

Statistical analysis

The statistical analysis was performed using SPSS (Statistical Package for Social Sciences) version 20. (IBM SPASS statistics [IBM corp. released 2011].

• Data was entered in the excel spreadsheet.

• The mean, standard deviation, frequency, and proportions for quantitative variables were used to produce descriptive statistics for the explanatory and outcome variables.

• Inferential statistics like

• The Chi-square test was applied for qualitative variables.

• Paired sample t-test was applied to compare the statistical difference of mean age between chronological age and biological age (Demirjian's and Willems).

• The chronological and biological ages were correlated using Pearson's correlation (Demirjian's and Willems).

• The level of significance is set at 5%

Results

The study included 230 participants of which 107 were female and 123 male. Data were analyzed separately for both genders. The median age of the study group was 11.92 ± 1.96 years for girls, 11.86 ± 1.87 for boys, and 11.89 ± 1.91 years for the whole study group (Table 1).

Table 1: Distribution of The Subjects Based on The Gender.

Gender	Frequency	Percent
Females	107	46.5
Males	123	53.5
Total	230	100.0

Table 2 showed the data on the number of study participants, the mean values of the chronological (real) age, the dental age was calculated with Demirjian's method. Mean age by Demirjian's method was higher 12.28 ± 2.03 as compared to Chronological age 11.89 ± 1.91 (Fig 1). Paired sample t-test was applied to compare the chronological age with Demirjian's method. Paired sample t-test showed a statistically significant difference between the chronological age and Demirjian's age (p=0.00).

Table 2: Comparison of The Chronological Age and Demirjian's Method Using Paired Test.

	N	Min	Max	Mean	S.D	Mean diff	P-value
Chronological Age (Ca)	230	8.10	16.00	11.89	1.91	0.39	0.00*
Demirijians Method	230	9.70	17.35	12.28	2.03		

Fig 1: Comparison of the chronological age and Demirjian's method
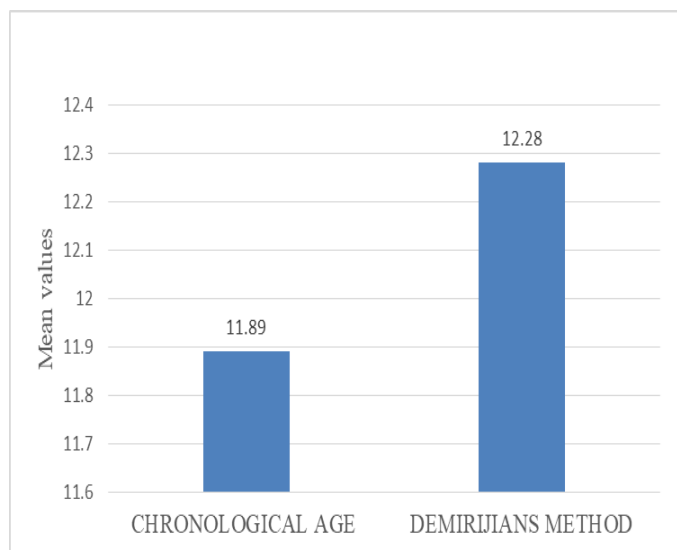
Table 3 Comparison of the Chronological Age and Willems Age Using Paired Test.

	N	Min	Max	Mean	SD	Mean diff	p-value
Chronological (CA)	230	8.10	16.00	11.89	1.91	0.002	0.97
Willems Method	230	7.82	16.03	11.88	2.08		

Table 3 shows the data on the number of participants in the study, the average values of the (real) chronological age, the dental age calculated by the Willems method. Mean Chronological age was slightly higher 11.89 ± 1.91 as compared to Willem's method 11.88 ± 2.08 (Fig 2). The chronological years of Willem's technique were compared using paired sample testing. Statistically significant differences between consecutive years and will years are not seen in paired sample tests (p = 0.97).
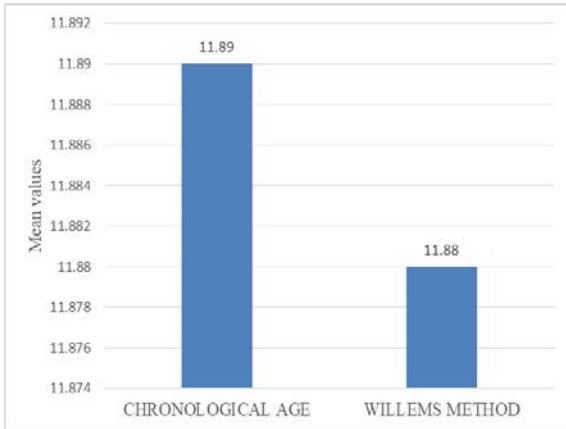
Fig 2: Comparison of the Chronological age and Willems age

Table 4: Comparison of The Chronological Age and Biological Age (Demirjian's and Willems) Method In Females Using Paired Test

	N	Min	Max	Mean	SD	Mean Diff	P-Value
Chronological Age (Ca)	107	8.11	16.00	11.92	1.96	0.28	0.011*
Demirijians Method	107	9.70	16.31	12.20	2.05		
Chronological Age (Ca)	107	8.11	16.00	11.92	1.96	0.29	0.007*
Willems Method	107	7.82	15.79	11.63	1.90		

In Females, the mean age by Demirjian's method was higher 12.20 ± 2.05 as compared to Chronological age 11.92 ± 1.96 whereas, the mean Chronological age was higher 11.92 ± 1.96 as compared to Willem's method 11.63 ± 1.90 (Fig 3). Paired sample t-test showed a statistically significant difference between the chronological age and Demirjian's age (p=0.011) and between chronological age and Willems age (p=0.007) (Table 4).

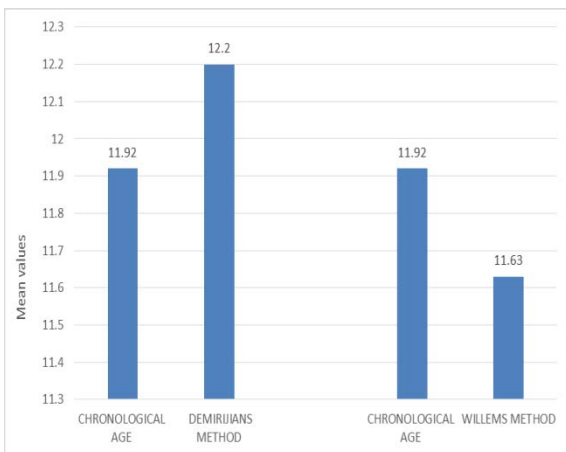Fig 3: Comparison of the Chronological age and biological age (Demirjian's and Willems) method in females

Table 5: Comparison of The Chronological Age and Biological Age (Demirjian's and Willems) Method In Males Using Paired Test

	N	Min	Max	Mean	SD	Mean diff	p-value
Chronological Age (Ca)	123	8.10	14.90	11.86	1.87	-0.49	0.00*
Demirijians Method	123	9.80	17.35	12.35	2.02		
Chronological Age (Ca)	123	8.10	14.90	11.86	1.87	-0.24	0.015*
Willems Method	123	8.21	16.03	12.11	2.21		

In males, the mean age by Demirjian's method was higher 12.35 ± 2.02 as compared to Chronological age 11.86 ± 1.87. Similarly, the mean age by Willem's method was higher 12.11 ± 2.21 as compared to Chronological age 11.86 ± 1.87 (Fig 4). Paired sample t- test showed a statistically significant difference between the chronological age and Demirjian's age (p=0.00) and between chronological age and Willems age (p=0.015) (Table 5).

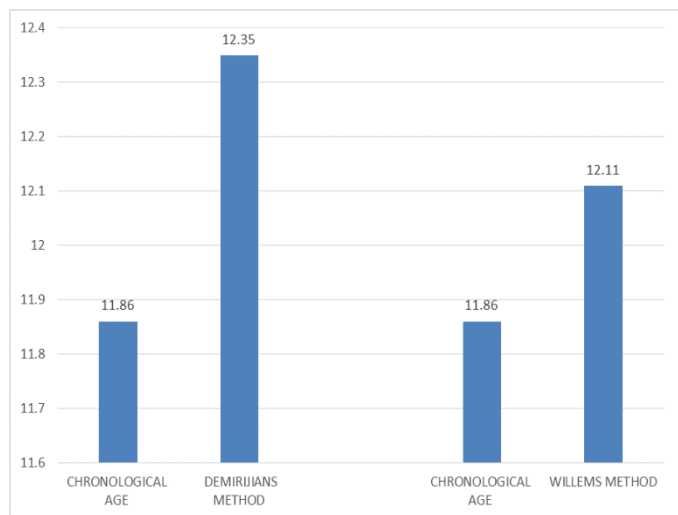Fig 4: Comparison of the Chronological age and biological age (Demirjian's and Willems) method in males.

Table 6: Pearson's Correlation Between Chronological Age and Biological Methods (Demirjian's and Willems)

		Demirijians Method	Willems Method
Chronological Age (Ca)	r value	.809	.841
	p value	.000*	.000*
	N	230	230

The association between chronological age and Demirjian's age (r=0.809, p=0.00) and chronological age and Willem's age (p=0.841, p=0.00) was extremely strong, positive, and significant according to Pearson's correlation (Table 6).

Fig 5 depict the correlation between chronological age and dental age computed using Demirjian's technique, and Fig 6 depict the correlation between chronological age and dental age derived using the Willems method, respectively.

Fig 5: Correlation between Chronological age and biological age (Demirjian's)
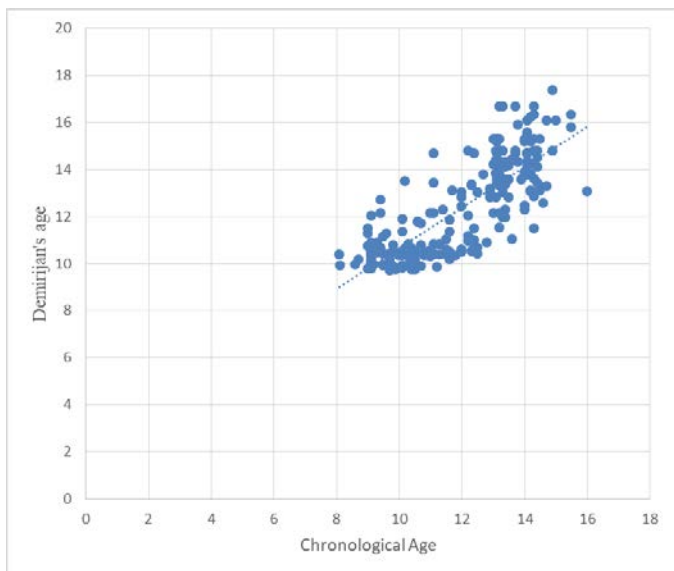

Fig 6: Correlation between Chronological age and biological methods (Willems age)
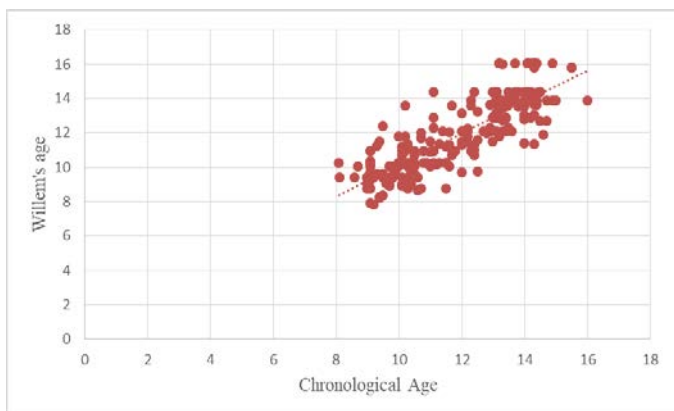

Table 7: Pearson's Correlation Between Chronological Age and Biological Methods (Demirjian's and Willems) Based on Gender.

	Gender		Biological Age (Demirijians Method)	Willems Method
Chronological Age (Ca)	Females (n=107)	r value	.838	.842
		p value	.000*	.000*
	Males (n=123)	r value	.785	.861
		p value	.000*	.000*

Pearson's correlation revealed a high, positive, and significant relationship between chronological age and Demirjian's age (r=0.838, p=0.00) and chronological age and Willem's age (p=0.842, p=0.00) in females.

Pearson's correlation revealed a strong, positive, and significant relationship between chronological age and Demirjian's age (r=0.785, p=0.00) in men, as well as a very strong, positive, and significant relationship between chronological age and Willem's age (p=0.861, p=0.00) in females (Table 7).

Fig 7 depicts the relationship between chronological age and dental age as determined by Demirjian's technique in men, whereas Fig 8 depicts the relationship between chronological age and dental age as calculated by

Demirjian's method in females. Fig 9 depicts the relationship between chronological age and Willems method-calculated dental age in men, whereas Fig 10 depicts the relationship between chronological age and Willems method-calculated dental age in females.

Fig 7: Correlation between Chronological age and biological methods (Demirjian's) in males.
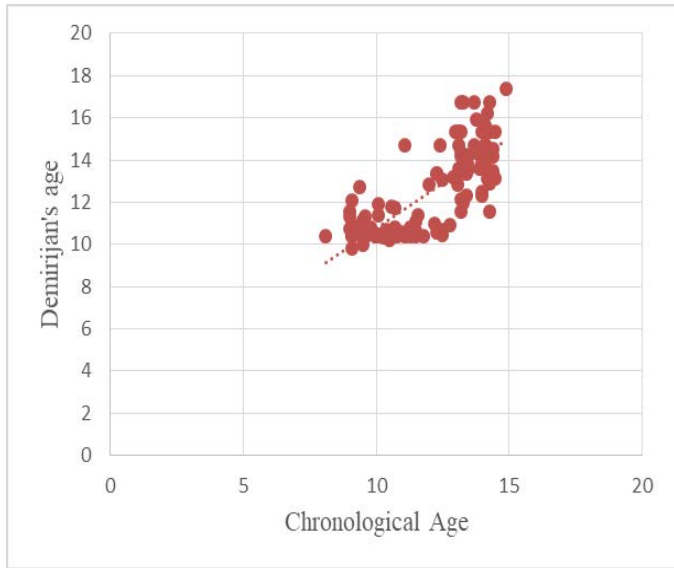

Fig 8: Correlation between Chronological age and biological methods (Demirjian's) in females.
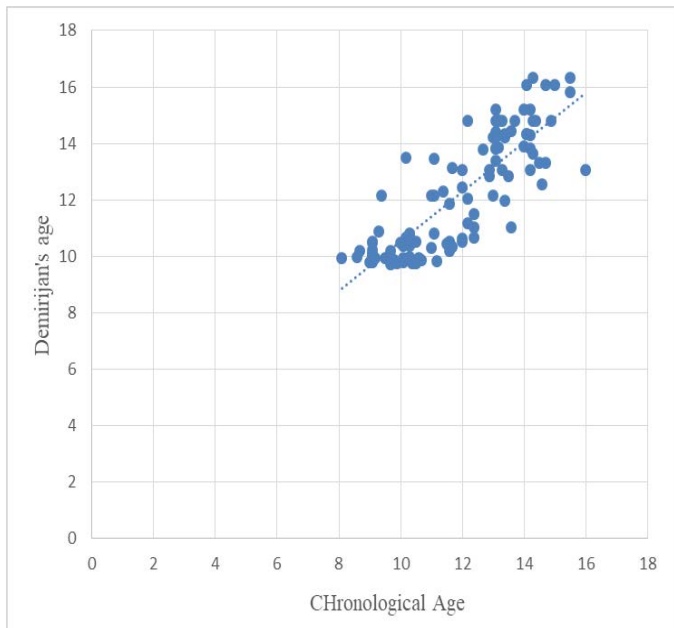
Fig 9: Correlation between Chronological age and biological methods (Willems) in males.
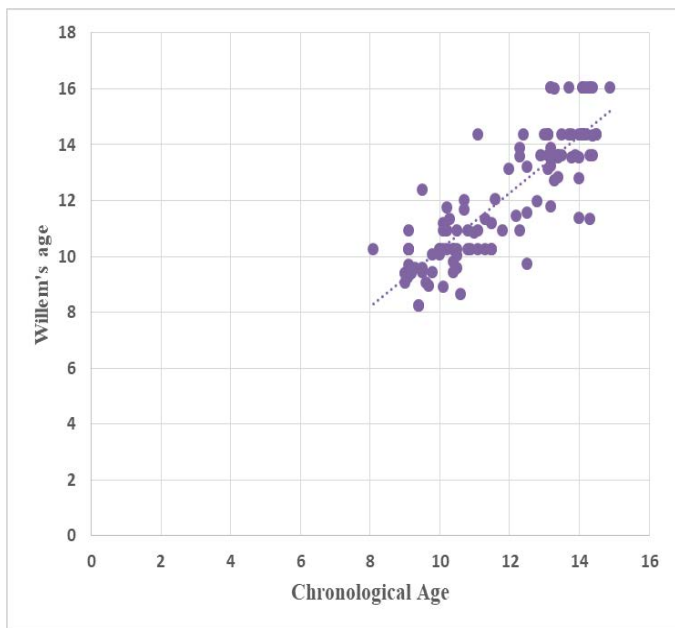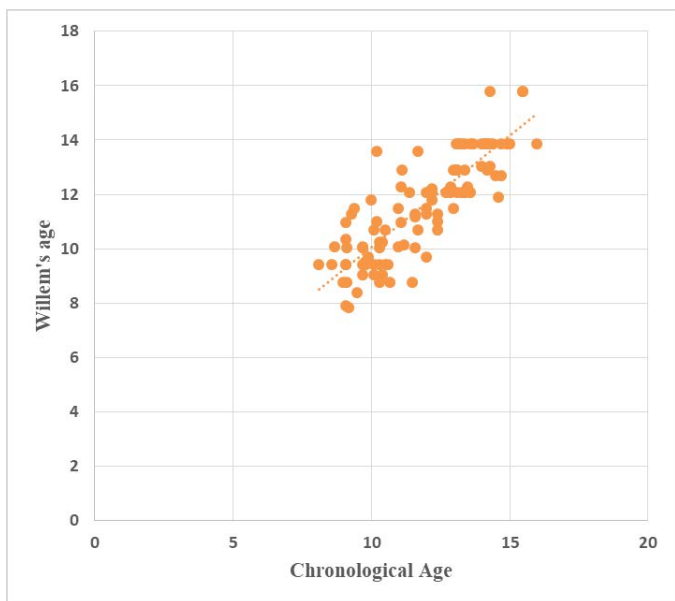

Fig 10: Correlation between Chronological age and biological methods (Willems) in females

Discussion

Getting an accurate age estimation is very important and it is usually assessed in the study. Dental age estimation is one of the most reliable methods in forensic age estimation especially in children and adolescents where the need is to identify forensic personal identification, legal age determination. Dental age is estimated based on the dental developmental pattern observation and characteristics of dental structure on radiographs.

Currently, there are many methods to estimate dental age. But the need of the hour is a reliable and accurate method of age estimation that provides low variability. The dental developmental staging system proposed by Demirjian has been one of the most widely used and practical methods for dental age estimation in children and adolescents [16]. Hegde et al. showed that Demirjian's method showed the greatest accuracy [21]. However, Demirjian's method has been shown to

overestimate or underestimate age in studies done in many countries [18]. The Demirjian's and Willems procedures, which thoroughly portray growth stages of the tooth and demonstrate using radiographic pictures and have acquired wide attention across diverse regions, are the principal approaches that are extensively utilized and have attracted attention [20]. According to a meta-analysis by Esan et al, Demirjian's approach considerably inflated chronological age in both male and female subjects, while the majority of research utilizing the Willems method found no significant overestimation of ages in either gender. In comparison to Willems technique [21], Demirjian's method greatly overstated chronological age. According to another study conducted by Sehrawat, the Willems approach overestimates the age of children to a smaller level than Demirjian's method. The purpose of this study was to compare and evaluate the accuracy of the Demirjian's and Willems dental-age estimate techniques in children from the Bengaluru community. The study was conducted in Bangalore city with participants aged 9 to 14 years in both males and females. Paired T-test showed that the Mean age of participants by Demirjian's method was higher 12.28 ± 2.03 as compared to the Chronological age 11.89 ± 1.91. whereas mean Chronological age was slightly higher- 11.89 ± 1.91 as compared to Willem's method 11.88 ± 2.08 in both the sexes. When both the sexes were analyzed separately by both methods, we found that the mean age of females analyzed by Demirjian's method was higher as compared to Chronological age whereas, mean Chronological age was higher as compared to Willem's method and in males, mean age by Demirjian's method was higher as compared to Chronological age. Similarly, the mean age by Willem's method was higher- as compared to Chronological.

Many studies in the literature showed that the Willems approach causes both considerable underestimating and overestimation of dental age. In a sample of Malay youngsters, there was a significant overestimation of 0.55 years in men and 0.41 years in girls [23]. A group of North Indian youngsters showed similar overestimation results [24]. Another research found that men's age was overestimated by up to 1.23 years and females' age was overestimated by up to 1.20 years [28]. and Whereas a few research (2,25) found substantial underestimating of age using the Willems approach, as well as overestimation of up to +0.55 years in males and +0.53 years in females [29]. However, the current study's findings indicate that the applicability of the Willems approach in the study population is capable of accurately predicting chronological age.

The findings of this study are confirmed by the findings of another study [26,27], which found that Demirjian's approach overstated dental age in proportion to calendar age. Demirjian's approach was used to yield age overestimations of 0.28 years for females and 0.49 years for males in this study. Whereas underestimation of 0.29 in females and overestimation of 0.24 in males were obtained using the Willems methods. Pearson's correlation showed a very strong and positive correlation between chronological age and the Willems method (p=0.841, p=0.00).

Conclusion

We may infer from our research that Willems technique provides a more accurate estimate of chronological order than Demirjian's method. However, sample quality, technique dependability, biological variability in dental growth, lack of bias, and complete or average scale variances can all impact the age measurement method's accuracy or precision. Natural variables that vary by population impact dental development in children and

teenagers. It is commonly recognized that there is no way to correctly establish everyone's actual age while estimating their age.

Acknowledgement

References

1. Ambarkova V, Galić I, Vodanović M, Biočina-Lukenda D, Brkić H. Dental age estimation using Demirjian's and Willems methods: cross sectional study on children from the Former Yugoslav Republic of Macedonia. Forensic Sci Int. 2014 Jan; 234:187. e1-7

2. Maber M, Liversidge HM, Hector MP. Accuracy of age estimation of radiographic methods using developing teeth. Forensic Sci Int. 2006 May 15;159 Suppl 1: S68-73.

3. Hegde S, Patodia A, Dixit U. A comparison of the validity of the Demirjian's, Willems, Nolla and Häävikko methods in determination of chronological age of 5–15-year-old Indian children. J Forensic Leg Med. 2017 Aug; 50:49-57.

4. A. Demirjian's, P.H. Buschang, R. Tanguay, D. Kingnorth Patterson, Interrelation ships among measures of somatic, skeletal, dental, and sexual maturity, Am. J. Orthod. 88 (5) (1985) 433–438. 198 G. Quaremba et al. / Forensic Science International 283 (2018) 190–199.

5. EASO, European Asylum Support Office, Age Assessment Practice in Europe, December 2013, Publications Office of the European Union, Luxembourg, 2013 Available: https://easo.europa.eu/wp-content/uploads/EASO-Age-assessment-practice-in-Europe.pdf.

6. T. Smith, L. Brownlees, Age Assessment Practices: A Literature Review & Annotated Bibliography, United Nations Children's Fund (UNICEF), Child Protection Section, New York, 2011.

7. Quaremba G, Buccelli C, Graziano V, Laino A, Laino L, Paternoster M, Petrone P. Some inconsistencies in Demirjian's method. Forensic Sci Int. 2018 Feb; 283:190-199.

8. A. Schmeling, W. Reisinger, G. Geserick, A. Olze, Age estimation of unaccompanied minors. Part I. General considerations, Forensic Sci. Int. 159(Suppl. 1) (2006) S61–S64.

9. S. Karkhanis, P. Mack, D. Franklin, Age estimation standards for a western Australian population using the coronal pulp cavity index, Forensic Sci. Int. 231(1–3) (2013) 412 e1–6.

10. Wang J, Bai X, Wang M, Zhou Z, Bian X, Qiu C, Li C, Yang Z, Chen G, Ji F, Tao J. Applicability and accuracy of Demirjian's and Willems methods in a population of Eastern Chinese subadults. Forensic Sci Int. 2018 Nov; 292:90-96

11. Roberts GJ, Parekh S, Petrie A, Lucas VS. Dental age assessment (DAA): A simple method for children and emerging adults. Br Dent J. 2008; 204:192–203.

12. Demirjian's A, Goldstein H, Tanner JM. A new system of dental age assessment. Hum Biol. 1973; 45:211–27

13. Moorrees CF, Fanning EA, Hunt EE. Age variation of formation stages for ten permanent teeth. J Dent Res. 1963;42(6):1490e1502.

14. Nolla CM. The development of the permanent teeth. J Dent Child. 1960;27:

15. Saunders S, DeVito C, Herring A, Southern R, Hoppa R. Accuracy tests of tooth formation age estimations for human skeletal remains. Am J Phys Anthropol.1993;92(2):173e188.

16. Shi L, Zhou Y, Lu T, Fan F, Zhu L, Suo Y, Chen Y, Deng Z. Dental age estimation of Tibetan children and

adolescents: Comparison of Demirjian's, Willems methods and a newly modified Demirjian's method. Leg Med (Tokyo). 2022 Jan 5; 55:102013

17. G. Willems, A.n. Van Olmen, B. Spiessens, C. Carels, Dental Age Estimation in Belgian Children: Demirjian's 's Technique Revisited, J Forensic Sci 46 (4) (2001)

18. Wang J, Bai X, Wang M, Zhou Z, Bian X, Qiu C, Li C, Yang Z, Chen G, Ji F, Tao J. Applicability and accuracy of Demirjian's and Willems methods in a population of Eastern Chinese subadults. Forensic Sci Int. 2018 Nov; 292:90-96

19. Jayaraman J, Wong HM, King NM, Roberts GJ. The French-Canadian data set of Demirjian's for dental age estimation: a systematic review and meta-analysis. J Forensic Leg Med. 2013 Jul;20(5):373-81.

20. Esan TA, Schepartz LA. Accuracy of the Demirjian's and Willems methods of age estimation in a Black Southern African population. Leg Med (Tokyo). 2018 Mar; 31:8289.doi:10.1016/j.legalmed.2018.01.004. E pub 2018 Feb 1.

21. Hegde RJ, Sood PB. Dental maturity as an indicator of chronological age: radiographic evaluation of dental age in 6 to 13 years children of Belgaum using Demirjian's methods. J Indian Soc Pedod Prev Dent. 2002 Dec;20(4)

22. Esan TA, Yen gopal V, Schepartz LA (2017) The Demirjian's versus the Willems method for dental age estimation in different populations: A meta-analysis of published studies. PLOS ONE 12(11): e0186682

23. Mani SA, Naing LI, John J, Samsudin AR. Comparison of two methods of dental age estimation in 7–15-year-old Malays. Int J Paediatr Dent. 2008; 18:380–8.

24. Grover S, Mohan C, Avinash J, Pruthi N. Dental age estimation of 6–15-year-old North Indian children using Willems method. Rev Latino Am Ortod Odontopediat Depóito Legal. 2011; 2011:1–11.

25. Mohammed RB, Krishna mraju PV, Prasanth PS, Sanghvi P, Reddy MA, Jyotsna S. Dental age estimation using Willems method: A digital orthopantomographic study. Contemp Clin Dent. 2014; 5:371.

26. Frucht S, Schnegelsberg C, Schulte-Mönting J, et al. Dental age in Southwest Germany, a radiographic study. J Orofac Orthop. 2000; 61:318–29

27. Sobieska E, Fester A, Nieborak M, Zadurska M. Assessment of the Dental Age of Children in the Polish Population with Comparison of the Demirjian's and the Willems Methods. Med Sci Monit. 2018; 24:8315-8321. Published 2018 Nov 19.

28. Abu Asab S, Noor SN, Khamis MF. The accuracy of Demirjian's method in dental age estimation of Malay children. Singapore Dent J. 2011;32(1):19–27. 10.1016/S0377-5291(12)70012-3

29. Kumaresan R, Cugati N, Chandrasekaran B, Karthikeyan P. Reliability and validity of five radiographic dental-age estimation methods in a population of Malaysian children. J Investig Clin Dent. 2016. Feb;7(1):102–9. 10.1111/jicd.12116.