

# A Comparison of the Accuracy of the London Atlas and Demirjian Age Estimation Methods Based on Panoramic Radiography of Developing Teeth

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## ABSTRACT

**Objective:** To compare two age estimation methods in children by using Demirjian's and the London Atlas of Tooth Development methods and to evaluate among these two methods which is more accurate.

**Study Design:** Cross-sectional study

**Place and Duration of Study:** This study was conducted at the Department of Orthodontics at Nishtar Institute of Dentistry, Multan from May 2021 to February 2022.

**Materials and Methods:** To conduct this research we included OPGS of 100 children of 7 and 16 years of age group, proforma each patient was filled containing their date of birth and date of X-ray done. Then we assessed each radiograph to find out the developmental stage of tooth in respective region. Dental age estimation was calculated by using Demirjian and London Atlas methods and the difference and correlations between these two methods and chronological age was assessed. Differences and associations between two selected dental age estimation methods and chronological age were evaluated by paired t-test and Pearson's correlation analysis. P value  $\leq 0.05$  was considered as significant.

**Results:** In this study the mean chronological age evaluated was  $10.23 \pm 2.7$  years, while in London atlas method it was estimated as  $10.11 \pm 2.91$  and in Demirjian  $10.44 \pm 2.5$  years. In few number of individuals, Demirjian's method slightly over-estimated the age in females than males, while in London Atlas it underestimated the age in girls than boys, but the overall difference was not statistically significant. Both of the methods which we used in our study to determine dental age have no significant differences between them in terms of accuracy. P value for London Atlas was 0.14 and for Demirjian 0.15.

**Conclusion:** These two methods are reliable in estimating age of individuals of unknown chronological age.

**Key Words:** Age estimation, Dental age. Demirjian method. London Atlas of tooth development and eruption method, Chronological age

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## INTRODUCTION

In different fields like in forensic and pediatric dentistry and also in orthodontics knowing exact age is of high importance. Tooth development is widely used in determining age and level of maturity. Age plays a critical role in orthodontic treatment planning, pediatric dentistry, surgeries<sup>1,2</sup> and also has a significant part in terms of legal perspective<sup>3,4,5</sup> and forensic dentistry<sup>6</sup>.

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Different studies from time to time have shown that from living persons to dead, accurate estimation of age is very important. Ever since its importance was realized various methods and techniques were proposed by researchers and dentists to evaluate age with accuracy. Age simply can be chronological that is the age which can be easily calculated by date of the birth and then there is a biological age that can be assessed by secondary sexual characteristics, bone maturity and dental age. If in some instances chronological age is not known and accurate age estimation is required as mentioned earlier than there are different methods to assess age, among these techniques developmental and mineralization stages of teeth to estimate age can be used and it is the most practical option when correlated with the patient's chronological age. Another advantage of this method is that it is not afflicted by the environmental factors. Dental age estimation (DAE) method using radiographs are non-invasive, simple, fast and reproducible<sup>7,8</sup>. Demirjian method was developed on French-Canadian population in 1973 is the most

commonly used radiograph-based method till now<sup>9,6</sup>. The London Atlas<sup>10</sup> technique is another approach for age estimation, this method is founded on the developmental stages of crown and root of teeth and has specific reference material for age estimation from third molars. The accuracy of these methods with chronological age and with other methods were evaluated before in many studies in different population but in Pakistan only few numbers of studies have been conducted. In past few years many unfortunate events like plane crash to non-consented marriages of minors had occurred in Pakistan where age estimation was crucial to identify individuals from remains to solve the legal issue respectively.

“Age is just a number” is a famous quote but it is not just a number in much legal, medical, dental and forensic perspective, to identify age is an important component in making decisions to solve the problems, for treatment planning and etc. In orthodontics if accurate age of patient is known it helps to plan treatment, for example many orthopedic or growth modification appliances are only applicable up to specific age, after that certain age they are of no help. There is another advantage of finding dental age in orthodontics, if chronological age of patient is known and there is a difference of  $\pm 2$  years exist between dental and chronological age than we can assess from these findings that patient is early grower or late grower, this helps in planning a treatment<sup>11</sup>.

As the importance of accuracy in age estimation was understood, many dental age evaluation methods were assessed to find out which technique is most trusted. In our study we compared the two most accurate dental age estimation methods found in various studies, in this study we used the London Atlas technique and Demirjian's method to estimate age. In the present study we assessed and compared the accuracy of these two methods.

## MATERIALS AND METHODS

Study was conducted from May 2021 to February 2022 at department of Orthodontics at Nishtar Institute of Dentistry, Multan. For the purpose of comparison and to find out the accuracy between the two methods of the

dental age estimation, in this cross-sectional study we evaluated OPGs of 100 participants in their growing age of between 7 to 16 years. This study group consisted of 45 boys and 55 girls and they were divided into four groups according to age. Dental age was assessed by Demirjian's and London Atlas method. The chronological age was obtained by subtracting date on which OPG was taken with the date of birth of the individuals<sup>12</sup>.

Differences and associations between two selected dental age estimation methods and chronological age were evaluated by paired t-test and Pearson's correlation analysis.

## RESULTS

In the current study the known chronological age of the participants was registered, which was calculated by the method explained above and then we compared the calculated and documented chronological age of each participants with the dental age which was estimated by London Atlas and Demirjian's methods separately, then with each other. In this study the mean chronological age evaluated was  $10.23 \pm 2.7$  years, while in London atlas method it was estimated as  $10.11 \pm 2.91$  and in Demirjian  $10.44 \pm 2.5$  years. These results showed that overall there was no significant difference between the estimated mean ages. In few number of individuals, Demirjian's method slightly over-estimated the age in females than males, while in London Atlas it underestimated the age in girls than boys, but the overall difference was not statistically significant. The second method mentioned was simple and quick to apply and time saving with equivalent or has slightly more accuracy than demirjian in this specific study. In our study the results showed that in majority of the participants the frequency of deviation from chronological age lies within range of  $\pm 0.5$  year as shown in table 1. P value was significant below 0.05. Pearson's correlation coefficient documented strong relation between chronological age and ages estimated by Demirjian and London atlas methods. No significant difference was detected between two methods and chronological age.

**Table No.1: The frequency of deviation of ages evaluated by Demirjian's and London Atlas method from the chronological age**

Chronological age	Gender	London Atlas			Demirjian's method		
		>1 y	-1 to +1	<-1 year	>1 y	-1 to +1	<-1 y
7-9	Boys	1	2	2	3	1	1
	Girls	1	3	1	2	2	1
10-12	Boys	1	10	1	2	9	1
	Girls	2	12	4	3	13	2
13-15	Boys	4	16	1	2	18	1
	Girls	4	17	3	4	18	2
>15	Boys	2	3	1	2	2	2
	Girls	3	1	4	2	5	1

**Table No.2: Ages estimated by London Atlas and Demirjian method and mean chronological age**

Age	Boys		Girls		Total	
	Mean	SD	Mean	SD	Mean	SD
Chronological age	9.8	2.92	10.1	2.28	10.23	2.7
London atlas	9.7	2.32	10.2	2.7	10.11	2.91
Demirjian's method	9.6	2.39	10.21	2.7	10.44	2.5

In the above table it was observed that majority of deviation ranges between -1 to +1. Therefore, overall difference was not found to be significant. Deviation categorized by age and sex were also insignificant. Positive correlation was observed between chronological age and age estimated by the two methods.

## DISCUSSION

Age determination is of a fundamental importance regarding many procedures including medical, legal and forensic perspectives and also plays a crucial part in dentistry as in treatment planning in orthodontics and pediatric dentistry and surgeries<sup>1,2</sup>.

The estimation of age accurately of a person is of central significance in law when crimes were committed by minors, to rule out underage slavery and employment, to solve the issues related to child marriage and in identification of individuals in cases of mass calamity in forensic medicine. In recent years, in our country many cases have been reported regarding the abovementioned crimes. Many countries are facing an alarming expansion in crime rate committed by juveniles<sup>6</sup> and age forgery in sports<sup>6</sup> which has increased the demand to find out the accurate estimation of age, so that only those who are guilty of crime can receive punishment.

In various fields of dentistry dental age estimation has gained popularity due to its central importance in planning treatment, like in orthodontics, in pediatric dentistry, in forensic dentistry and in maxillofacial surgeries<sup>1,2</sup>.

For the age estimation various methods have been proposed including height, weight, secondary sexual characteristics, bone and dental development<sup>12</sup>. Among these the one mentioned in last is commonly used. Dental development stages regarded as the most appropriate technique for determination of age because these stages are resistant to environmental changes unlike other methods which can be severely affected by intrinsic and extrinsic factors like hormonal changes, behavioral changes and socioeconomic conditions<sup>12</sup>.

In our study for the purpose of comparison and to check the accuracy we selected two methods, one is Demirjian<sup>9</sup> method of dental age estimation which is simple, non-invasive and one of the oldest and the most widely used method<sup>6</sup>. The second technique is London Atlas method which we used in our study, it is also simple, novel, fast and accurate method that was developed by Alqahtani et al in 2010<sup>12</sup>, also known as

atlas of tooth development and eruption. The objective of our study was to establish a comparison between the two chosen methods and to assess the precision of the London Atlas and Demirjian age estimation methods and for this purpose we used panoramic radiographs of developing teeth.

According to the study done by Bianca Gelbrich<sup>13</sup> and coworkers, the London Atlas method provides more precise estimates of dental age. In our study the dental age estimated by London atlas method also showed more accuracy than demirjian but the difference between the two was not found to be significant enough. In comparing our study with other relevant studies like by Chhapparwal et al<sup>3</sup>, a strong correlation between chronological and dental age estimated by Demirjian method was observed like in our study.

V. Jain et al<sup>6</sup> used the original Demirjian method in OPGs of 102 individual showed significant mean underestimation of age unlike our study, in which among sample few were overestimated but overall difference was not significant. In our study frequency of deviation of age estimation of London Atlas from chronological age was between +1 to -1, it was similar to the results found from the study conducted by Alshihri et al<sup>14</sup> in Saudi Arabian children and adolescents in which they used London Atlas method for age estimation, the majority (65.5%) of estimate frequency deviation was within 12 months of chronological age which was calculated. The current study demonstrated Demirjian's method to have accuracy in both genders similar to the study done by Javadinejad et al<sup>1</sup>.

The main goal of our study was to investigate if any difference exists between dental ages estimated by the Demirjian and the London Atlas method and chronological age and how accurate the two methods were. The result of our study was similar to many studies like V. Jain et al<sup>6</sup>, Alshihri et al<sup>16</sup> and Rezwana Begum Mohammed et al<sup>15</sup>, they all documented that these age estimation methods are reliable and accurate. Similar to the study done in Sri Lankan population by S. Ranasinghe<sup>16</sup> which they compared three accuracy of the three dental age estimation methods including Demirjian and documented that all three methods are reliable and applicable. By comparing different studies we came to know that in each population different methods are more reliable and in our study both methods prove to be applicable and reliable in our population.

## CONCLUSION

The present research showed that London Atlas and Demirjian's methods determine dental age of children and adolescents with acceptable accuracy. Both of the methods are simple but the one mentioned first was more easy and time saving and slightly more accurate than demirjian in this specific study.

### Author's Contribution:

Concept & Design of Study: Laila Azher Jawa  
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**Conflict of Interest:** The study has no conflict of interest to declare by any author.

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