FORENSIC AGE ASSESSMENT: INSIGHTS FROM DECIDUOUS TOOTH ERUPTION AND CARPAL OSTEOGENESIS

Dr. Muhammad Arif[1], Dr. Nadia Aslam[2], Dr. Waheed Ali Nahyoon[3], Dr. Nasim Irshad[4], Dr. Aisha Khalid[5*], Dr. Aasia[6], Dr. Marvi[7]

[1]Associate professor, Department of Forensic Medicine & Toxicology, Rawal Institute of Health Sciences, Islamabad, Pakistan. Email: dosandhi@hotmail.com
[2]Lecturer, Department of Forensic Medicine & Toxicology, Liaquat University of Medical and Health Sciences, Jamshoro Sindh, Pakistan. Email: drnadiaaslam77@gmail.com
[3]Professor, Department of Forensic Medicine & Toxicology, Liaquat University of Medical and Health Sciences, Jamshoro Sindh Pakistan. Email: dr_waheednahyoon@yahoo.com
[4]Assistant professor, Department of Forensic Medicine & Toxicology, Army Medical College, Rawalpindi, Pakistan. Email: maakhanj@yahoo.com
[5*]Assistant Professor, Department of Forensic Medicine & Toxicology, Liaquat University of Medical and Health Sciences Jamshoro Sindh Pakistan. Email: aeshakhalid@yahoo.com
[6]Intern, Department of Oral Maxillofacial Surgery, Bhittai Dental and Medical College Hospital, Mirpurkhas, Sindh Pakistan. Email: aasiaab1@gmail.com
[7]Assistant Professor, Department of Pharmacology, Faculty of Pharmacy and Health Sciences, University of Baluchistan, Quetta. Email: marvibaloch56@yahoo.com

*Correspondence Author: Dr. Aisha Khalid,
*Assistant Professor, Department of Forensic Medicine & Toxicology, Liaquat University of Medical and Health Sciences Jamshoro Sindh, Pakistan Email: aeshakhalid@yahoo.com

ABSTRACT

Background: Estimating age is a vital component of forensic science, especially when it comes to identifying individuals and determining their age in legal and criminal cases **Objective:** This study compares the accuracy of two methods for estimating forensic age: deciduous teeth eruption and carpal bone ossification in the hand. **Study Design**: Conducted as a randomized controlled trial. **Study place**: Department of Radiology and Imaging, LUH Hyderabad. **Study duration:** Six-month from January 2023 to June 2024. **Methodology:** The study included 120 children, aged 5-15, who were divided into 02 groups of 60 each. Group A had their dental age estimated using radioscopic pictures (RVG) of their lower left teeth, analyzed with the Demirjian method. Group B had their skeletal age estimated using hand-wrist radiographs, analyzed with the Greulich & Pyle method. The study compared the actual ages of the children with their estimated skeletal and dental ages to see how closely they matched. **Results:** In this study, total 120 children enrolled, 02 groups were included of 60 children each. Group A had 35 (57.14%) boys and 25(42.86%) girls, while Group B had 32 (54.29%) boys and 28 (45.71%) girls. In Group A, 32 patients (52.86%) were between 5-10 years old and 28 patients (47.14%) were between 11-15 years old. Similarly, in Group B, 31 patients (51.43%) were between 5-10 years old and 29 patients (48.57%) were between 11-15 years old. In Group A, the gap between actual age and dental age was slightly less than a year for both younger (5-10 yrs.) was 0.64±1.24 yrs.) & in older kids (11-15 yrs.) was 0.67±0.18 years. In Group B, the gap between

actual age & skeletal age was also less than a year for both age groups. The results showed no significant difference between the 02 groups. **Conclusion:** It is concluded that both dental age estimation by using Demirjian's method & skeletal age estimation using Greulich and Pyle's and Greulich method are useful approaches for forensic age estimation. Notably, the results show that both methods yield comparable outcomes, with no significant difference observed between them. This suggests that either method can be confidently used in forensic contexts to estimate an individual's age.

Keywords: Age Estimation, Bone Age (Greulich and Pyle), Forensic, Dental Age (Demirjian's),

INTRODUCTION
The concept of age refers to the duration of time a person or living being has existed since birth [1]. Age estimation plays a vital role in forensic science, especially when it comes to identifying human remains or investigating crimes [2]. As people grow and develop at different rates, chronological age isn't always a reliable indicator of maturity [3]. Instead, physiological age - which can be measured through skeletal, dental, and other developmental markers - provides a more accurate picture. In orthodontics, assessing skeletal maturity is crucial for effective treatment planning and predicting outcomes [4]. One way to evaluate skeletal age is by analyzing hand-wrist X-rays, which can show the extent of bone development [5]. The Greulich Pyle Atlas and Greulich is mainly used for interpreting these X-rays [6].

Teeth undergo various changes as we age, which can be categorized into three main types: developmental, degenerative, and histological changes [7]. Developmental changes i.e, teeth eruption and calcification are useful for estimating age in children and adolescents. Various techniques have been created to evaluate age through dental development, including atlas methods and scoring systems like the one proposed by Demirjian.

In adults, where developmental changes are less useful for age estimation, other methods such as those developed by Gustafson and Kvaal are employed [8-9]. These methods often rely on changes that occur in the teeth over time, such as wear and tear or changes in the structure of the teeth. Demirjian's method, which assesses the developmental stage of teeth based on their shape and development rather than precise measurements, is widely accepted for its practicality and reliability in forensic contexts [10]. Demirjian's method has advantages, including clear and objective criteria for tooth development stages [11-12].

Our research has the main objective to evaluate the accuracy of main two methods for age estimation in forensic contexts: the Demirjian method, which relies on tooth eruption and development, and the Greulich and Pyle method, which assesses bone age through the ossification of carpal bones in the hand.

MATERIALS AND METHODS
Department of Radiology and Imaging, LUH Hyderabad & Department of Forensic Medicine and Toxicology, LUMHS, Jamshoro, from January 01, 2023 to June 30 2023. A total of 120 children, aged 05 to 15, participated after their parents or guardians provided written consent. The participants' demographic details were recorded, and those who refused to participate, were uncooperative, had psychiatric conditions, or had abnormal tooth or hand radiographs were not included.

The participants were mainly divided into two groups of 60 each. First group underwent dental age estimation using the Demirjian method, which involves analyzing radiographs of the lower left teeth. Group B underwent skeletal age estimation using the Pyle and Greulich method, which involves assessing hand-wrist radiographs.

The study compared the estimated ages with the actual ages and analyzed the data using SPSS 24.0 software. A chi-square test was conducted to evaluate the accuracy of the two methods, with a p value under 0.05 deemed significant.

RESULTS

In this study, total 120 children enrolled, two groups were included of 60 children each. Group A consisted of 35 (57.14%) boys and 25(42.86%) girls, while Group B had 32 (54.29%) boys and 28 (45.71%) girls. In Group A, 32 patients (52.86%) were between 5-10 years old and 28 patients (47.14%) were between 11-15 years old. Similarly, in Group B, 31 patients (51.43%) were between 5-10 years old and 29 patients (48.57%) were between 11-15 years old.

For children aged 5-10 in Group A, the average actual age was 7.42 years, while their estimated dental age was 6.81 years. For children aged 5-10, the typical discrepancy between real age and dental age was 0.64 years, which wasn't statistically significant (p-value 0.063). For children aged 11-15, the average actual age was 13.53 years, while their dental age was 12.86 years, resulting in a difference of 0.67 yrs. This difference was not statistically significant either (p-value > 0.05).
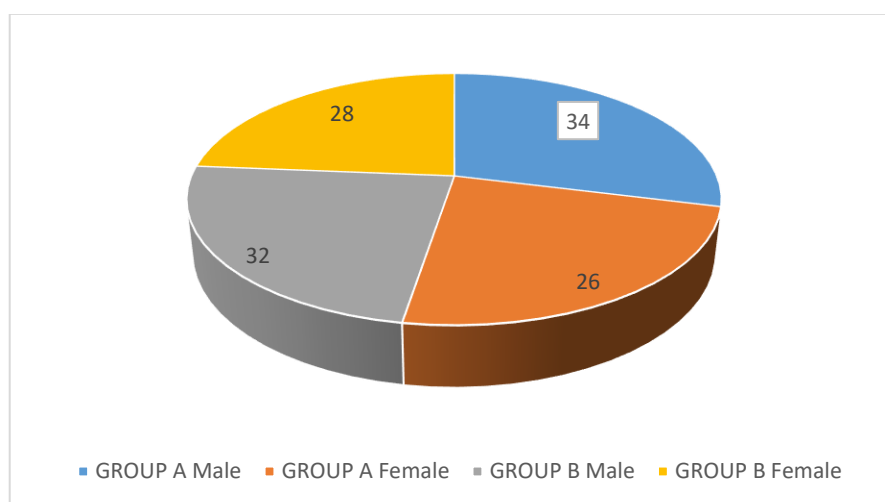

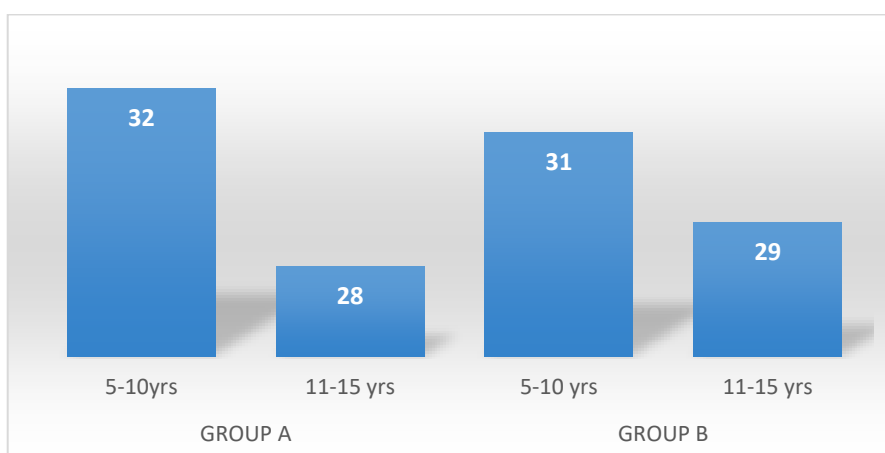Figure 1: Gender-wise distribution between both groups

Figure 2: Age-wise distribution between both groups

Table 1: Comparison of Age estimation between both groups

Group A					Group B				
Age Group	Chronological age	Dental Age	Difference	P-value	Age Group	Chronological age	Skeletal Age	Difference	P-value
5 to 10	7.42±2.36	6.81±1.12	0.64±1.24	0.063	5 to 10	7.75±2.33	7.03±1.15	0.72±1.18	0.084
11 to 15	13.53±1.84	12.86±2.02	0.67±0.18	0.071	11 to 15	12.65±1.82	11.99±0.64	0.66±1.18	0.67

DISCUSSION

Accurate age estimation is crucial in forensic investigations. Despite the availability of various age determination methods, a standardized framework has not been established due to variations in results across different ethnic groups. This highlighted the need for population-specific methods to ensure accurate age estimation [13-14]. Given the variations across different populations, it's essential to validate age estimation methods within specific communities. To achieve this, our study focused on a uniform ethnic group, comprising 120 subjects divided into two groups of 60 each. One group underwent age estimation using dental methods, while the other group underwent age estimation using skeletal methods, allowing for a comparison of the two approaches within this specific population. Group A consisted of 35 (57.14%) boys and 25(42.86%) girls, while Group B had 32 (54.29%) boys and 28 (45.71%) girls. In Group A, 32 patients (52.86%) were between 5-10 years old and 28 patients (47.14%) were between 11-15 years old. Similarly, in Group B, 31 patients (51.43%) were between 5-10 years old and 29 patients (48.57%) were between 11-15 years old [15-16].

Our study revealed that among children aged 5-10 years, the average chronological age was 7.42 years, while their dental age was estimated to be 6.81 years, resulting in a difference of 0.64 years. Statistical analysis showed insignificant difference, with a p-value of 0.063. In the 11-15 yr. age group, the average chronological age was 13.53 yrs. & the dental age was 12.86 years, resulting in a difference of 0.67 years. This disparity was likewise determined to be statistically insignificant, with a p-value greater than 0.05. The results showed insignificant difference between the two groups. However, Willem's approach to estimating dental age was determined to be the most dependable and consistent method [17]. A study by Azzawi AM et al found a statistically significant increase in dental age compared to chronological age among 400 boys & girls. The study revealed that boys were ahead by 0.208 yrs. & girls by 0.294 years. The researchers concluded that the Demirjian method may not be suitable for Egyptian children and suggested the need for developing a new, adapted dental scoring system for each sex and age group specific to the Egyptian population [18]. A study conducted by Manzoor Mughal A et al explored various methods for estimating bone age, including radiation-based hand and wrist visualization techniques, as well as ultrasound. While these methods show promise, they are not as precise as radiographic approaches. The study also noted that hand and wrist X-rays are not useful for determining bone age after the age of 18. For individuals between 18 and 22 years old, the medial end of the clavicle is often used as an alternative site for bone age measurement [19]. Another study by Saade A et al found similar results to ours, concluding that both skeletal and dental methods are effective for estimation of age, but the dental method being more reliable [20].

In our study, we analyzed the skeletal age of children using a specific method. For children aged 5-10 years, the average chronological age was 7.75 years, while their skeletal age was estimated to be 7.03 years. This resulted in a difference of 0.72 years, which was statistically insignificant with p-value, 0.063. For 11-15 years group, the chronological age was 12.65 yrs. & the skeletal age was 11.99 years, making a difference of 0.66 yrs, which was also statistically insignificant (p-value > 0.05) like the younger group.

CONCLUSION

In conclusion, our study found both dental age assessment and skeletal age assessment through bone ossification are effective methods for forensic age determination. These methods are not only reliable but also safe and straightforward to apply, making them valuable tools in forensic investigations.

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