

Medicolegal and Physiological Age Estimation by Third Molar Development Using Demirjian Classification and Its Correlation with Physiological Markers of Growth and Puberty Among Students Aged 17–25 Years at Ayub Medical College, Abbottabad

Mahwish Zeb¹, Asfandiyar Qureshi^{2*}

¹Department of Forensic Medicine and Toxicology, Ayub Medical College, Abbottabad, Pakistan

²Department of Physiology, Ayub Medical College, Abbottabad, Pakistan

ARTICLE INFO	ABSTRACT
*Correspondence to Asfandiyar Qureshi Department of Physiology, Ayub Medical College, Abbottabad, Pakistan Email: drasfand@gmail.com Article History Received: 07-08-2026 Revised: 17-09-2026 Accepted: 24-09-2026 Published: 30-09-2026 How to Cite Zeb M, Qureshi A. Medicolegal and Physiological Age Estimation by Third Molar Development Using Demirjian Classification and Its Correlation with Physiological Markers of Growth and Puberty Among Students Aged 17–25 Years at Ayub Medical College, Abbottabad. Pak J Clin Res. 2026;3(9):63–68. doi:10.65761/pjcr.2026.351 DOI: https://doi.org/10.65761/pjcr.2026.351	Background: Age estimation is essential in forensic dentistry, particularly for determining legal adulthood. Third molar development is a useful biological marker during late adolescence, although its relationship with physiological growth and pubertal maturation remains unclear. Objective: To evaluate third molar development using Demirjian classification and its association with chronological age, anthropometric parameters, and pubertal maturation among students aged 17–25 years. Methods: This analytical cross-sectional study was conducted at Ayub Medical College, Abbottabad, from April to August 2025 and included 100 students. Panoramic radiographs were assessed using Demirjian stages A–H. Chronological age, anthropometric measurements, and self-reported pubertal milestones were recorded. Statistical analyses included Spearman correlation, Mann–Whitney U, chi-square, and receiver operating characteristic (ROC) curve analyses. Statistical significance was set at $p < 0.05$. Results: Participants had a mean age of 20.99 ± 2.33 years, with equal male and female representation. Demirjian stage H was observed in 72% of participants, increasing from 28% among those aged 17–18 years to 100% among those aged 23–25 years. Third molar development correlated significantly with chronological age ($p = 0.629$, $p < 0.001$), but not with height, weight, body mass index, or reported pubertal milestones (all $p > 0.05$). At the 18-year threshold, stage H showed 78.4% sensitivity, 75.0% specificity, 95.8% positive predictive value, and 78.0% classification accuracy. The ROC area under the curve was 0.810. Conclusion: Third molar maturation may support forensic age estimation; however, individual developmental variability and the limitations of a single dental indicator must be considered when assessing legal adulthood. Keywords: Age estimation; Demirjian classification; Forensic odontology; Third molar development; Chronological age; Pubertal maturation; Medicolegal age assessment.

INTRODUCTION

Age estimation is one of the essential and crucial elements of forensic medicine, forensic odontology and human identification, especially in cases where chronological age is unknown, questionable or controversial. Determining an individual's age has many implications, such as civil and criminal cases, immigration, identification of unknown persons, legal responsibilities, etc. Biological age assessment relies on changes that occur in anatomical structures over the course of development such as dental mineralization, skeletal maturation and secondary sexual characteristics. Of these indicators, the formation of the teeth is widely used, as the development of the teeth occurs in a predictable order, and can be assessed using a radiograph. The mineralisation of teeth is also thought to be more stable in response to some environmental influences than other developmental measures, although the timing of maturation may vary depending on genetic, nutritional, and population differences^{1–3}.

Molar teeth are most important for dating in late adolescence and early adulthood, as they typically finish forming later than other permanent teeth. Their length of development gives them the chance to test their biological maturity in those who are nearing legal adulthood. The Demirjian classification is a widely used radiographic classification of dental mineralization that divides the development of crowns, roots, and apices into eight stages (A to H) according to the characteristics of the morphological changes. Stage H refers to a stage in which roots are fully developed and the root apex is closed. The panoramic radiograph can be used to assess these developmental changes, and provides a method for evaluating maturation of the third molar. There is, however, considerable variation in developmental timing and reference standards should therefore be interpreted with caution and be population specific^{4–6}.

Medicolegal age determination frequently focuses on the chronological threshold of 18 years, which represents legal adulthood in many jurisdictions. The developmental status of the



third molars of the mandible may help in determining the likelihood for being this age. However, there is not necessarily a linear correlation between full mineralization of the third molars and legal adulthood. Dental development may sometimes be advanced before the age of 18 and may take longer to complete than normal. Therefore, relying solely on 3rd molar growth for age estimation can lead to age estimation errors. The accuracy of these assessments also relies on the age distribution of the population being assessed, sex-related differences, inter-observer reliability and diagnostic criteria used. Therefore, third molar maturation should be considered a complimentary biological indicator, not a definitive indicator of chronological age⁷⁻¹⁰.

Other aspects of adolescent development including physiological growth and pubertal maturation must also be considered in the understanding of the concept of "biological age. Physical growth is reflected by height, weight, body mass index, and pubertal milestones (menarche, development of voice, and growth spurt) give information about sexual and somatic maturation. While there is a biological relationship between dental and skeletal development to overall maturation, developmental pathways are not necessarily synchronous. Variations in endocrine influences, genetic differences, nutrition and individual growth rates may result in variations in the timing of dental mineralization and pubertal development. Additionally, the significance of physiological indicators may vary between adolescence and early adulthood due to the fact that most of the pubertal changes are completed in early adulthood. This exploration may shed light on the question of whether or not there is useful information in these relationships beyond chronological age in dental age assessment¹⁰.

Other aspects of adolescent development including physiological growth and pubertal maturation must also be considered in the understanding of the concept of "biological age. Physical growth is reflected by height, weight, body mass index, and pubertal milestones (menarche, development of voice, and growth spurt) give information about sexual and somatic maturation. While there is a biological relationship between dental and skeletal development to overall maturation, developmental pathways are not necessarily synchronous. Variations in endocrine influences, genetic differences, nutrition and individual growth rates may result in variations in the timing of dental mineralization and pubertal development. Additionally, the significance of physiological indicators may vary between adolescence and early adulthood due to the fact that most of the pubertal changes are completed in early adulthood. This exploration may shed light on the question of whether or not there is useful information in these relationships beyond chronological age in dental age assessment. Despite the recognized role of third molar development in forensic age estimation, limited information is available regarding its combined relationship with chronological age, anthropometric growth, and retrospectively reported pubertal milestones among Pakistani young adults. This gap highlights the need for localized assessment of dental and physiological maturation, particularly in the age range surrounding legal adulthood. The present study was designed to evaluate third molar developmental stages using Demirjian classification, determine their correlation with chronological age and physiological markers of growth and puberty, examine sex-related differences, and assess the potential medicolegal applicability of third molar maturation for age classification at the 18-year threshold among students aged 17–25 years at Ayub Medical College, Abbottabad.

METHODOLOGY

This analytical cross-sectional study was conducted at Ayub Medical College, Abbottabad, Pakistan, from April 1 to August 30,

2025, to investigate the relationship between mandibular third molar development, chronological age, and physiological markers of growth and pubertal maturation among students aged 17–25 years. The study also evaluated the potential medicolegal utility of third molar maturity in differentiating individuals younger than 18 years from those aged 18 years or older. The target sample comprised 100 participants, with the minimum sample size estimated at approximately 85 using Fisher's Z transformation for correlation analysis, assuming a correlation coefficient of 0.30, a 95% confidence level, 80% statistical power, and a two-sided significance level of 0.05. The sample was increased to accommodate incomplete records and non-assessable radiographs¹¹. Participants were recruited through non-probability consecutive sampling. Eligible participants included males and females with documented dates of birth, at least one assessable mandibular third molar on a digital orthopantomogram (OPG), and available demographic and physiological data. Individuals with congenital craniofacial abnormalities, developmental dental anomalies, relevant maxillofacial trauma, previous orthodontic or surgical treatment affecting third molar assessment, or systemic and endocrine disorders influencing growth and maturation were excluded from the relevant assessments. Radiographs with inadequate visualization of the crown, roots, or apices were considered unsuitable.

Demographic information, including sex and date of birth, was collected using a structured data collection form. Chronological age was calculated from the documented date of birth and assessment date, expressed in completed years and decimal years. Height and weight were recorded, and body mass index (BMI) was calculated as weight in kilograms divided by height in metres squared. Pubertal milestones, including reported age at peak adolescent growth spurt, menarche in females, and voice deepening in males, were obtained through a confidential questionnaire. Unreliable or unavailable responses were treated as missing data, and sex-specific markers were analysed separately. Anthropometric measurements were considered indicators of body size rather than direct measures of pubertal status.

Digital panoramic radiographs obtained for clinical indications were assessed for mandibular third molars (FDI teeth 38 and 48) using the Demirjian classification system, comprising eight developmental stages (A–H), from initial calcification to complete root formation and apical closure. One assessable mandibular third molar per participant was designated as the index tooth for the primary analysis. Contralateral tooth stages were recorded when available to evaluate bilateral agreement. Missing, extracted, and unassessable teeth were documented separately. Chronological age was concealed during radiographic assessment to minimize observer bias.

For medicolegal analysis, participants were classified as younger than 18 years or aged 18 years or older. Stage H represented complete dental maturity, whereas stages A–G indicated incomplete maturation. Sensitivity, specificity, positive predictive value, negative predictive value, diagnostic accuracy, and receiver operating characteristic (ROC) curve analysis were used to evaluate classification performance. Dental maturity was interpreted as a probabilistic indicator rather than definitive proof of legal adulthood. Data were analysed using IBM SPSS Statistics version 26.0.

Continuous variables were summarized using means and standard deviations or medians and interquartile ranges, as appropriate, while categorical variables were presented as frequencies and percentages. Normality was assessed using the Shapiro–Wilk test. Spearman's rank correlation, the Mann–Whitney U test, Pearson's chi-square test or Fisher's exact test,

and weighted Cohen's kappa were applied, as appropriate. ROC analysis estimated discriminatory performance at the 18-year threshold, with the area under the curve and 95% confidence interval reported. Statistical significance was set at a two-sided p-value of less than 0.05.

RESULTS

The study comprised 100 students, including 50 males (50.0%) and 50 females (50.0%). The mean chronological age was 20.99 ± 2.33 years with an even distribution of age groups. The mean height was 166.12 ± 8.85 cm, mean weight was 65.00 ± 11.38 kg, and mean BMI was 23.45 ± 2.95 kg/m². The mean age at which females reported having their first period was 12.85 ± 1.16 years, while the mean age at voice deepening for males was 14.37 ± 0.89 years (Table 1).

Table 1. Demographic and physiological characteristics of participants (N=100)

Variable	Results
Chronological age (years)	20.99 ± 2.33
Male	50 (50.0%)
Female	50 (50.0%)
Age 17–18 years	25 (25.0%)
Age 19–20 years	25 (25.0%)
Age 21–22 years	25 (25.0%)
Age 23–25 years	25 (25.0%)
Height (cm)	166.12 ± 8.85
Weight (kg)	65.00 ± 11.38
BMI (kg/m²)	23.45 ± 2.95
Age at menarche, females (years)	12.85 ± 1.16
Age at voice deepening, males (years)	14.37 ± 0.89
Age at reported growth spurt (years)	12.76 ± 1.46

Values are expressed as mean $\pm$ standard deviation or frequency (%).

Demirjian classification was used to classify the development of third molars. The most common finding was complete root development (stage H) with a prevalence of 72.0%. Stage G was identified in 15.0%, stage F in 9.0%, and stage E in 4.0%. Stages A–D did not have any participants. As the ages increased, the percentage of individuals in the 23–25 age group with stage H was 100%, showing higher dental maturity than the other age groups (Table 2).

Table 2. Distribution of Demirjian third molar developmental stages by chronological age (N=100)

Stage	17–18 years	19–20 years	21–22 years	23–25 years	Total n (%)
E	4	0	0	0	4 (4.0)
F	8	1	0	0	9 (9.0)
G	6	8	1	0	15 (15.0)
H	7	16	24	25	72 (72.0)
Total	25	25	25	25	100 (100.0)

Demirjian stages A–D had zero.

Chronological age was significantly correlated with the Demirjian developmental stage (Spearman's $\rho=0.629$, $p<0.001$). Age group also had a significant correlation with the completion of the root ($\chi^2=41.67$, $p<0.001$). There was no significant difference between development stages of males and females (Mann–Whitney $U=1280.0$, $p=0.797$). The assessments of the right and left third molars were in good agreement, with a quadratic weighted kappa coefficient of 0.898 (Table 3).

Table 3. Association of third molar development with chronological age and sex

Comparison	Statistical test	Test statistic	p-value
Chronological age vs. Demirjian stage	Spearman correlation	$\rho=0.629$	<0.001
Demirjian stage by sex	Mann–Whitney U	$U=1280.0$	0.797
Age group vs. stage H	Chi-square	$\chi^2=41.67$	<0.001
Right vs. left mandibular third molar	Weighted kappa	$\kappa=0.898$	—

Statistical significance was defined as $p<0.05$. Weighted kappa describes agreement rather than an association with chronological age.

Relationships between the developmental stage of third molars and physiological markers were mostly low. There was a weak positive correlation between height and the weight ($\rho=0.109$, $p=0.281$) and BMI ($\rho=-0.022$, $p=0.829$) respectively and there was no correlation between weight and BMI ($\rho=-0.022$, $p=0.829$). Likewise, no statistically significant correlation was observed between age at menarche, voice deepening or reported growth spurt with third molar developmental stages. These results suggest that physiological variables (evaluated) and chronological age were strongly associated with dental maturity (Table 4).

Table 4. Correlation between Demirjian developmental stage and physiological parameters

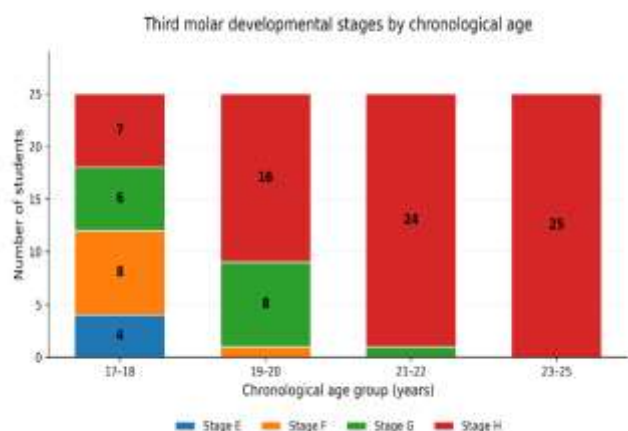
Physiological parameter	Spearman's ρ	p-value
Height (cm)	0.109	0.281
Weight (kg)	0.056	0.579
BMI (kg/m²)	-0.022	0.829
Age at menarche (females)	-0.083	0.567
Age at voice deepening (males)	-0.119	0.411
Age at growth spurt	0.004	0.970

Spearman's rank correlation was used. Menarche and voice-deepening correlations were calculated separately for their respective sex-specific subgroups ($n=50$ each).

Medicolegal classification: 88 participants were age 18 years or older and 12 were less than 18 years old. The sensitivity was 78.4%, specificity 75.0%, positive predictive value 95.8% and negative predictive value 32.1% based on Demirjian stage H as an indicator of adulthood. The overall classification accuracy was 78.0%. In the (Table 5) moderate-to-good discriminatory ability was achieved with an area under the curve of 0.810 from receiver operating characteristic analysis performed on ordinal Demirjian stages.

Table 5. Diagnostic performance of Demirjian third molar development for medicolegal age classification

Parameter	Result
Participants aged ≥ 18 years	88 (88.0%)
Participants aged under 18 years	12 (12.0%)
True positives	69
False positives	3
True negatives	9
False negatives	19
Sensitivity	78.4%
Specificity	75.0%
Positive predictive value	95.8%
Negative predictive value	32.1%
Overall accuracy	78.0%
ROC AUC (ordinal stages)	0.810

Fig. 1: Distribution of third molar developmental stages according to Demirjian classification among students aged 17–25 years (N=100)

DISCUSSION

Third molar development has considerable importance in forensic odontology because it represents one of the final stages of dental maturation during late adolescence and early adulthood. Estimation of chronological age using dental mineralization is particularly relevant when authentic birth records are unavailable or when confirmation of legal adulthood is required. The Demirjian classification provides a standardized radiographic method for evaluating third molar development through sequential stages of crown formation, root elongation, and apical closure. The progressive advancement of these stages generally corresponds with increasing chronological age, although considerable individual variation may occur. This relationship supports the usefulness of third molar assessment as an adjunctive approach to estimating age among adolescents and young adults. Nevertheless, the accuracy of dental age estimation depends on the developmental characteristics of the population, the age distribution of individuals examined, and the reliability of radiographic interpretation¹²⁻¹⁴.

The growth rate of the third molar and chronological age of the patient are of special significance around 18 years of age, a significant age threshold in many jurisdictions. It is more often

seen in older adolescents and young adults at stage H of the Demirjian classification for formation of the roots. The age at which this developmental stage occurs, however, is different for each person and the formation of the roots does not prove a person is "legally" an adult. Very few people might be considered to be at a mature age for their dentition before 18 years of age, while others might be at a mature age after. The developmental differences may impact the sensitivity, specificity and predictive value of dental age estimation. Therefore, the most important aspect of medicolegal evaluation is to assess the likelihood of maturity, not a specific age based on a single tooth. The results of dental examinations may be more reliable if combined with corroboratory chronological data and other reliable biological maturity indicators¹⁵⁻¹⁶.

The maturation rate of the third molars may also be affected by sex related variation, anatomy, and physiological development. A male-female difference in dental developmental timing has been reported but has a variable degree of expression and consistency between populations. Variations in mineralization may be due to genetic differences, nutritional status, and systemic growth characteristics, as well as to differences in development of individuals. The biological relevance of the relationship between dental maturity and physiological markers (e.g., height, body weight, BMI, pubertal growth spurt, menarche, voice deepening) is that they represent various aspects of adolescent maturation. But dental development is not entirely correlated with pubertal development, nor are anthropometric measurements a direct index of skeletal or hormonal maturity. Moreover, the retrospective reporting of pubertal milestones may lead to recall bias, especially in the young adult population who were previously at earlier stages of puberty. Hence, the use of physiological growth indicators should be considered as additional information on growth development and not as independent alternatives for dental age assessment^{17,18}.

Radiographic evaluation of the dentition of the mandibular third molars provides a practical method for assessing developmental age since the panoramic radiograph allows crown and root mineralization to be seen without invasive assessment. Use of standardized interpretation using Demirjian stages can enhance the consistency of the interpretation between observers and allow for comparison among the different age groups. However, developmental assessment may be influenced by the variations in tooth position, impaction, root morphology, and the quality of the X-ray. Third molars which are impacted can show variations in mineralization age in relation to their normal third molars, and thus may affect the calculated likelihood of reaching a given chronological age. When using dental maturation methods in forensic practice, it is therefore important to have population-specific reference standards. Depending on age-estimation standards from different ethnic or geographical groups, there can be systematic errors due to differences in developmental timing and sample characteristics. Sex-specific evaluations, bilateral tooth assessment and the use of adequately validated statistical models could enhance the accuracy and repeatability of dental ageing^{19,20}.

Although highly applicable, third molar age estimation can be constrained and should be taken into consideration in the interpretation of the forensic findings. Cross sectional design limits the ability to measure individual developmental change over time, and the small sample size could limit the accuracy of estimates of developmental change by age or sex. Small numbers of patients around the legal age limit may have a disproportionate impact on estimates of sensitivity and/or specificity. Being chosen from one school can also limit generalizability to the broader population. In addition, the development of third molars can occur independent of physiological pubertal maturation and self-

reported ages for pubertal milestones may be influenced by inaccurate recall. Larger multicenter samples, with an equal number of people below and above the age of 18, a uniform radiographic evaluation, and longitudinal studies of dental and physiological development would be beneficial in future research. Third molar maturation could be used in conjunction with an accepted skeletal maturity indicator and a population-specific prediction model to improve the scientific underpinning in medicolegal age estimation.

CONCLUSION

Third molar development assessed through the Demirjian classification provides a useful biological indicator of chronological age during late adolescence and early adulthood. The sequential progression of dental mineralization offers an objective framework for evaluating developmental maturity, particularly in individuals approaching the medicolegal age threshold of 18 years. However, individual variation in third molar maturation, sex-related developmental differences, and incomplete correspondence with physiological growth and pubertal markers limit its usefulness as an independent determinant of chronological age. Dental maturity should therefore be interpreted alongside other relevant clinical, physiological, and documented age indicators. Population-specific standards, standardized radiographic assessment, and integrated age-estimation approaches are recommended to improve the reliability and medicolegal applicability of third molar development.

Ethical Approval

Ethical approval for this study was obtained from the Institutional Ethical Review Board of Ayub Medical College, Abbottabad, Pakistan. The study was conducted in accordance with the ethical principles and institutional requirements governing research involving human participants.

Data Availability

The data analyzed in this study are available from the corresponding author upon reasonable request.

Author Contributions

Mahwish Zeb and Asfandiyar Qureshi contributed to conceptualization, methodology, data collection, and formal analysis. Mahwish Zeb prepared the original draft, and both authors contributed to reviewing and editing the manuscript. Both authors have read and approved the final manuscript, accept responsibility for the integrity and accuracy of the research, and are accountable for all aspects of the work.

Informed Consent

Informed consent was obtained from all participants before their enrollment in the study. The participants were adequately informed about the study objectives and procedures, and their privacy and confidentiality were ensured throughout the study.

Funding

No.

Conflict of Interest

No.

Acknowledgments

The authors acknowledge Ayub Medical College, Abbottabad, Pakistan, and thank all participants who contributed to this study.

Declaration of AI-Assisted Language Editing

Grammarly AI was used for language and grammar correction, while Gemini AI was used for figure generation.

REFERENCES

1. Ramaswami, T.B., et al., Third molar development by Demirjian's stages and age estimation among Brazilians. *Forensic Imaging*, 2020. 20: p. 200353 DOI: <https://doi.org/10.1016/j.fri.2020.200353>.
2. Kanchan, T., et al., Age estimation using third molar maturation based on Demirjian's criteria. *Leg Med (Tokyo)*, 2021. 53: p. 101959 DOI: [10.1016/j.legalmed.2021.101959](https://doi.org/10.1016/j.legalmed.2021.101959).
3. Wilson, Y.P., et al., Age estimation from developing third molars. *Med Leg J*, 2021. 89(4): p. 254-259 DOI: [10.1177/00258172211052930](https://doi.org/10.1177/00258172211052930).
4. Melo, M., et al., Demirjian and Cameriere methods for age estimation in a Spanish sample of 1386 living subjects. *Scientific Reports*, 2022. 12(1): p. 2838 DOI: [10.1038/s41598-022-06917-x](https://doi.org/10.1038/s41598-022-06917-x).
5. Meghana, R.V., et al., A test to study the influence of impaction on mandibular third molar development and forensic age estimation in a sample of south Indian children and young adults. *Leg Med (Tokyo)*, 2022. 54: p. 101998 DOI: [10.1016/j.legalmed.2021.101998](https://doi.org/10.1016/j.legalmed.2021.101998).
6. Mutebi, A.K., et al., Determination of age reference standards based on mandibular third molar root development in a Ugandan population aged 10-22 years. *Egypt J Forensic Sci*, 2022. 12(1): p. 56 DOI: [10.1186/s41935-022-00308-z](https://doi.org/10.1186/s41935-022-00308-z).
7. Magat, G. and S. Ozcan, Age estimation based on the third molar development in a Turkish population: A radiographic study. *Annals of Medical Research*, 2021. 26(7): p. 1178-1183.
8. Taha, A. and S. Yousif, Age estimation of Iraqi children and young adults based on third molar development and its relation to chronological age. *Pediatric Dental Journal*, 2022. 32(2): p. 87-93 DOI: <https://doi.org/10.1016/j.pdj.2022.02.003>.
9. Oh, S., et al., Accuracy of age estimation and assessment of the 18-year threshold based on second and third molar maturity in Koreans and Japanese. *PLOS ONE*, 2022. 17(7): p. e0271247 DOI: [10.1371/journal.pone.0271247](https://doi.org/10.1371/journal.pone.0271247).
10. Arthanari, A., et al., Age Estimation Using Third Molar Eruption Stages and Its Maturation—A Retrospective Study among South Indian Population. 2022. 22(1): p. 106-111.
11. Bonett, D.G. and T.A. Wright, Sample Size Requirements for Estimating Pearson, Kendall and Spearman Correlations. *Psychometrika*, 2000. 65(1): p. 23-28 DOI: [10.1007/BF02294183](https://doi.org/10.1007/BF02294183).
12. Vila-Blanco, N., et al., A systematic overview of dental methods for age assessment in living individuals: from traditional to artificial intelligence-based approaches. *International Journal of Legal Medicine*, 2023. 137(4): p. 1117-1146 DOI: [10.1007/s00414-023-02960-z](https://doi.org/10.1007/s00414-023-02960-z).
13. Klingberg, G., et al., How old are you? A systematic review investigating the relationship between age and mandibular third molar maturity. *PLoS One*, 2023. 18(5): p. e0285252 DOI: [10.1371/journal.pone.0285252](https://doi.org/10.1371/journal.pone.0285252).
14. Khan, A., S. Manica, and A. Franco, Dental Age Estimation Methods Tested in a Sample of the Pakistani Population: Cross-Sectional Study. *Oral*, 2023. 3, 511-525 DOI: [10.3390/oral3040042](https://doi.org/10.3390/oral3040042).
15. Bashir, M.B., et al., Relationship between Chronological Age and Dental Age Using Third Molar Calcification in the Pakistani Population. *J Coll Physicians Surg Pak*, 2023. 33(1): p. 15 DOI: [10.29271/jcpsp.2023.01.15](https://doi.org/10.29271/jcpsp.2023.01.15).
16. Ullah, I., et al., Forensic Age Estimation from Lower Third Molar Maturity Index. *Pakistan Armed Forces Medical Journal*, 2023. 73(2): p. 531-34 DOI: [10.51253/pafmj.v73i2.7364](https://doi.org/10.51253/pafmj.v73i2.7364).

17. Paddenbergh, E., et al., Individual dental and skeletal age assessment according to Demirjian and Baccetti: Updated norm values for Central-European patients. *J Orofac Orthop*, 2024. 85(3): p. 199-212 DOI: 10.1007/s00056-022-00431-5.
18. Ercan, D.E. and S. Yüksel, Skeletal, dental, and sexual maturation as an indicator of pubertal growth spurt. *American Journal of Human Biology*, 2023. 35(12): p. e23957 DOI: <https://doi.org/10.1002/ajhb.23957>.
19. Ferrillo, M., et al., Skeletal maturation evaluation: which is the reliability of dental calcification Demirjian method versus hand-wrist X-ray in growing subjects? A systematic review. *Acta Odontol Scand*, 2024. 83: p. 230-237 DOI: 10.2340/aos.v83.40485.
20. Nausheen, N., N. Shafiq, and S. Mohammed, Assessment of Chronological Age through Mandibular Third Molar Development. *Journal of Bacha Khan College of Dentistry*, 2024. 2: p. 34-40 DOI: 10.65293/jbkcd.v2i02.27.