A Simpler Way of Medico-Legal Age Estimation for Indian Population Using Mincer Third Molar Method

Dr. Vidhya Arumugam1, Dr. Nagabhushana Doggalli2*

1B.S, M.Sc (FOD), Post Graduate Student, JSS Academy of Higher Education and Research, JSS Dental College and Hospital, SS Nagar, Mysuru, Karnataka – 570015, India
2M.D.S, M.Sc (FOD), Reader, Department of Oral Medicine and Radiology, JSS Academy of Higher Education and Research, JSS Dental College and Hospital, SS Nagar, Mysuru, Karnataka – 570015, India

Background: To determine the age or status of Juvenile or adult based on Third Molar Development in population belonging to south India for medico-legal or Forensic application. Objectives: Application of Mincer (ABFO recommended) method of dental age estimation through third molars in Indian population using digital OPGs and deriving Indian specific simpler formula for age estimation. Methodology: The study was conducted on 400 digital OPGs (200 males, 200 females) of the age groups 14-22 years. They were divided into 8 groups (50 in each age group). Which were taken with PROMAX digital Planmeca Machine. Staging of all four third molars were done using Mincer adapted Demirjian et al., [9] mineralization stages A-H. Statistical analysis was performed, Descriptive statistics were obtained by calculating the means, standard deviations, and Regression formulas were obtained for calculating direct dental age from tooth developmental stages, Empirical probability was also obtained. Results: Result showed a strong relation of age with development stages of third molar teeth. The standard deviation of mean of tooth development stages is ±0.5 to ±1 years of age. Conclusion: As shown in the stepwise regression analysis lower left third molar (38) is not significantly contributing for predicting the age, hence the use of all four molar (maxillary and mandibular right and left third molars) provided a statistically significant improvement in predictive accuracy, From the observation, the present study predicted ages are closure to the observed ages. Keywords: Orthopantomogram, Digital OPG, Mincer method, Demirjian method, dental age estimation, forensic odontology, radiographic age estimation, third molar age estimation.

INTRODUCTION

Forensic odontology deals with appropriate handling, examination and evaluation of all the possible dental evidences acquired from Oral and Para-oral structures [1]. Teeth are harder than any other tissue in the body and can withstand very high levels of thermal, chemical and physical insults. Therefore teeth and the dentition as a whole, is considered as an important source of identification in the living and the dead [2].

Age estimation is very important in the area of Forensic science when matters of consent or criminal liability arise, or in the identification of individuals in different situations. Teeth present useful material for age estimation! In addition to its clinical importance, the radiographic diagnosis is an important parameter for determination of age in the undocumented youth [3].

Dental age estimation can be evaluated by either invasive or non-invasive methods, where indirect methods constructed by analysis of mineralization stages, amount of calcification during tooth development, root maturation, root developmental stages by intra-oral and extra-oral radiographs were also established as an age estimation tool [4]. Age estimation by assessing the chronology of tooth eruption or by tooth development (formation) processes is considered more accurate, quick and non-invasive [5].

Various radiographic images that can be used in age identification, among the extra-oral radiographic techniques, use of the panoramic X-ray (Orthopantomograms) facilitates visualization of teeth from the beginning of crown formation till the root apex closure within or outside the jaw bone even during the
absence of an individual throughout the identification process [6].

Various classification systems have been employed which divide the tooth development into as many as 21 stages [7], to as less as 3 stages classification [8]. The system devised by Demirjian, Goldstein and Tanner [9] and later modified Demirjian & Goldstein [10], assessed the 7 left permanent mandibular teeth discernible, dividing each tooth into eight developmental stages.

Estimation of age becomes tedious particularly beyond 14-years of age, as the mineralization of most teeth except third molars are completed around this age [11]. Hence the study of third molar development and its clinical or forensic application beyond 14 years of age are especially related to the individual variability in the formation, morphological characteristics of these teeth among different population [6, 12, 13]. This technique also assigns equal weight to each tooth in the age estimation method instead of tooth-specific standards to overcome similar scenarios mincer method has been recommended by ABFO [13].

**METHODOLOGY**

A retrospective study was conducted on 400 digital OPG samples (14-22 years) of digital orthopantomograms archived in the Department of Oral Medicine and Radiology, Mysuru. They were divided into 8 continuous groups (50 in each group) with equal sex distribution, which were taken with PROMAX digital Planmeca Machine (Planmeca OY, Asentajankatu 6, FIN - 00880 Helsinki, Finland). All four third molars were included in this study, Dental maturity of all four third molars were estimated by the method proposed by Mincer et al., [13], adapted from Demirjian [9] (stages A-H). The study protocol was approved by the ethical committee of the college. All the data’s were entered into Microsoft Excel Spreadsheet and analysis done by using SPSS Software version 23.0.

![Cusp tips are mineralized but have not yet coalesced.](image1)

**A**

![Formation of the inter-radicular bifurcation has begun. Root length is less than the crown length.](image2)

**E**

![Mineralized cusps are united so the mature coronal morphology is well-defined.](image3)

**B**

![Root length is at least as great as crown length. Roots have funnel-shaped endings.](image4)

**F**

![The crown is about half formed; the pulp chamber is evident and dentinal deposition is occurring.](image5)

**C**

![Crown formation is complete to the dentinoenamel junction. The pulp chamber has a trapezoidal form.](image6)

**D**

![Root walls are parallel, but apices remain open.](image7)

**G**

![Apical ends of the roots are completely closed, and the periodontal membrane has a uniform width around the root.](image8)

**H**

**FIG. 1—Schematic drawings and definitions of the eight stages of crown and root formation used to score third molar development (modified from Demirjian et al. [9]). Grades A and B did not occur in the age interval examined (14.1 to 24.9 yrs), and grade C occurred in less than 1% of the sample and was omitted from analysis.**

Figure-1, Mincer et al., (1993) [13] adopted Staging system given by Demirjian et al., (1973) Eight stages (stages A-H) [9]

**RESULTS**

The study consisted of 200 male and 200 female digital OPGs, ranging in age from 14 years to 22 years, the mean ages and standard deviations were derived from the data’s are described in the following (Table-1), and a simpler formulae of age estimation from regression analysis were obtained. Statistically significant differences (P < 0.05) were revealed in third molar development between maxillary and mandibular third molar.
Table-1: Mean ages and standard deviation for combination of all four third molars (18, 28, 38, 48) according to mineralization stages

| Demirjian staging stated by Mincer et al., | Sex | Mean ages | Standard deviation |
|------------------------------------------|-----|-----------|--------------------|
| C                                        | Male | 14.1      | 0.10               |
|                                          | Female | 14.4      | 0.40               |
| D                                        | Male | 14.7      | 0.52               |
|                                          | Female | 14.8      | 0.65               |
| E                                        | Male | 15.5      | 0.60               |
|                                          | Female | 15.8      | 0.60               |
| F                                        | Male | 17        | 0.70               |
|                                          | Female | 17.1      | 0.75               |
| G                                        | Male | 18.6      | 0.87               |
|                                          | Female | 18.9      | 1.02               |
| H                                        | Male | 20.7      | 0.85               |
|                                          | Female | 20.7      | 0.90               |

In Table-1, According to present radiographic study samples - mineralization stages of Third molar: Stage A, B are not applicable to the present study, as the study sample starts from the age group of 14 years, thus the Calcification (stage A) and Fusion of mineralisation (stage B) would have occurred in the earlier ages.

Table-2: Univariate Regression parameter based on individual tooth, Maxillary right and maxillary left third molar for male and female (18, 28)

| Staging | Univariate, Maxillary right third molar (18) | Univariate, Maxillary left third molar (28) |
|---------|---------------------------------------------|--------------------------------------------|
| Parameter | Male | Female | Male | Female |
| Intercept | 20.728 | 20.784 | 20.689 | 20.725 |
| Stage C | -6.678 | -6.684 | -6.689 | -6.625 |
| Stage D | -5.996 | -5.938 | -6.000 | -5.858 |
| Stage E | -5.067 | -4.817 | -5.024 | -4.803 |
| Stage F | -3.600 | -3.698 | -3.598 | -3.681 |
| Stage G | -2.056 | -1.908 | -1.978 | -1.963 |
| Stage H | -1.073 | -1.158 | -0.573 | -1.251 |

Interpretation: If we decide to use univariate regression for Age on maxillary right third molar (18) alone, then look at the stage of the third molar (18) on OPG: if we give stage C for Male OPG, then age prediction will be (refer Table-2 for values).

- **Univariate Regression Formula, Age = Intercept value + individual tooth Staging value**

    Age = 20.728 + (- 6.678)
    =14.05 years

    If it is D then Age =20.728 + (- 5.996)
    =14.73 years

Likewise one may interpret age for both male and female by using single third molar (either 18 or 28) from this univariate regression equation (values in Table-2).

Table-3: Univariate Regression parameter based on individual tooth, Mandibular left and mandibular right third molar for male and female (38, 48)

| Staging | Univariate, Mandibular left third molar (38) | Univariate, Mandibular right third molar (48) |
|---------|---------------------------------------------|--------------------------------------------|
| Parameter | Male | Female | Male | Female |
| Intercept | 20.743 | 20.690 | 20.705 | 20.719 |
| Stage C | -6.693 | -6.290 | - | - |
| Stage D | -6.088 | -5.886 | -6.105 | -5.913 |
| Stage E | -5.260 | -5.086 | -5.274 | -5.061 |
| Stage F | -3.813 | -3.640 | -3.799 | -3.640 |
| Stage G | -2.133 | -1.678 | -2.011 | -1.698 |
| Stage H | -1.100 | -1.163 | -0.567 | -0.865 |

- **Univariate Regression Formula, Age = Intercept value + individual tooth Staging value**

Likewise the above mentioned formula, one may interpret age for both male and female by using single third molar (either 38 or 48) from this univariate regression equation (values in Table-3).
Table-4: Multiple Regression parameter based on maxillary and mandibular right and left third molars for both male and female (18, 28, 38, and 48)

| Parameter | Male | Female |
|-----------|------|--------|
| Intercept | 20.917 | 21.055 |
| [URTM, 18=C] | -2.612 | -2.833 |
| [URTM, 18=D] | -2.712 | -2.137 |
| [URTM, 18=E] | -2.382 | -1.350 |
| [URTM, 18=F] | -1.424 | -1.223 |
| [URTM, 18=G] | -0.835 | -1.033 |
| [URTM, 18=H] | -0.580 | -0.917 |
| [ULTM, 28=C] | -2.374 | -3.452 |
| [ULTM, 28=D] | -1.614 | -2.852 |
| [ULTM, 28=E] | -1.327 | -2.860 |
| [ULTM, 28=F] | -1.114 | -2.039 |
| [ULTM, 28=G] | -0.540 | -0.940 |
| [ULTM, 28=H] | -0.282 | -0.397 |
| [LLTM, 38=C] | -2.086 | -0.106 |
| [LLTM, 38=D] | -1.426 | -0.010 |
| [LLTM, 38=E] | -1.046 | -0.203 |
| [LLTM, 38=F] | -0.604 | -0.298 |
| [LLTM, 38=G] | -0.620 | -0.032 |
| [LLTM, 38=H] | -0.613 | 0.000 |
| [LRTM, 48=D] | -0.505 | -1.260 |
| [LRTM, 48=E] | -0.532 | -1.209 |
| [LRTM, 48=F] | -0.776 | -0.395 |
| [LRTM, 48=G] | -0.403 | -0.525 |
| [LRTM, 48=H] | -0.398 | -0.268 |

[Note: URTM- upper right third molar, ULTM- upper left third molar, LLTM- lower left third molar, LRTM- lower right third molar]

**Interpretation** - If we decide to use multiple regression for Age on all four third molar (18, 28, 38 and 48), then look at the stage of all four third molars on OPG and substitute the values, referring from Table-4.

- **Multiple Regression Formula, Age = Intercept value + sum of individual Staging value of all four third molars.**

Table-5: Stepwise Regression parameter based on Maxillary right third molar and Mandibular left third molar for both male and female (18 and 38)

| Parameter | Stepwise Regression(18, 38) |
|-----------|-----------------------------|
| Intercept | 20.856 20.923 |
| [MAXILA, 18 =C] | -4.643 -5.111 |
| [MAXILA, 18 =D] | -4.167 -4.444 |
| [MAXILA, 18 =E] | -3.516 -3.753 |
| [MAXILA, 18 =F] | -2.462 -2.967 |
| [MAXILA, 18 =G] | -1.323 -1.536 |
| [MAXILA, 18 =H] | -0.845 -0.734 |
| [MANDIBLE,38 =C] | -2.402 -2.079 |
| [MANDIBLE,38 =D] | -2.070 -1.713 |
| [MANDIBLE,38=E] | -1.731 -1.361 |
| [MANDIBLE,38=F] | -1.389 -0.927 |
| [MANDIBLE,38=G] | -0.946 -0.616 |
| [MANDIBLE,38=H] | -0.413 -0.386 |

**Interpretation** - If we decide to use Stepwise regression for Age on one maxillary third molar (18) and one mandibular third molar (38).

- **Stepwise Regression Formula, Age = Intercept value + sum of individual Staging value of both 18 and 38.**
Table-6: Empirical probabilities (%) of an individual being at least 18 years of age based on the stage of third molar formation

| GROUP       | GRADE OF FORMATION |
|-------------|--------------------|
|             | G                  | H                  |
| MAXILLA     | 40.5               | 59.5               |
| MALE        | 42.9               | 57.1               |
| FEMALE      | 47.1               | 52.9               |
| MANDIBLE    | 52.2               | 47.8               |

Table-6, shows Probabilities for the stage (G) presume the subject is less than or equal to 18 years (≤ 18) and the terminal stage (H) presume that the subject is greater than 18 years of age (>18).

DISCUSSION

Chronologic age estimation by tooth development has been used over a long period. Tooth development is an accurate measure of chronologic age that is independent of exogenic factors such as malnutrition or disease. The third-molar calcification staging is one of the few tools that can be used to assess age when development is nearing completion [14].

From the above comparative studies, significant positive correlation was observed between developmental stages of maxillary and mandibular third molars in both males and females. Considering each stage separately, it was found that sexual dimorphism was not always the case, and significant differences concerned only stages F, G, and H, for all four teeth. Though lower arch correlation coefficient is not as strong as that observed in upper arch with coefficient of 0.91 and 1.0 respectively. This were in contradiction to Panchbhai et al., [16], who revealed lowest coefficient for developmental stages between upper right and upper left third molar than in lower quadrant.

Completion of third molar before the age of 18 years adds to variability in development of third molar and very negligible proportion of third molars have reached the stage G before 18 years of age and also the number and locations of completely developed third molars, the probability of an individual to be older than 18 years can be derived. This suggests that linking the completion of third molar development with 18 years of age and above will not be irrational. These differences were all statistically significant. However, it must be noted that, in attempting to compare the findings of this study with previous research by mincer, Demirjian, Tonin, Quidemat et al., [9, 15, 23], the accuracy of dental age assessment methods and its comparisons are complicated by different sample sizes, age structures, grouping and statistical analysis used, making the comparisons difficult. This diversity could be explained by the differences in the selected population and the sample size.

Demirjian et al., 1973 (stages A-H), original study was done only on mandibular left quadrant for all seven teeth (i.e from central incisor to second molar), later Mincer applied Demirjian seven teeth method (stages A- H) on all four third molars for legal age estimation obtained through Regression Analysis and empirical probability, likewise the same method followed by other authors in different countries to obtain the legal age, the mean ages of different populations are shown in the Table-7, where Spanish [26], China [14] are ahead in maturation, where Turkish [19], Americans [13], Japanese [24], German [24], South Africans [25] are slower in maturation of third molar mainly observed in the stage G, and also Males are ahead and females are slower, compared to other studies.
Multiple similar studies by Yung et al. [15] have shown earlier development than females and the result is significant, \( p < 0.05 \). Regression analysis were performed for 18, 28, 38, 48, 54, and 60, which showed the variations in eruption timings stated by Priyadharshini et al. [18]. The other populations is the main factor underlying the differences in eruption timing between the maxillary and mandibular third molars. Thus we can conveniently conclude that stage C, D, E, and F have lower mean age than the corresponding stage H by Teelana et al. [22]. These results also agree with studies on genetic, racial, socioeconomic, and maternal factors, which vary considerably between Indians and those from the rest of the world. As per the existing literature, Indians show a lower nutritional status as compared to westerners. This suggests that racial difference between the populations is the main factor underlying the variation in eruption timings stated by Priyadharshini et al. [18].

In the present study univariate, multiple regression analysis were performed for 18, 28, 38, 48, which showed the result of which is significant \( p < 0.05 \). Males showed earlier development than females and there were significant gender differences in stage D-H as shown in similar study in similar studies by Yung Hoa Jung, Tonin, Sisman, Sabitha Devi et al. [17, 15, 19, 21] in contrast lower mean age was observed by approximately 2 to 4 months than the corresponding pseudo mean age may be results of impact of inappropriately censored data in stage H by Teelana et al. [20]. This may be due to the difference of statistical processing. It is also observed that eruption of third molar occurs first in the maxillary followed by mandible, these differences because of geographical and ethnic variations as stated by priyadharshini et al. [18].

Thus we can conveniently conclude that stage C, D, E, and F have lower mean age than the corresponding stage H by Teelana et al. [22]. These results also agree with studies on genetic, racial, socioeconomic, and maternal factors, which vary considerably between Indians and those from the rest of the world. As per the existing literature, Indians show a lower nutritional status as compared to westerners. This suggests that racial difference between the populations is the main factor underlying the variation in eruption timings stated by Priyadharshini et al. [18].

### Table 7: Mean Ages of Indian study compared with other study populations

| Demirjian stages | Sex | American (mincer et al., 1993) | German (Olze et al., 2003) | S.African (Olze et al., 2004) | Japanese (Olze et al., 2004) | Spanish (Prieto et al., 2005) | Turkish (Sisman et al., 2007) | China (Bai et al., 2008) | India Present study, 2020 |
|------------------|-----|-------------------------------|-----------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|---------------------------|
|                  |     | Mean (S.D)                    | Mean (S.D)                  | Mean (S.D)                    | Mean (S.D)                    | Mean (S.D)                    | Mean (S.D)                    | Mean (S.D)                    | Mean (S.D)                 |
| D                | Male| 15.2 (1.50)                   | 16.30 (3.10)                | 15.08 (1.04)                  | 18.20 (3.30)                  | 15.08 (1.04)                  | 12.90 (1.50)                  | 13.1 (0.72)                  | 14.7 (0.52)                |
|                  | Female| 16.0 (1.60)                  | 15.50 (2.60)                | 15.11 (1.00)                  | 18.00 (2.80)                  | 15.11 (1.00)                  | 13.60 (2.24)                  | 14.02 (0.66)                 | 14.8 (0.65)                |
| E                | Male| 17.3 (2.50)                   | 16.70 (2.30)                | 15.20 (2.40)                  | 18.50 (2.70)                  | 15.22 (1.03)                  | 14.42 (1.69)                  | 14.38 (0.57)                 | 15.5 (0.60)                |
|                  | Female| 16.9 (1.70)                  | 16.80 (2.30)                | 15.90 (2.30)                  | 18.60 (2.30)                  | 16.00 (1.43)                  | 15.42 (2.40)                  | 15.23 (0.70)                 | 15.8 (0.60)                |
| F                | Male| 17.5 (2.10)                   | 18.30 (2.20)                | 18.70 (2.30)                  | 20.40 (2.40)                  | 16.42 (1.34)                  | 16.90 (1.50)                  | 16.83 (0.86)                 | 17 (0.70)                 |
|                  | Female| 17.7 (1.80)                  | 19.10 (2.50)                | 21.30 (2.50)                  | 20.50 (2.20)                  | 16.83 (1.56)                  | 16.84 (2.10)                  | 16.49 (0.44)                 | 17.1 (0.75)                |
| G                | Male| 18.3 (1.90)                   | 20.60 (2.40)                | 20.80 (2.20)                  | 21.80 (2.50)                  | 17.92 (1.50)                  | 18.08 (2.38)                  | 18.23 (0.85)                 | 18.6 (0.87)                |
|                  | Female| 19.1 (2.10)                  | 21.70 (2.10)                | 19.80 (2.30)                  | 21.80 (2.00)                  | 18.41 (1.44)                  | 19.29 (2.32)                  | 18.79 (0.64)                 | 18.9 (1.02)                |
| H                | Male| 20.5 (1.90)                   | 22.70 (1.90)                | 22.60 (1.90)                  | 22.70 (2.00)                  | 19.74 (1.09)                  | 22.10 (2.87)                  | 23.02 (1.19)                 | 20.7 (0.85)                |
|                  | Female| 20.9 (2.00)                  | 23.00 (1.80)                | 22.40 (1.90)                  | 22.40 (2.10)                  | 19.56 (0.98)                  | 22.66 (2.18)                  | 22.09 (1.52)                 | 20.7 (0.90)                |

Table 7, shows the mean ages varies according to the population and this present study shows the standard deviation of \( \pm 0.5 \) to \( \pm 1 \).

In the present study mineralization of maxillary third molar (28) was more advanced than mandibular third molar (18) and mandibular right third molar (48) and a statistical differences was observed in the stages C-H, no statistical differences was seen in mandibular left third molar (38), this is similar to the study reported by Yun Hoa Jung et al., [17] (significant only in maxillary 18 and 28), where Tonin L. O et al., [15] (significant for both maxilla and mandibular third molar) suggestive of a large number of maxillary third molars are in earlier stages of mineralization than the mandibular third molars. It is also observed that eruption of third molar occurs first in the maxillary followed by mandible, these differences because of geographical and ethnic variations.

The variation in Indians may be attributed to genetic, racial, socioeconomic, and maternal factors, which vary considerably between Indians and those from the rest of the world. As per the existing literature, Indians show a lower nutritional status as compared to westerners. This suggests that racial difference between the populations is the main factor underlying the variations in eruption timings stated by Priyadharshini et al., [18].

In the present study univariate, multiple regression analysis were performed for 18, 28, 38, 48, which showed the result of which is significant \( p < 0.05 \). Males showed earlier development than females and there were significant gender differences in stage D-H as shown in similar study in similar studies by Yung Hoa Jung, Tonin, Sisman, Sabitha Devi et al., [17, 15, 19, 21] in contrast lower mean age was observed by approximately 2 to 4 months than the corresponding pseudo mean age may be results of impact of inappropriately censored data in stage H by Teelana et al., [20]. This may be due to the difference of statistical processing. It is also observed that eruption of third molar occurs first in the maxillary followed by mandible, these differences because of geographical and ethnic variations as stated by priyadharshini et al., [18].

Thus we can conveniently conclude that stage C, D, E, and F have lower mean age than the corresponding stage H by Teelana et al. [22]. These results also agree with studies on other population highlighting the low reliability of this type of examination when used in isolation. There is no need to calculate the maturity scores in this regression process, mincer adopted Demirjian’s stages are used directly as variables, which makes the statistical process simpler with reduced possibility of statistical errors. Ethnicity could not be the sole factor to sufficiently explain this deviation. The difference might be brought about by the difference in age range, which was set between age 4 and 20 in both previous studies in contrast to age 16–22 in male and 16 and 24 in female subjects in this study.
Multiple Predictors

Because there is appreciable left-right asymmetry and since the maxillary and mandibular third molars often develop at different rates, it seemed likely that information from multiple teeth would give more accurate estimates of chronological age than any of the third molars taken singly. This was tested using multiple linear regression. The modal age of the tooth-specific data for each grade (Table-6) was assigned to each third molar in each case, and these four dental ages were used to predict chronological age. There was a modest improvement in the fit of the model when multiple teeth were used. Taken singly, third molars accounted for 40 to 59% in male and 42 to 57% in female in the upper arch, 47 to 52% in male and decreased from 52 to 47% in female in case of lower arch the two maxillary teeth yielded slightly higher correlations than the mandibular molars in these data.

CONCLUSION

Numerous reports have been published on the age estimation issue concerning adolescents and young adults in whom the assessment of third molar development was frequently investigated similar to the present study. Although the reliability of third molars in age estimation has been evaluated by several research groups, consensus on the usefulness of these teeth has not been reached. As concluded by Mincer et al in the A.B.F.O study, the examination of third molars may provide reasonable accuracy for the likelihood that a person is at least 18 years of age, instead of the estimation of exact chronological age. We could conclude that tooth development stage at “G or H” will definitely say that the individual is a major having completed 18 years of age. We could predict the age with the average standard deviation of 0.5 years. The regression analysis revealed a direct age estimation with a simpler and convenience form.

SUMMARY

In overview stage G, maxillary right and left third molar with mandibular right third molars are considerable variability in age prediction. It was concluded that the eight stage system was less prone to examiner error. Finally, we believe that, based on our results, and the differences between them and those of other populations, where in agreement with Mincer et al., [13] present study shows better accuracy. Nevertheless, this remains as an yet to be proven concept since there is no indication at all regarding the use of country-specific information influencing the percentage of correctly identified subject.

Acknowledgement: Nil

Ethical clearance: Taken from Ethical committee

Source of funding: Self

Conflict of Interest: Nil

ACKNOWLEDGEMENT

Dr. Roshan Chowdhary BDS, M.Sc for his kind support.

REFERENCES

1. Forensic Odontology: An Essential Guide, First Edition. Edited by Catherine Adams, Romina Carabott and Sam Evans, published in 2014.
2. Masthan, K. M. K. (2009). Age and sex. Textbook of forensic odontology. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd.
3. Kullman, L., Johanson, G., & Akesson, L. (1992). Root development of the lower third molar and its relation to chronological age. Swedish dental journal, 16(4), 161-167.
4. Brbic, H., Milicevic, M., & Petroveck, M. (2006). Age estimation methods using anthropological parameters on human teeth–(A0736). Forensic science international, 162(1-3), 13-16.
5. Acharya, A. B. (2011). Accuracy of predicting 18 years of age from mandibular third molar development in an Indian sample using Demirjian’s ten-stage criteria. International journal of legal medicine, 125(2), 227-233.
6. Albieri, R. J., & Araújo, F. G. (2010). Reproductive biology of the mullet Mugil liza (Teleostei: Mugilidae) in a tropical Brazilian bay. Zoologia (Curitiba), 27(3), 331-340.
7. Schour, I. (1941). The development of the human dentition. Journal of the American Dental Association, 28, 1153-1160.
8. Garn, S. M., Lewis, A. B., & Bonné, B. (1962). Third molar formation and its development course. The Angle Orthodontist, 32(4), 270-279.
9. Demirjian, A. (1973). Tooth eruption in the French Canadian child. Journal Dentaire du Quebec. 10(10): 9.
10. Demirjian, A., & Goldstein, H. (1976). New systems for dental maturity based on seven and four teeth. Annals of human biology, 3(5), 411-421.
11. Amarit, M. L., Restori, M., De, F. F., Paganelli, C., Faglia, R., & Legnani, G. (1999). Age determination by teeth examination: a comparison between different morphologic and quantitative analyses. Journal of clinical forensic medicine, 6(2), 85-89.
12. Martin-de las Heras, S., García-Fortea, P., Ortega, A., Zodocovich, S., & Valenzuela, A. (2008). Third molar development according to chronological age in populations from Spanish and Magrebian origin. Forensic science international, 174(1), 47-53.
13. Mincer, H. H., Harris, E. F., & Berryman, H. E. (1993). The ABFO study of third molar development and its use as an estimator of chronological age. Journal of Forensic Science, 38(2), 379-390.
14. Bai, Y., Mao, J., Zhu, S., & Wei, W. (2008). Third-molar development in relation to chronologic age in young adults of central China. *Journal of Huazhong University of Science and Technology [Medical Sciences]*, 28(4), 487-490.

15. Galo, R., Leite, N. P., de Oliveira Tonin, L., & Silva, R. H. A. (2016). Age estimation based on the stage of mineralization of third molars on orthopantomograms. *Bioscience Journal*, 32(3):805-812.

16. Panchbhail, A. S. (2012). Radiographic evaluation of developmental stages of third molar in relation to chronological age as applicability in forensic age estimation. *Dentistry*, 1(2), 1-7.

17. Jung, Y. H., & Cho, B. H. (2014). Radiographic evaluation of third molar development in 6- to 24-year-olds. *Imaging science in dentistry*, 44(3), 185-191.

18. Priyadharshini, K. I., Idiculla, J. J., Sivapathasundaram, B., Mohanbabu, V., Augustine, D., & Patil, S. (2015). Age estimation using development of third molars in South Indian population: A radiological study. *Journal of International Society of Preventive & Community Dentistry*, 5(Suppl 1), S32.

19. Sisman, Y., Uysal, T., Yagmur, F., & Ramoglu, S. I. (2007). Third-molar development in relation to chronologic age in Turkish children and young adults. *The Angle Orthodontist*, 77(6), 1040-1045.

20. Boonpitaksatith, T., Hunt, N., Roberts, G. J., Petrie, A., & Lucas, V. S. (2011). Dental age assessment of adolescents and emerging adults in United Kingdom Caucasians using censored data for stage H of third molar roots. *The European Journal of Orthodontics*, 33(5), 503-508.

21. Ramisetti Sabitha Devi, D. M., Rajsekar, B., Madhuriya, C., Bhardwaj, A., & Singh, S. (2017). Third molar as a diagnostic tool for age estimation in forensic odontology: An exploratory study. *Sch Acad J Biosci*. 5(5):337-340.

22. Solari, A. C., & Abramovitch, K. (2001). The accuracy and precision of third molar development as an indicator of chronological age in Hispanics. *Journal of Forensic Science*, 47(3), 531-535.

23. Qudeimat, M. A., & Behbehani, F. (2009). Dental age assessment for Kuwaiti children using Demirjian's method. *Annals of Human Biology*, 36(6), 695-704.

24. Olze, A., Taniguchi, M., Schmeling, A., Zhu, B. L., Yamada, Y., Maeda, H., & Geserick, G. (2003). Comparative study on the chronology of third molar mineralization in a Japanese and a German population. *Legal Medicine*, 5, S256-S260.

25. Olze, A., Schmeling, A., Taniguchi, M., Maeda, H., van Niekerk, P., Wernecke, K. D., & Geserick, G. (2004). Forensic age estimation in living subjects: the ethnic factor in wisdom tooth mineralization. *International Journal of Legal Medicine*, 118(3), 170-173.

26. Prieto, J. L., Barberia, E., Ortega, R., & Magaña, C. (2005). Evaluation of chronological age based on third molar development in the Spanish population. *International Journal of Legal Medicine*, 119(6), 349-354.