

# The accuracy of 15 – 25 years age estimation using panoramic radiograph with thevissen method in Indonesia

**D S Hidayati, H Suryonegoro\* and B N Makes**

Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Universitas Indonesia, Jakarta, Indonesia

\*E-mail: herusuryonegoro@yahoo.com

**Abstract.** Age estimation is important for individual identification. Root development of third molars occurs at age 15-25 years. This study was conducted to determine the accuracy of age estimation using the Thevissen method in Indonesia. The Thevissen method was applied to 100 panoramic radiographs of both male and female subjects. Reliability was tested by the Dahlberg formula and Cohen's Kappa test, and the significance measurement was tested by the paired t-test and the Wilcoxon test. The deviation of estimated age was then calculated. The deviation of age estimation was  $\pm 3.050$  years and  $\pm 2.067$  for male and female subjects, respectively. The deviation of age estimation of female subjects was less than male subject. Age estimation with the Thevissen method is preferred for age 15-22 years.

## 1. Introduction

Indonesia's geographical position at the tip of the three world plane movement of Eurasian, Indo-Australian, and Pacific cause Indonesia to be prone to disaster [1]. The 2009 Constitution about Health No. 36 provided a mandate to Indonesian government and society to make every effort to identify unidentified corpses in the wake of these disasters [2]. This kind of identification is also necessary in criminal and civil law, and the identification of living persons is necessary in cases of employment counterfeiting, marriage, child custody battles, immigration, or rape. Age verification is also an important legal tool for categorizing people as children or adults, as there are differences in legal and judicial processes for children and adults [3,4]. Because of the importance of identifying the age of the victims and the perpetrators of crime in forensics aspects, a method is needed to estimate age.

Skeletal and dental materials of disaster or crime victims are helpful in the age-determining process [5]. Teeth may last longer than other parts of the body after death; therefore, they give a better indication of age. This method can be used to assist in identifying living or dead individuals [6]. For years, the development of adult third molars has been observed in several population studies. This study compares the stages of root growth of third molars with the chronological age [7]. All permanent teeth other than third molars finish developing around age 15 or 16, and the position of the third molar does not change after age 25 [8,9]. One method for estimating age via evaluation of third molar development is the Thevissen method, which is based on the development of third molar roots. This method was first performed on the Thai population in 2009 [10,11]. Indonesia and Thailand have urban societies with similar socio-economic and cultural characteristics, although they differ on some key issues, one of which is nutrition-related problems [12]. In some studies, it is made clear that there



is a strong relationship between malnutrition and tooth formation [13]. Because Indonesia and Thailand might have different nutritional statuses, the purpose of this study is to find out whether the age estimation of 15 - 25 years using the Thevissen method can be applied in Indonesia.

## 2. Materials and Methods

This was a cross-sectional study. It was performed at the dental hospital at Faculty of Dentistry, Universitas Indonesia, between July and October 2015. A sample of panoramic radiographs from the medical records of 100 subjects (50 male and 50 female), ages 15-25, were examined on one side of the mouth. The independent variable was the Thevissen method and the dependent variable was the estimated ages. The tools used in this study were the research results form, UMAX© scanner PowerLook 1120 (maximum resolution 9600 dpi), an ASUS X401U Series laptop equipped with Adobe Photoshop cs 5.0 software, statistical analysis program, and panoramic radiographs. Intraobserver and interobserver reliability tests were performed using Technical Error of Measurement (TEM) and Cohen's Kappa test. Kolmogorov-Smirnov and Shapiro-Wilk tests were performed to determine the normality of data distribution. To see a significant difference between true chronological age and chronological age estimation, paired t-tests were used for normal data distribution, and the Wilcoxon test was used for abnormal data distribution [14].

## 3. Results and Discussion

### 3.1 Results

The subjects of this research were one hundred samples of panoramic radiographs of the right or left regions, as in the inclusion criteria. The sample consisted of 50 men and 50 women aged 15-25 years (table 1). To test the reliability of the two observers, the Technical Error Measurements and Cohen's Kappa coefficients was calculated (table 2). The Kappa values for third molars measurement are 0.815 and 0.868 for intraobserver reliability and interobserver reliability, respectively. Paired t-tests for normally distributed data and the Wilcoxon test for not normal distributed data were performed.

**Table 1.** Distribution of age and gender.

Age	Men	Women	Total
15	6	8	14
16	2	2	4
17	2	2	4
18	3	6	9
19	7	4	11
20	2	4	6
21	3	5	8
22	6	7	13
23	13	4	17
24	4	4	8
25	2	4	6
Total	50	50	100

**Table 2.** TEM value in intra- and interobserver reliability test to measure second and third molars

Test	Interpretation	TEM Value Measurement							
		Upper Jaw				Lower Jaw			
		M2 (mm)		M3 (mm)		M2 (mm)		M3 (mm)	
Lowest	Highest	Lowest	Highest	Lowest	Highest	Lowest	Highest		
Intraobserver Reliability	AI vs AII	0.035	0.530	0	0.919	0	0.954	0	0.742
Interobserver Reliability	AI vs BI	0	0.919	0	0.848	0	0.883	0	0.777

A = first observer, B = second observer, I = first observation, II = second observation

**Table 3.** Data results of paired t-test for chronologic age with age estimation of 15-25- and 15-22-year-olds

Paired T-Test	Mean	SD	CI 95%	p-value
CA_MW (25) vs AE_MW (25)	1.60360	2.64236	1.07930 – 2.12790	0.000
CA_M (25) vs AE_M (25)	2.27720	2.75655	1.49380 – 3.06060	0.000
CA_MW (22) vs AE_MW (22)	0.31507	1.96410	-0.15676 – 0.78690	0.187
CA_M (22) vs AE_M (22)	0.76806	2.26705	-0.06350 – 1.59963	0.069
CA_W (22) vs AE_W_(22)	-0.05447	1.61568	-0.58553 – 0.47659	0.836

(25): test on the sample until the age of 25; (22): test on the sample until the age of 22; CA: Chronological Age; AE: Age Estimation; M: Men; W: Woman

The results of the paired t-tests, as shown in Table 3, shows that there is a significant difference ( $p < 0.05$ ) between the chronological ages of men and women (MW) and the estimated ages of men and women (MW), as well as between the chronological ages of men (M) and the estimated ages of men (L) in the sample until the age of 25. In all samples of ages until to 22, t-test results showed that chronological age did not have a significant difference with age estimation ( $p > 0.05$ ). There is a significant difference between the chronological age of women and the estimated age of women in the sample for ages 15-25 years ( $p = 0.023$ ), using the Wilcoxon test. To compare the age estimation results between male and female subjects, a calculation of age deviations was made for the difference between estimated age and chronological age. The comparison of deviation estimation between male and female with the Thevissen method (chronological ages of 15-25 years old) showed that the deviation of estimated age for males is  $\pm 3.050$  years, while the deviation of estimated ages for females is  $\pm 2.067$  years.

### 3.2 Discussion

Because teeth remain intact after death for much longer than other parts of the body, they can be used in forensic cases to provide important information about age estimation. Some dental conditions that help estimate age are root resorption of deciduous teeth, eruption of teeth, tooth calcification levels, dental length, crown length, root length, root-pulp length, dental attrition, and aspartic acid ratio. Individual age categories were considered in the selection of age estimation methods [3]. In this study, the age category was 15-25 years old. The age estimation method used is based on the development of third molars, since growth of all permanent teeth has been completed after the age of 14 [11]. The objective of this study was to estimation age using panoramic radiographs with the Thevissen method. Panoramic radiographs are used because they can show the position of the third molars throughout the jaw, as well as because the comparison study in Thailand used panoramic radiographs. The Thevissen method is one of the ways to determine the estimation age based on the root length of the third molar. In the Thevissen method, the root length of the second molars and maxillary upper and lower jaw teeth

are measured. In a previous study in Thailand, consisting of 613 females and 586 males, no significant difference was shown between the development of right and left third molars, so that the samples could be selected from the right or left regions depending on the condition of second and third molars.

A multiple regression analysis resulted in a regression equation for predicting the dental age of men and women. In the regression equation for the Thailand population, the smallest standard deviation is calculated with the upper and lower regions. Nonetheless the equation used for the estimation age in this study requires measurements of the second and third molar roots of the upper and lower jaw [10]. The Dahlberg formula reliability test was performed along with the measurement of Technical Error of Measurements and Cohen's Kappa coefficients to measure intra- and interobserver reliability on all M3 measurement data. According to the Dahlberg formula, acceptable measurement tolerance (MT) values for bone and tooth measurements are  $\leq 1$  mm [15]. For both intra- and interobserver measurements, the TEM values for all MT  $\leq 1$  mm data were obtained. Kappa intraobserver reliability was valued at 0.815, while interobserver reliability was valued at 0.868. Both Kappa values indicate that the degree of agreement among the observers is very good [16]. Because the TEM value is 1 mm and the Kappa value is  $> 0.81$ , all the measurement data in this study can be interpreted as acceptable.

The result of the paired t-tests and Wilcoxon tests showed that there was a significant difference between chronological age and estimated age in 15-25-year-old. Furthermore, in this study, many samples over age 22 have no significant development of the third molar. The difference might also be caused due to the use of panoramic radiographs. Accuracy of tooth length measurements in panoramic radiographs depends on the patient's head position (incorrect position can cause distortion) and appropriate use of radiograph machine protocol [17]. The 15-22-year-old sample showed no significant difference between chronological age and age estimation. From the results of the t-test and Wilcoxon test, the use of the Thevissen method on subjects over 22 years old has a low level of accuracy. The researchers therefore concluded that age estimation using the Thevissen method is preferred until the age of 22.

A comparison of age estimation deviation for both males and females in the 15-25-year-old sample shows that women have a smaller deviation ( $\pm 2.067$  years) than men ( $\pm 3.050$  years). The comparison of deviation results showed different results than previous research on the Thevissen method, in which the deviation of male age estimation was smaller than deviation of female estimation [10]. This is because this research has more males over age 22, and there are variations in the sample from previous studies that affect the results of the calculations. In Indonesia, the legal ages law starts at the age of 18 years old [4]. Multiple methods are needed to identify individuals. Willems *et al.* concluded that the most important aspect of dental age estimation is the application of multiple techniques and the performance of repeated measurements and calculations in order to improve the reproducibility and reliability of the estimated age [18].

Several things affect age estimation via dental radiograph, a process that requires skill and accuracy in measurement. The biggest challenge in measuring radiographs with digital formats is determining the reference points on the radiographs when measurements are taken directly on the monitor. Previous study stated that the observer must make a decision about whether the reference point is at the beginning, middle, or end of the zone [19]. Viewing conditions are also important when interpreting radiographs. Research has shown that digital images may make it difficult for observers to interpret radiographic images. Several studies have reported that lighting conditions play an important role in influencing the interpretation of digital images. The study recommends reducing the intensity of light or installing curtains on laptop screens when interpreting radiograph images [20]. The weakness of these studies is the lack of samples in the form of panoramic radiographs and uneven distribution of sample ages (with many over age 22).

#### 4. Conclusion

Estimated age using panoramic radiographs and the Thevissen method yielded low accuracy in samples aged 15-25, while the estimation age in samples aged 15-22 showed better accuracy. The

Thevissen method is therefore preferred for an estimated age of 15-22. Further studies on the application of the Thevissen method on third molars using periapical radiographs, with a greater variety of samples and corresponding proportions in each age range in Indonesia are required. In addition, research is also needed to examine estimation ages above 22 years using other methods.

## References

- [1] Indonesia Negara Rawan Bencana 2011 [Internet] [Cited 2015 May 9] Available from: [http://www.bbc.co.uk/indonesia/berita\\_indonesia/2011/08/110810\\_indonesia\\_tsunami.shtml](http://www.bbc.co.uk/indonesia/berita_indonesia/2011/08/110810_indonesia_tsunami.shtml)
- [2] Henky S O 2012 Identifikasi korban bencana massal: praktik DVI antara teori dan kenyataan. Indonesian. *J. Leg. Forensic. Sci.* **2** 5-7.
- [3] Putri A S, Nehemia B and Soedarsono N 2013 Prakiraan usia individu melalui pemeriksaan gigi untuk kepentingan forensik kedokteran gigi. *J. PDGI.* **62** 55-63.
- [4] Republik Indonesia 2012 Undang-Undang Republik Indonesia Nomor 11 Tahun 2012 Tentang Sistem Peradilan Pidana Anak.
- [5] Vodanović M, Dumančić J, Galić I, *et al.* 2011 Age estimation in archaeological skeletal remains: evaluation of four non-destructive age calculation methods. *J. Forensic. Odontostomatol.* **29** 14-21.
- [6] Shamim T, Varghese V I, Shameena P M and Sudha S 2006 Age estimation: a dental approach. *JPAFMAT.* **6** 14-6.
- [7] Bowers C M 2011 *Forensic Dental Evidence: An Investigator's Handbook* 2nd Ed. (London: Elsevier) p 4.
- [8] Schmitt A, Cunha E and Pinheiro J 2006 *Forensic Anthropology and Medicine: Complementary Sciences From Recovery to Cause of Death.* (New Jersey : Humana Press) p 63-5.
- [9] Miloro M, Ghali G E, Larsen P E and Waite P D 2009 *Peterson's Principles of Oral and Maxillofacial Surgery* 2nd Ed. 1. (Ontario: BC Decker Inc) p 139-140.
- [10] Thevissen P W, Pittayapat P, Fieuws S and Willems G 2009 Estimating age of majority on third molars developmental stages in young adults from Thailand using a modified scoring technique. *J. Forensic Sci.* **54** 428-32.
- [11] Firdaus, Priaminiarti M and Puspitawati R 2013 Gigi molar tiga sebagai indikator prakiraan usia kronologis pada usia 14-22 tahun. *J. PDGI.* **62** 1-6.
- [12] Kasmini O W, Rahayu T, Budiono I, Hunnirun P, Tornee S and Hansakul A 2014 Modal sosial dan status gizi balita di daerah pedesaan di Indonesia dan Thailand. *J. Kes. Mas.* **10** 88-95.
- [13] Alvarez J O 1995 Nutrition, tooth development, and dental caries. *Am. J. Clin. Nutr.* **61** 410S-6S.
- [14] Dahlan M S 2009 *Statistik untuk Kedokteran dan Kesehatan: Deskriptif, Bivariat, dan Multivariat, Dilengkapi Aplikasi dengan Menggunakan SPSS* 4th ed. (Jakarta: Salemba Medika).
- [15] Wijayati A T 2011 *Ketepatan prakiraan usia dengan menerapkan metode Tooth Coronal Index pada radiograf periapikal* Theses Paper. (Jakarta: Universitas Indonesia) p 30-1.
- [16] Dahlan M S 2008 *Statistik untuk Kedokteran dan Kesehatan* 5th ed. (Jakarta: Salemba Medika).
- [17] Stramotas S, Geenty J P, Petocz P and Darendeliler M A 2002 Accuracy of linear and angular measurements on panoramic radiographs taken at various positions in vitro. *Euro. J. Orthod.* **24** 43-52.
- [18] Senn D R and Stimson P G 2010 *Forensic Dentistry* 2nd Ed. (Florida : CRC Press) p 281-3.
- [19] Talreja A P, Acharya A B and Naikmasur V G 2012 An assessment of the versatility of Kvaal's method of adult dental age estimation in Indians. *Arch. Oral. Biol.* **57** 277-84.

- [20] Kutcher M J, Kalathingal S, Ludlow J B, Abreu M and Platin E 2006 The effect of lightning conditions on caries interpretation with a laptop computer in a clinical setting. *Oral. Surg. Oral. Med. Oral. Pathol. Oral. Radiol. Endod.* **102** 537-43.