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Accuracy of Tooth Development as an Indicator of Dental Age Estimation for Children in Indonesia

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Abstract: Dental age estimation methods have been developed in such a way as to fulfill various requirements of medico-legal, law enforcement, and victim identification in mass disasters. This study aimed to evaluate the accuracy of the Willems dental age estimation method for children in Indonesia. The estimated dental age (EDA) was assessed using the Willems method by two examiners. The statistical analysis was carried out using IBM® SPSS® Statistics version 23.0 (IBM, Armonk, New York, USA). The results obtained 92 panoramic radiographs ranging in age from 8 to 14 years from the Departments of Forensic Odontology and Radiology, Universitas Airlangga, Surabaya, Indonesia. The average chronological age (CA) of the subjects in this study was 11.30±1.43 years for boys and 11.65±1.55 years for girls. The overall mean differences between the CA and the EDA for boys and girls were -0.08±0.76 and -0.31±0.97. In this study, the mean age difference was more significant in girls than in boys. The difference in growth spurt timing between boys and girls may explain the difference in dental maturation, as girls begin their pubertal growth spurt about two years earlier than boys. In general, girls' dental development begins and ends earlier than boys'. In conclusion, the dental age estimation method proposed by Willems can be applied to boys, as there is no significant statistical difference. However, when applying this method to girls, a thorough analysis may be required.

Keywords: chronological age; dental age; forensic odontology; human rights; justice

INTRODUCTION

Indonesia is a huge archipelagic country located in the ring of fire, which is prone to natural disasters. Because of its location, Indonesia is vulnerable to volcanic eruptions, earthquakes, floods, and tsunamis.¹ The National Board of Disaster Management (BNPB) reported that from January to December 2021, 5,402 disasters happened in Indonesia, with more than 700 people deaths and 14,915 injured.² With a population of over 250 million and a diversity of cultures and religions, an effective identification method will be required in the event of a mass disaster.³ Age estimation is one method for simplifying human identification by categorizing victims based on their estimated ages.

Age estimation, on the other hand, is required in law enforcement, immigration cases, sports competitions, and marriage.⁴⁻⁶

The usefulness of teeth in estimating an individual's age is widely acknowledged in forensic fields. Age estimation is important in many aspects of human life, including social and legal aspects, research, dental treatment planning, and forensic sciences.^{7,8} Many studies in forensic fields deal with the estimation of biological age in humans have been developed.⁹ The most common methods rely on skeletal indicators¹⁰ such as epiphyseal fusion,¹¹ hand-wrist bones,¹² sternoclavicular bones,¹³ cranial sutures fusion and dental maturation.¹⁴

According to the previous study, the

10 radiograph of the hand-wrist and dental development is the most reliable method for assessing the biological age of children and juveniles.¹⁵ Evaluation of tooth development is considered a reliable method for estimating ages, as maturational events associated with tooth formation are less variable, and mineralization of teeth is not affected by external factors, such as crowding, retention, or early extraction of deciduous teeth.¹⁶⁻¹⁸ On the other hand, socio-economic or malnutrition status may affect skeletal growth.¹⁹

3 A study by Willems, 2001, confirmed the significant overestimation of the dental age in Belgian Caucasians using the original methods by Demirjian. It was stated that there is a significant overestimation due to the different rates of tooth development in different populations.²⁰ Based on the this statement, we proposed to examine the accuracy of tooth development as an indicator for dental age estimation among children in Surabaya, Indonesia, using the Willems method.

22 METHODS

The present study was approved by the Health Research Ethical Clearance Commission of Faculty of Dental Medicine Universitas Airlangga (number: 523/HRECC.FODM/XI/2021). Panoramic radiographs were obtained from the Departments of Forensic Odontology and Dental Radiology, Faculty of Dental Medicine Universitas Airlangga. The data set included 92 panoramic radiographs of boys and girls ranging in age from 8 to 14 years. The panoramic radiographs were selected based on following inclusion criteria: panoramic radiographs of children aged 8 to 14 years old without any developmental disorder; good quality panoramic radiographs; and available date of birth and date of the radiographic recording.⁴⁵

The tooth development staging of the present study was based on the calcification stage by Demirjian, which was divided into eight stages (A-H). The scoring of each tooth development stage was calculated according to the Willems method. Seven mandibular teeth on the third quadrant were included in the staging and scoring process. In case of any missing tooth on the third quadrant, the

corresponding tooth on the opposite side is used as the substitute and scored.²⁰ The stage of each tooth development was then converted into scores by Willems and summed up to calculate the estimated dental age (EDA) of each subject. The staging and scoring process of tooth development was conducted by two examiners.

The statistical analysis was conducted using IBM® SPSS® Statistics version 23.0 (IBM, Armonk, New York, USA). The Shapiro-Wilk test was used to determine the normality of the data distribution. The difference between individual age groups was analyzed using the paired sample t-test.

7 RESULTS

Subjects of the present study consisted of 92 panoramic radiographs (42 boys and 50 girls, ranging from 8–14 years old). The descriptive analysis of the chronological age (CA) and estimated dental age (EDA) was demonstrated in Table 1. The average CA of boys was 11.30±1.43 years, whereas of girls was 11.65±1.55 years. The mean CA of the total subjects was 11.49±1.50 years.

EDA calculation using the Willems method shows that the mean age of boys was 11.21±1.30 years, and 11.34±1.63 years of girls. The overall mean difference between CA and EDA for boys and girls was -0.08±0.76 and -0.31±0.97. The mean age difference in boys was not significant in all age ranges. Whereas, in girls, the mean difference was significant in the range of 11–14 years, $p < 0.05$.

The Shapiro-Wilk test was done for each group to examine whether the data was normally distributed or not. The results of the Shapiro-Wilk test indicate that the data was normally distributed, $p > 0.05$. Subsequently, the difference between CA and EDA in boys and girls was analyzed using the paired t-test, $p > 0.05$ for boys and $p < 0.05$ for girls.

Further analysis was done by classifying the age groups as 8-10 and 11-14 years old. The descriptive analysis of each age group was shown in Table 2. Overestimation of age was observed in 8-10 year groups, both boys and girls, with no significant statistical difference. Underestimation of age was described

in 11-14 year groups, in both sexes. Nevertheless, the underestimation of age was significant in girls, $p < 0.05$.

DISCUSSION

Estimation of a person's age is one of the important aspects of human identification.²¹ Through the dental age estimation, the identification of the suspected victim can be limited to the estimated ages.²² In this study, the accuracy of tooth development as an indicator of dental age estimation using the Willems method was evaluated. The study involved Indonesian children, which was classified as the Mongoloid race, whereas, the original Willems method was conducted in Belgian Caucasian population.²⁰

The previous study by Olze et al²³ examined the various methods of dental development staging and discovered that the Demirjian method could accurately define chronological age. However, another study found that Willems' modification of the Demirjian method was more accurate in estimating age and had been tested in different populations.^{24,25} Because of its accuracy, the Willems method was considered for use in the Indonesian children population, and there was no established dental age estimation method for the Indonesian children population.^{20,26-28}

Previous research by Ismail et al²⁹ in

Malay children (also classified as Mongoloid race) found that the Willems method was overestimated in the 5 and 15 year age groups and underestimated in the 10 year age group in both sexes, with no significant statistical difference. Unlike the previous study in Malay children, there was an underestimation of age in both boys and girls in the current study, with 11.21 (CA=11.30) and 11.34 (CA=11.65), respectively. The mean age difference between boys and girls was calculated using the independent sample t-test, with $p > 0.05$. A more detailed statistical analysis revealed that there was no significant difference between CA and EDA in boys ($p > 0.05$), but there was in girls ($p < 0.05$).

The fact that the mean age difference was greater in the girls may be due to differences in dental maturation between boys and girls. Girls experience the growth spurts phase earlier than boys. Moreover, girls go through growth spurts when they are young, between the ages of 6 and 7, and between the ages of 12 and 14. Some literature discussed that the mean difference of the onset of a pubertal growth spurt in boys and girls is about two years earlier for girls.^{30,31}

According to Nolla,³² there were significant differences in the distribution of tooth calcification and mineralization between the sexes. In general, girls start and finish their dental development before boys.^{32,33}

Table 1. Descriptive analysis of CA and EDA (in years)

Groups	Distribution	Chronological age (CA)		Estimated dental age (EDA)	
		Mean	SD	Mean	SD
Boys	42	11.30	1.43	11.21	1.30
Girls	50	11.65	1.55	11.34	1.63
Total	92	11.49	1.50	11.28	1.48

Table 2. Mean age difference between CA and EDA based on age groups (in years)

Age group (years)	Age difference					
	Boys			Girls		
	Mean	SD	Remarks	Mean	SD	Remarks
8-10	0.21	0.76	Overestimation	0.07	0.96	Overestimation
11-14	-0.25	0.73	Underestimation	-0.48*	0.98	Underestimation*

*significant difference

Routine radiographs for dental treatment, such as panoramic and periapical, may be used as evidence in the forensic fields. Estimating dental age in children can be accomplished by defining tooth calcification and mineralization. For further consideration and investigation of the dental age estimation, some combined methods, such as hand-wrist radiographs, may be required.

CONCLUSION

In this study, dental age estimation method proposed by Willems can be applied to boys, as there was no significant statistical difference. However, when applying this method to girls, a thorough analysis may be required. More research with larger sample sizes will be required to confirm the reliability of the Willems method in Indonesia.

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Conflict of Interest

The authors have no conflicts of interest to declare.

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