

# Radiographic evaluation of third molar development in relation to chronological age among Turkish children and youth

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## Abstract

A sharp increase in forensic age estimation of living persons has been observed in recent years. However, ethnic populations residing in different countries have been insufficiently analyzed. According to 2004 data compiled by the Essen-based Turkey Research Center, there are 3.8 million Turkish people living abroad, and 3.2 million of them reside in European Union countries. Despite the high number of Turks living abroad, little is known about third-molar development for forensic application in this population. Hence, it was considered worthwhile to determine the developmental stages of the third molar in a group of Turkish population, to assess chronological age estimation based on the developmental stages, and to compare third molar development according to sex, age and location. Orthopantomograms of 1134 Turkish patients, ages 4–20 years were examined and third-molar developmental stages were evaluated based on Demirjian's classifications. Orthopantomograms were scored by two different observers, and Wilcoxon matched-pairs signed-ranks test used to test intra- and inter-observer reliability revealed a strong agreement between both intra- and inter-observer measurements. Linear regression analysis was performed to correlate third-molar development and chronological age, and further statistical analysis was performed to determine the relation between sex, age and location. Results showed a strong linear correlation between age and molar development (males:  $r^2 = 0.57$ ; females:  $r^2 = 0.56$ ). Mineralizations of left and right third molars were compared using Wilcoxon tests, and no statistical differences were found. No significant differences were found in third-molar development between males and females. Mandibular third molar crypt formation was observed in 2.4% of patients at age seven and maxillary third molar crypt formation was observed in 1.3% of patients at age seven. A strong correlation was found between third-molar development and chronological age. Among the Turkish population, third molar crypt formation is observable at as early as 7 years in both the mandible and maxilla. Anagenesis can be determined conclusively if no radiolucent bud is present by age 14.

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## 1. Introduction

Forensic age estimation is one of the key research areas in the field of forensic medicine [1–18]. In general, morphological and radiological examinations of third molars comprise part of orthodontic, pedodontic and oral surgical treatments, providing clinicians with valuable information [3,10,12,13,19]. From a forensic odontologic perspective, sufficiently precise and reliable determination of age using third-molar mineralization is crucially important because it has been one of the parameters proposed to aid in determining the age

of unidentified cadavers and human remains as well as the age of living persons for purposes of differentiation between juvenile and adult status in criminal law cases [2–7,11] to determine whether a suspect without valid identification documents has reached the age of criminal responsibility and whether general criminal law in force for adults is to be applied. In many European countries, the legally relevant age thresholds range from 14 to 18 years of age [20].

Since the early 1960s there has been a continuous migration of Turkish citizens to EU countries, especially Germany. In recent years, economic globalization and European integration have led to an increase in cross-border migration [21]. As a result, the Turkish population abroad increased from 600,000 in 1972 to 3,800,000 million in 2004 [22]. Moreover, studies have predicted a continuing flow

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Table 1  
Distribution of age and sex in the study population

Age (years)	Male	Female	Total
4	24	15	39
5	21	15	36
6	19	21	40
7	41	29	70
8	35	39	74
9	45	45	90
10	57	51	108
11	33	43	76
12	46	53	99
13	37	57	94
14	43	52	95
15	40	31	71
16	23	45	68
17	13	30	43
18	7	21	28
19	13	22	35
20	27	41	68
Total	524	610	1134

of between 1.3 and 2.7 million migrants from Turkey to various countries, especially those within the EU, up until 2030 [23,24]. Despite the high number of Turks living abroad, little is known about third-molar development of the Turkish population that would have forensic application in aiding in the determination of maturity parameter variations applicable to this population. Hence, it was considered worthwhile to determine third-molar developmental stages in a Turkish sample population, to assess chronological age estimation based on developmental stages and to compare third-molar development by sex, age and location.

## 2. Material and methods

In this retrospective study, orthopantomograms of 1134 Turkish Caucasian individuals with known chronological age and gender were selected. Of these, 524 were male and

610 were female, and their ages ranged from 4 to 20 years. Both parents of all the subjects were of Turkish Caucasian origin and had Turkish nationality. The radiographs used were taken from patient files of the Faculty of Dentistry, Department of Oral Diagnosis and Radiology of the Ankara University, Ankara, Turkey for the period from 1996 to 2005. Table 1 shows the distribution of orthopantomograms by gender and age. The criteria for inclusion in the sample were the availability in their clinical records of an orthopantomography of adequate quality, and no history of medical or surgical disease that could affect the presence and development of third molars. Exclusion criteria were; image deformity affecting third molar visualization, orthopantomograms showing obvious dental pathology. Radiographs meeting these selection criteria were evaluated using the formation stages described by Demirjian et al. (from Stages “A” to “H”) [18] with two modifications. Stage 0 was indicating the case of absence and Stage 1 was indicating the radiolucent bud, prior to calcification (Fig. 1). Radiographs of adequate quality were evaluated using a magnifying glass on a standard viewing box in a darkened room for improved visualization. The scores were determined by two observers (an oral and maxillofacial radiologist and a pediatric dentist) who had previously not established agreement concerning reference orthopantomographs on the classification of the teeth. Thus, individual differences in the examination were included intentionally in order to evaluate the variation between independent observers.

To assess reliability, 100 randomly selected radiographs were re-examined 2 months after the initial examination by the same observers, and inter- and intra-observer agreement was determined using the Wilcoxon matched-pairs signed-ranks test. Statistical analysis was performed using the Mann–Whitney *U*-test and Wilcoxon test between gender, location and age. Multiple regression analysis was performed to determine the relation between tooth development and chronological age. Statistical analysis was performed using the SPSS 11.0 package (SPSS Inc., Chicago, IL) for Windows.

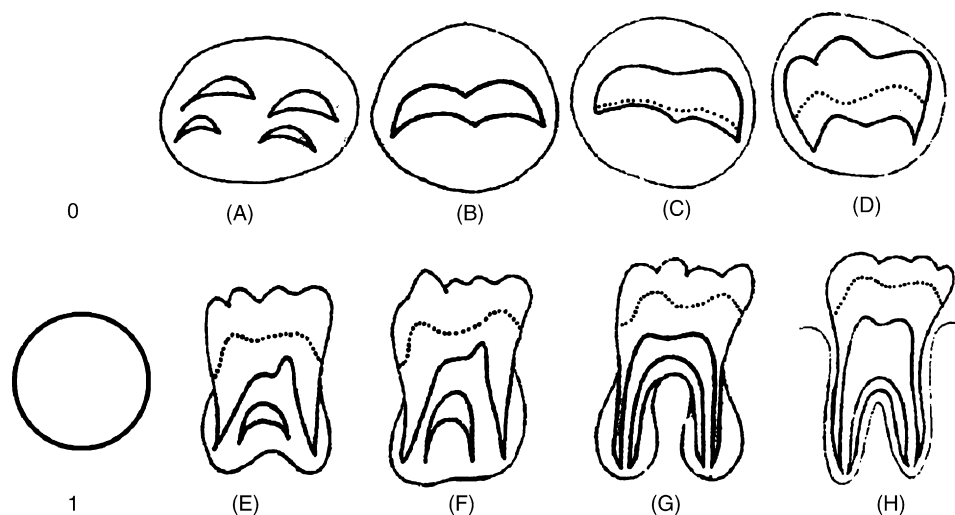


Fig. 1. Schematic drawings of the developmental stages of third molars (modified from Demirjian et al. [34]).

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