Forensic Science International 259 (2016) 155–160

Contents lists available at ScienceDirect

Forensic Science International

journal homepage: www.elsevier.com/locate/forsciint

Secular trend in the maturation of permanent teeth in a sample of Turkish children over the past 30 years

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ARTICLE INFO

Article history:
Received 4 August 2015
Received in revised form 15 November 2015
Accepted 2 December 2015
Available online 31 December 2015

Keywords:
Dental maturity
Age estimation
Population differences
Positive secular trend
Turkish children

ABSTRACT

This study was performed to evaluate the influence of secular trends on dental maturation among Turkish children over the past 30 years.

Orthopantomograms of 757 (385 boys, 372 girls) Turkish children born in the 1980s, 1990s, and 2000s were evaluated. Three groups were formed based on decade with five subgroups by age from 9 to 13 years old for each gender. The number of samples in each age group and gender were matched. The mandibular left seven permanent teeth were evaluated based on formation stage to determine the overall dental maturity score. The groups were compared based on decade and gender. The Bonferroni-corrected Mann–Whitney U test and Kruskal–Wallis tests were used for statistical evaluation.

Among 11-, 12-, and 13-year-olds born in the 2000s, girls exhibited significantly more mature dentition than did boys ($p < 0.01$, $p < 0.05$, and $p < 0.05$, respectively). Twelve-year-old girls born in the 1990s and 2000s exhibited significantly more mature dentition than did girls born in the 1980s ($p < 0.01$).

Girls generally exhibited more mature dentition than boys. No significant positive secular trends in dental maturity were observed from the 1980s through the 2000s. Dental maturation among Turkish children was not affected by a secular trend.

1. Introduction

Determining dental maturity is important for diagnosis and treatment planning in both paediatric dentistry and orthodontics. In addition to determining child's growth and developmental status, dental maturity is one of the most reliable indicators of chronological age in estimation methods used for criminal, forensic and anthropologic purposes [1–3].

However, dental maturation patterns of children at similar ages in different ethnic groups may differ, which may affect the dental age estimate accuracy [2–7]. Populations in specific geographic regions may exhibit biological differences due to different gene pools, differences in living conditions, climate, socioeconomic status, nutrition and secular changes, which scholars claim are important explanatory factors for the population differences in dental development timing [7–12]. Additionally, the differences in dental age estimates between populations may also be derived from a methodological bias [13–15].

Dental age not only varies across several ethnic populations but may also vary across different regions in the same country [4,12,16,17], which supports establishing population- or geographic-specific tables for determining dental age [4,6,8,18].

Recent researches show that dental age assessment quality does not predominantly depend on using geographic-specific standards [14,19–21]. Researchers have mentioned a marked level of normal biological variation between individual children in dental development timing among different populations, and likely only a small amount of the variation can be explained by genetic influences [8].

From another perspective, Liversidge et al. [13] mentioned that a positive secular trend during the last 25 years may partially explain the dental age overestimation by Demirjian's method recently found in different populations. In support, other scholars have also mentioned a secular trend [7,8,10,11,22–24].

Although secular trends in human growth based on physical, sexual, and skeletal maturity have been well-documented in the literature [1,25–28], few reports have focused on dental maturity [4,8,22]. Studies involving longitudinal observations of growth and maturational parameters indicate positive secular trends towards

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http://dx.doi.org/10.1016/j.forsciint.2015.12.031
0379-0738/

increasing height and earlier maturation accompanied by a declining menarche age in many populations, especially in developing countries [27,28]. However, whether a population exhibits a secular trend in dental maturity is crucial. The literature includes conflicting reports [5–7]. Certain authors [29–32] have reported low or insignificant correlations between skeletal and dental maturation. These authors have concluded that the level of tooth formation is predominantly determined by genetics and is, therefore, less variable and affected by environmental factors than other growth systems. Other scholars have noted that dental growth is not a steady and uniform process but is associated with peripubertal growth fluctuations [2], nutrition [1], living standards, climate [12], and disease [33]. In support, certain researchers have reported that dental development and age also follow secular trends and that teeth mature at an earlier chronological age than several decades ago [2,3,13,34].

The effect of a positive secular trend that is perceived as faster tooth development should be considered when estimating dental age using various methods [4,8,35]. Correcting for a secular trend is significant for forensics, particularly if the subject for which a dental age estimate is necessary is from a lower socioeconomic status in a developing country, and the reference standard used was developed using an affluent segment of more developed nations [8]. The influence of a secular trend in predicting chronological age from dental maturity/dental age increases prediction precision [4], especially in judicial processes that require high scientific quality in odontological judgement [36].

Secular trends may be reversible, are not universal, and exhibit ethnic and geographic differences [37]. To our knowledge, the literature does not include a study on secular trends in dental maturation among Turkish children from the past 30 years. No evaluations have been performed to clarify whether the teeth of current children mature earlier than children from the past two decades. Therefore, this study was undertaken to compare variations in dental maturation among 9- to 13-year-old Turkish children born in the 1980s, 1990s, and 2000s. We hypothesize that children from these different decades do not exhibit differences in dental maturity.

2. Materials and methods

Ethical approval was provided by the Ethics Committee of Gazi University for this study (77082166-604.01.02).

Good quality pre-treatment orthopantomograms of 757 Turkish orthodontic patients born in the 1980s (126 boys, 125 girls), 1990s (132 boys, 123 girls), and 2000s (127 boys, 124 girls) were examined. All children were Caucasian and met the following additional selection criteria: no serious illness affecting tooth growth and development; no impacted, congenitally missing, or transposed teeth; no previous history of trauma or injury to the face; no extraction of permanent teeth; and no cleft lip and/or palate. The patients were from the middle socioeconomic class.

Three groups were formed based on decade, Group 1 (1980s), Group 2 (1990s), and Group 3 (2000s), with five age subgroups from 9 to 13 for each gender. The number of samples in each age group and both genders were matched.

The subjects' chronological ages were calculated by subtracting the date of the panoramic radiograph from the date of birth after converting both to a decimal age. All assessments were performed in a darkened room with a radiographic illuminator to ensure enhanced contrast of the tooth images. One experienced orthodontist without prior knowledge of the children's age, gender, or decade evaluated the dental maturity of the mandibular left seven permanent teeth based on the formation stages (''A'' through ''H'') as described by Demirjian et al. [38] (Table 1). The stage for each of the seven mandibular teeth was allocated a biologically weighted score that differed according to the sex of the individual, and the sum of the scores provided an estimate of dental maturity, which was measured on a scale from 0 to 100 [38].

2.1. Statistical analysis

Although a sample size of 10 patients per group at $\alpha = 0.05$ yields a statistical power close to 0.80 for this study, the sample size was increased to more than 20 patients for all age groups in each gender.

All statistical analyses were performed using the SPSS 20.0 program (IBM Corp., Armonk, New York, USA). To test the reproducibility of the dental development stage assessments, the same investigator re-evaluated 50 randomly selected panoramic radiographs 2 weeks after the first evaluation. Cohen kappa coefficients were used to assess intra-observer reliability and ranged between 0.89 and 0.97.

A data normality test was performed using the Komogorov–Smirnov test. As the test results showed a non-normal distribution, the nonparametric tests Mann–Whitney U and Bonferroni-corrected Kruskal–Wallis tests were used for statistical analyses. The values are expressed as the mean and standard error, median and minimum, maximum values. A p value of <0.05 was considered statistically significant.

3. Results

The distribution of girls and boys in different age groups and decades as well as the dental maturity scores with statistical comparisons are shown in Table 1 and Figs. 1 and 2.

In general, girls showed more advanced dental maturation than boys in all age groups and decades. However, 11-, 12- and 13-year-old girls born in the 2000s exhibited significantly more advanced dental maturation than boys born in the same decade ($p < 0.01$, $p < 0.05$, and $p < 0.05$, respectively).

Significant differences were found in dental maturation between 12-year-old girls born in the 1980s versus the 1990s and 2000s ($p < 0.01$).

4. Discussion

This study was performed to detect a secular trend in dental development among Turkish children over the past 30 years. Therefore, we separately evaluated dental maturity in the 1980s, 1990s, and 2000s. No previous study has compared these three decades separately. Evaluating the influence of a secular trend on the dental maturity of the Turkish population before deviating specific data for the Turkish population is advantageous.

We preferred to measure dental maturity in this study by assessing the tooth formation stage rather than tooth eruption [34,36]. Dental eruption is influenced by environmental factors [26] and various local factors, including local infection, crowding, extractions, ankylosis, ectopic positioning, and primary teeth persistence [39]. Tooth formation stages are less affected by local factors and provide a more reliable indicator of dental maturation [40]. In addition, we can assess the dental maturity stage over a broader age range using radiographs.

In this study, we used the Demirjian method to estimate the dental maturity stage; nowadays, it is one of the most widely used methods, and its reliability and reproducibility have been confirmed by several studies [3,6,7,41,42]. Many studies have evaluated the accuracy and applicability of this method in determining dental age in different racial and ethnic groups [6–8,41,43]. When the Demirjian data set was used for different populations, it mostly overestimated the age rather than underestimated it [4], which means that the subjects studied