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Comparison of the applicability of Demirjian and Willems methods for dental age estimation in children from the Thrace region, Turkey

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ABSTRACT

Objectives: Dental age (DA) estimation is frequently used in the fields of orthodontics, paediatric dentistry and forensic science. DA estimation methods use radiology, and are reliable and non-destructive according to the literature. The Demirjian method is currently the most frequently used method, but recently, the Willems method was reported to have given results that were more accurate for some regions. The aim of this study was to detect and compare the accuracy of DA estimation methods for children and adolescents from the Thrace region, Turkey. The mean difference between the chronological age (CA) and the DA was selected as the primary outcome measure, and the difference range according to sex and age group was selected as the secondary outcome.

Materials and methods: Panoramic radiographs (n = 766) from a Thrace region population (380 males and 386 females) ranging in age from 6 to 14.99 years old were evaluated. DA was calculated using both the Demirjian and the Willems methods.

Results: The mean CA of the subjects was 11.39 ± 2.34 years (males = 11.08 ± 2.42 years and females = 11.70 ± 2.23 years). The mean difference values between the CA and the DA (CA–DA) using the Demirjian method and the Willems method were −0.87 and −0.17 for females, respectively, and −1.04 and −0.40 for males, respectively. For the different age groups, the differences between the CA and the DA calculated using the Demirjian method (CA–DA) ranged from −0.53 to −1.46 years for males and from −0.19 to −1.20 years for females, while the mean differences between the CA and the DA calculated by the Willems method (CA–DA) ranged from −0.19 to −0.50 years for males and from 0.20 to −0.49 years for females.

Conclusion: The results suggest that the Willems method produced more accurate results for almost all age groups of both sexes, and it is better suited for children from the Thrace region of Turkey, than the Demirjian method.

1. Introduction

Dental age (DA) estimation is an essential step for legally identifying a person. DA estimation is mostly used to assess the age of unidentified dead people and to assess the age of living people for legal reasons [1,2].

In underdeveloped countries and underdeveloped states in Turkey, age-related legal problems are commonly encountered. In terms of Turkish criminal law relating to children, the ages of 12 and 15 years are critical limits. Several Turkish laws are age-dependent, such as criminal responsibility, legal capacity and mental strength. Age is also accepted as a requisite to attend school, enter the civil service, obtain a driver's license and to retire, and it is of vital importance in recruitment and forensic medicine [3,4].

Currently, various age-estimation methods use general physical examinations, evaluations of left-hand radiographs and dental evaluations [5]. Age estimation using an evaluation of tooth development from radiographic images is a more certain method because tooth development is fundamentally influenced by genetics and is less affected by environmental and nutritional factors compared to skeletal and physical development [6].

Currently, the Demirjian method is the most commonly used radiological method, based on the anatomical shape of the teeth, and it provides very good intra- and inter-examiner agreement. These stages of Demirjian method and some intermediate stages enable better reproducibility [1,2]. The Demirjian method was developed by Demirjian et al. [7] using data from French-Canadian

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Table 1
Distribution of subjects by age and sex.

Sex Age	Female	Male	Total
6–6.99	14	28	42
7–7.99	16	30	46
8–8.99	27	30	57
9–9.99	29	30	59
10–10.99	51	53	104
11–11.99	46	49	95
12–12.99	69	63	132
13–13.99	71	52	123
14–14.99	63	45	108
Total	386	380	766

children, but consequent studies that used the Demirjian method for subjects from different regions and with different ethnicities found some inaccuracies; the Demirjian method has a tendency to overestimate age [8]. With the aim of reducing the error rates of the Demirjian method, Willems [4] modified the Demirjian method's scoring system by creating new tables. This modified method has been used for studies of various populations and has been reported to give more accurate estimations than the original Demirjian method [9–11].

The aim of this study was to compare and assess the accuracy of the two dental-age estimation methods (the Demirjian method and the Willems method) in children from the Thrace region, Turkey.

2. Materials and methods

2.1. Sample

The sample was derived from a database from the Paediatrics Dentistry Department, Trakya University. Ethical approval (decision number: 06/26) was provided by the ethics committee of the Medical Faculty of the Trakya University.

Digital panoramic radiographs of 766 Turkish children and adolescents (386 females and 380 males) aged between 6 and 14.99 years were evaluated. These data were divided into 10 age groups by year of age (Table 1).

The inclusion criteria were:

- Patients aged between 6 and 14.99 years old.
- Panoramic radiographs of sufficient quality.
- Patients with normal eruption of teeth and no pathological conditions relevant to the jaw bone.
- Patients with no systemic diseases.

The exclusion criteria were:

- Patients with congenital anomalies.
- Patients with a history of previous orthodontic treatment, dental anomalies, missing lower teeth (except the third molar) and any pathological condition relevant to the jaw bone, such as cysts or tumours.
- Patients with systemic disease or a history of dental trauma.
- Panoramic radiographs of insufficient quality.

Table 2
Differences between mean chronologic age (CA) and calculated dental age (DA) using the Demirjian method, and *p*-values of the differences for different age groups for males and females.

Age	Sex	Mean (SD)			*P* Value (CA–DDA)			*P* Value
		Chronological age	Demirjian's dental age (DDA)	Age difference (CA–DDA)		Willems' dental age (WDA)	Age difference (CA–WDA)	(CA–WDA)
6–6.99	F	6.63 (0.25)	7.20 (0.37)	−0.57 (0.33)	<0.001	6.54 (0.53)	0.09 (0.50)	0.490
	M	6.58 (0.27)	7.49 (0.22)	−0.92 (0.35)	<0.001	6.90 (0.43)	−0.32 (0.49)	0.002
7–7.99	F	7.64 (0.25)	7.83 (0.46)	−0.19 (0.41)	0.085	7.51 (0.64)	0.13 (0.57)	0.376
	M	7.52 (0.30)	8.05 (0.54)	−0.53 (0.56)	<0.001	7.83 (0.64)	−0.31 (0.64)	0.013
8–8.99	F	8.52 (0.27)	8.72 (0.72)	−0.20 (0.64)	0.125	8.32 (0.77)	0.20 (0.68)	0.133
	M	8.46 (0.25)	9.18 (0.75)	−0.72 (0.62)	<0.001	8.95 (0.67)	−0.50 (0.55)	<0.001
9–9.99	F	9.46 (0.32)	10.12 (0.93)	−0.66 (0.85)	<0.001	9.35 (0.65)	0.11 (0.61)	0.358
	M	9.50 (0.30)	10.44 (0.63)	−0.94 (0.58)	<0.001	9.88 (0.45)	−0.38 (0.48)	<0.001
10–10.99	F	10.45 (0.30)	11.35 (0.82)	−0.90 (0.73)	<0.001	10.41 (0.85)	0.05 (0.75)	0.639
	M	10.62 (0.28)	11.40 (0.76)	−0.79 (0.75)	<0.001	10.80 (0.80)	−0.19 (0.79)	0.094
11–11.99	F	11.54 (0.28)	12.32 (1.30)	−0.77 (1.24)	<0.001	11.47 (1.27)	0.07 (1.20)	0.700
	M	11.47 (0.30)	12.36 (1.09)	−0.89 (1.08)	<0.001	11.81 (0.93)	−0.34 (0.93)	0.013
12–12.99	F	12.47 (0.30)	13.68 (1.02)	−1.20 (0.95)	<0.001	12.81 (1.17)	−0.34 (1.11)	0.013
	M	12.45 (0.29)	13.80 (1.34)	−1.35 (1.29)	<0.001	12.94 (1.04)	−0.50 (1.02)	<0.001
13–13.99	F	13.51 (0.27)	14.66 (0.89)	−1.16 (0.84)	<0.001	13.99 (1.17)	−0.49 (1.11)	<0.001
	M	13.46 (0.27)	14.92 (1.29)	−1.46 (1.23)	<0.001	13.94 (1.13)	−0.49 (1.08)	0.002
14–14.99	F	14.47 (0.29)	15.32 (0.86)	−0.84 (0.87)	<0.001	14.88 (1.14)	−0.40 (1.13)	0.007
	M	14.50 (0.29)	15.76 (0.47)	−1.26 (0.47)	<0.001	15.07 (0.94)	−0.58 (0.90)	<0.001
All ages included 7–14.99	F	11.70 (2.23)	12.57 (2.60)	−0.87 (0.92)	<0.001	11.87 (2.65)	−0.17 (1.02)	0.001
	M	11.08 (2.42)	12.12 (2.80)	−1.04 (0.95)	<0.001	11.48 (2.61)	−0.40 (0.85)	<0.001