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Badanie zależności dojrzewania dla wieku chronologicznego, zębowego i szkieletowego w odniesieniu od aktywności fizycznej

Investigation of the relationship of chronological, dental and skeletal age maturation according to physical activity

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Wkład autorów: A Plan badań B Zbieranie danych C Analiza statystyczna D Interpretacja danych E Redagowanie pracy F Wyszukiwanie piśmiennictwa

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Streszczenie

Wiek zębowy jest powszechnie stosowany jako potencjalny predyktor dojrzewania układu szkieletowego. Wyrzynanie zębów może być oceniane na podstawie wymiany zębów mlecznych lub etapów rozwoju zębów. **Cel.** Celem niniejszego badania jest ocena zależności w odniesieniu do wieku chronologicznego, wieku zębowego i wieku szkieletowego w grupie sportowców wyczynowych i dzieci nieuprawiających sportu. **Materiał i metody.** Badanie przeprowadzono z wykorzystaniem pantomogramów i zdjęć radiologicznych nadgarstka w grupie 100 osób w wieku od 12 do 17 lat. W badaniu wzięło udział 50 osób uprawiających sport oraz 50 osób,

Abstract

Dental age is widely used as a potential predictor of skeletal maturation. The eruption of teeth can be evaluated by the change of deciduous teeth or the stages of development of the teeth. **Aim.** The aim of this study is to evaluate the relationship of performance athletes with children who do not play sports in terms of chronological age, dental age and skeletal age. **Material and methods.** This study was conducted using panoramic and wrist radiographs on a total of 100 people whose ages ranged between 12 and 17. 50 individuals who do sports and those who do not participated in the study. Dental age of all individuals was calculated

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które go nie uprawiają. Wiek zębowy wszystkich osób obliczono według metody Demirjiana, a wiek szkieletowy według metody Fishmana. W odniesieniu do danych, zmienne zbadano analizą chi-kwadrat i stwierdzono, że istnieje istotna różnica, jeśli p wynosi <0,05. **Wyniki.** Nie stwierdzono różnicy w porównaniu wieku zębowego i chronologicznego dla płci męskiej i żeńskiej (p > 0,05). Istnieje dodatnia korelacja pomiędzy wiekiem chronologicznym a wiekiem szkieletowym, wiekiem zębowym a wiekiem szkieletowym dla obu płci. **Wniosek.** W niniejszym badaniu nie wykazano, aby istniała zależność pomiędzy wiekiem chronologicznym sportowców a metodami oceny zarówno uzębienia, jak i układu szkieletowego. **(Sadry S, Duran B. Badanie zależności dojrzewania dla wieku chronologicznego, zębowego i szkieletowego w odniesieniu od aktywności fizycznej. Forum Ortod 2021; 17 (1): 20-6).**

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Słowa kluczowe: Aktywność fizyczna; pantomogram; wiek kręgowy, wiek kostny, wiek chronologiczny

according to the Demirjian method was used for dental age determination and Fishman method was used for skeletal age determination. In the data, variables was examined by Chi-Square analysis, and it was stated that there was a significant difference if p <0.05. **Results.** There was no difference in the comparison of dental age and chronological age in both sex groups (p> 0.05). There is a positive correlation between chronological age and skeletal age, dental age dental age and skeletal age in both sex groups. **Conclusion.** In this study, it does not show that there is a relationship between chronological age of sports and evaluation methods of both dental and skeletal structure. **(Sadry S, Duran B. Investigation of the relationship of chronological, dental and skeletal age maturation according to physical activity. Orthod Forum 2021; 17 (1): 20-6).**

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Key words: Physical activity; Panoramic radiograph; Vertebral Age, Bone Age, Chronological Age

Introduction

Age is defined as the time that an organism or individual survives after birth. When examining the maturation status of individuals, it is based on somatic factors and "biological age" based on gender and dental and skeletal maturity evaluation (1). In order to make orthodontic diagnosis and appropriate treatment plan, it is important to know and evaluate the growth and development (2). Radiographic images are one of the most basic methods that are frequently used for both evaluation of anatomical structures and determination of dental ages (3). In sexual maturity, criteria such as chronological age, dental development, height increase, onset of menstrual cycle, changes in sound, and wrist measurements are used to define development levels (4). The most commonly used method in the evaluation of bone age, the main indicator of skeletal development, is hand-wrist radiography. The bones of the wrists or finger bones are evaluated using the standards in the Greulich-Pyle (5) and Tanner-Whitehouse (6) atlases. Hand-wrist radiographs have been the most studied and standardized skeletal age assessment method by enabling the examination of consecutive stages of skeletal development (7). Fishman had developed a system based on skeletal maturation indicators used to assess pubertal growth spurt in hand-wrist radiographs. This system provides a methodological approach to identify specific skeletal maturation stages covering the entire adolescence. In this method, the developmental stages of eleven different anatomical regions including radius and sesamoid bones and phalanges are examined (8). Dental age is widely used as a potential predictor of skeletal maturation. In general, dental age can be evaluated by eruption of teeth, deciduous teeth change or development stages of teeth (9). As they offer more reliable criteria for determining dental age, the calcification stages of the teeth are preferred for evaluation. Demirjian et al. developed a system by scoring the calcification degrees on the radiographic images of the seven teeth in the left quadrant of the mandible (10). Willems et al. modified this system in such a way that the sum of the scores can directly refer to the dental age (11). Although there are many studies on dental age, there are limited number of studies on the effect of individuals with different physical activity on dental age (12,13). It is reported that the positive effect of regular physical activity on BMD (bone mineral density) begins in childhood. Especially, there are studies showing that bone-loading exercises have an effect on increasing bone mass (14-17).

In our study, it has been examined whether sports has an impact on dental age and skeletal age. The aim of this study is to compare the relationship between chronological age and dental and skeletal age in terms of dental development.

Material and methods

This study was examined and approved by the Istanbul Aydin University Institute of Health Sciences Non-Interventional Clinical Research Ethics Committee (Number: Ethics

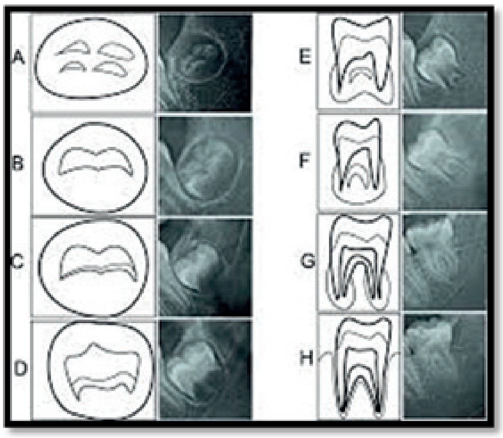

Figure 1. Demirjian's dental calcification stages evaluating dental maturation, and schematic representation of the developmental stages of mandibular third molar teeth on panoramic radiographs

- ***A. calcification of occlusal points without junction;***
- ***B. the joining of the occlusal points undergoing mineralization;***
- ***C. complete formation of the enamel and the formation of dentin;***
- ***D. formation of crown-enamel-cement connection;***
- ***E. the root length is shorter than the crown length;***
- ***F. the root length is equal to or longer than the crown length;***
- ***G. cessation of root development and apical region open;***
- ***H. The period when the apical opening is closed (Figure 1). For the statistical analysis, each step of the mineralization was scored from 0 (A) to 7 (H).***

approval and consent to participate The present study was approved by the Ethics Committee of Istanbul Aaydin University of Medical Sciences, Istanbul, Turkey (code B.30.2. AYD.0.00.00.-050.06.04/178). All materials and facilities needed for this this study were obtained from Istanbul Aydin University Faculty of Dentistry, Orthodontics Department between 2017-2018. In the study, images of 100 patients (43 males, 47 females) whose chronological ages ranged between 12-17 years old with hand-wrist radiographs and panoramic radiographs taken on the same day were evaluated. 50 participants from Istanbul Cerrahpaşa University Sports Association and BD tennis club (n = 50) had visited for routine check up in the out patient department of IAU and 50 participants (n = 50 who did not do engage in sports in the same age group were recruited from orthodontics department of Istanbul Aydin University Faculty of Dentistry). Images of patients who consented for a a hand-wrist radiograph to evaluate the growth and development pattern and panoramic radiography to evaluate the dental condition were included. Although the lowest number of samples for each group was determined as α = 0.05, 0.80 power level was determined as 40 individuals, in this study, the number of patients in each age and gender group was increased to be 50 and above.

Patients with all the teeth in the mandibular jow, the right hand and wrist intact, who had not received prior orthodontic treatment were included in the study, while patients with orthodontic treatment, mandibular left quadrant, impacted transposed or restorated teeth, and any trauma or growth disorder in the face or wrist region, significant medical history, patients with systemic disease (cardiovascular disease, Diabetes mellitus, thyroid disease and tendency to bleed) were excluded from the study. All evaluations and measurements were made by the same observer. All hand-wrist radiography and panoramic radiography data used in the study were obtained from Morita Veraviewpocs Dental X-ray 2D (Type: J Morita,Kyoto JAPON) branded device. The chronological age of the patients was determined by calculating the time between the day of the radiographs and the date of birth.

In determining the dental age, the teeth in the mandibular jow were evaluated according to the dental development stages of Demirjian (Tab. 1) and these stages were numbered according to the scores detected by Willems. Dental age was specified by summing the scores obtained for the seven teeth (18,19).

Statistical Analysis

Chi-Square analysis test was used to compare the development of third molar teeth in terms of gender, age and jaws. All statistical evaluations were made using SPSS (version 21.0, SPSS Inc., Chicago, IL, USA) software program. The significance level was considered statistically significant for $p < 0.05$.

Results

There was no significant difference between individuals who did sports and those who did not ($p > 0.05$) (Tab. 1.2). In our study, it was scored as C-F due to the age range of individuals. Table 2 shows distribution according to gender and chronological age. The number of male patients were 53 and female patient were 47. There was no statistically significant difference in the comparison of the skeletal age and chronological age averages in the male sports group, while the difference was found in the female group (male $p = 0.918$, female $p = 0.044$). There was no difference in the comparison of dental age and chronological age in both sex groups ($p > 0.05$) (Tab. 3). There is a positive correlation between chronological age and skeletal age and dental age in both sex groups. In addition, a positive correlation was found between dental age and skeletal age (Tab. 4). When the chronological ages with and without sports were compared, no significant difference was found between the 2 different groups in terms of chronological ages (P> 0.05). Since teeth number 38 and 48 represent different mineralization stages in some individuals, these teeth were evaluated separately. No significant difference was observed in terms of teeth 38 and 48 when each period of mineralization was evaluated separately (Tab. 5,6).

Discussion

Several methods have been defined dental age in literature. These methods are difficult to use as some have quite a few steps. However, the method of Demirjian et al. is a reliable method since it has a total of eight development steps, four for crown and four for root, and has a scoring system based on both easy and objective criteria for calculating dental age (19). For this reason we chose this method to evaluate the age of teeth in our study. Dental age development standards in Demirjian et al. method are based on France-Canadian children. Studies have reported that different developmental stages are seen in different population groups (20, 21). Therefore, it may be necessary to study in neighboring similar populations to determine the age of the teeth. However, in our study, three different groups are compared in the same population. In this way, differences in tooth development from population are eliminated. When Jamroz et al. compared patients with long and short face lengths in terms of dental age, they did not find any statistical difference (22). In the study conducted by Janson et al. stated that the patients with long face length are 6 months ahead of the dental development of the patients with short face length (23). Skeletal age assessment allows the clinician to determine the maturity of patients, thereby assessing advanced or delayed growth patterns. Skeletal age determination is widely used in the evaluation of the growth pattern since the change in skeletal age according to chronological age is limited in the ± 10% range in healthy individuals (10). Mohammed et al. evaluated the skeletal age using Fishman's skeletal maturation method in their study and reported that the simplicity of the Fishman method and the use of net SMI values contributed to its reproducibility. Since there is a significant correlation between skeletal age and chronological age in both sex groups, they concluded that using the Fishman method is a reliable technique for age prediction (7). In our study, we calculated the skeletal age according to the Greulich-Pyle (4) atlas, as in chronological age. We found a very important positive correlation between the obtained cervical vertebra ages and chronological and skeletal age at a p <0.01 level. Looking at the averages of these three ages, it was observed that there was no difference between ages, and our results were found to be compatible with Mito et al. (24), Küçükkeleş et al. (25). Some researchers have shown that dental parameters are more suitable for age estimation in children because the developmental stages of teeth are controlled by genetic factors rather than environmental factors (26). Williem et al, provided the Demirjian technique, which is frequently used in dental age determination, to be used with an easily applicable scoring while preserving the advantages (27). Patel et al compared the Demirjian method with the Williem method and stated that the Williem method gave more reliable results (28). In our study, this method was used for dental age prediction and it was found that it showed a positive correlation with chronological age and skeletal

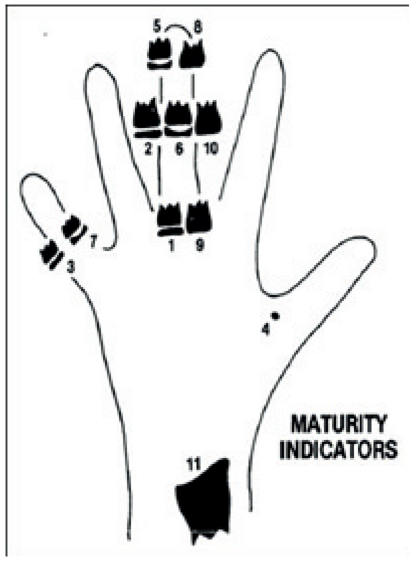

Figure 2. SMI (Skeletal Maturation Indicators) stages defined in the wrist.

1. ***In the proximal phalanx of the third finger, the pineal diaphysis is equal.***
2. ***In the middle phalanx of the third finger, the pineal diaphysis is equal.***
3. ***In the middle phalanx of the fifth finger, the pineal diaphysis is equal.***
4. ***Adductor sesamoid has begun to be observed.***
5. ***Envelops the pineal diaphysis in the distal phalanx of the third finger.***
6. ***Envelops the pineal diaphysis in the middle phalanx of the third finger.***
7. ***Envelops the pineal diaphysis in the middle phalanx of the fifth finger.***
8. ***In the distal phalanx of the third finger, the pineal diaphysis fuses.***
9. ***In the proximal phalamx of the third finger, the pineal diaphysis fuses.***
10. ***The pineal diaphysis fuses to the middle phalanx of the third finger.***
11. ***Radius there was an epiphysis and diaphyseal fusion.***

Table 1. The relationship between gender and maturation variable (Chi-Square Analysis)

		1 engaged in sports/2 not engaged in sports						Chi-Square analysis	
		Engaged in Sports		Not Engaged in Sports		Total			
		n	%	n	%	n	%	Chi-Square	p
Gender	Female	26	53.2	21	48.8	57	100,0		
	Male	24	44.2	29	51.2	53	100,0	1.27	0.259
	Total	50	48.7	50	50.3	100	100,0		
Maturasyon	Prepeak	32	55.5	9	44.5	119	100,0		
	Peak	18	25.7	41	74.3	35	100,0	9.5	0.002*
		50	48.7	50	51.3	100	100,0		

Table 2. The Number of age with engaged and non-engaged sport

Age	Engaged in Sports Female	Engaged in Sports Male	Not Engaged in Sports Female	Not Engaged in Sports Male
12	5	7	7	6
13	5	6	7	5
14	5	6	5	5
15	3	5	3	4
16	2	4	2	2
17	1	3	2	2

Table 3. The relationship between chronological (CA), skeletal (SA) and dental (DA) age values, minimum, maximum, average values and dental and skeletal age according to chronological age in femal-male groups (t Test)

Gender	Number	Min.	Max.	ss	Min.	Max.	ss	P
Engaged in Sports			CA			SA		
Female	21	12.42	16.1	14.29±1.39	13.3	17.5	14.98±1.5	0.044*
Male	29	12.3	17.5	14.62±1.29	12.7	17.1	14.7±1.81	0.085
			CA			DA		
Female	21	12.42	16.1	14.29±1.39	11.2	17.2	14.52±1.51	0.445
Male	29	12.3	17.5	14.62±1.29	12.5	17.1	14.57±1.4	0.506
Not Engaged in Sports			CA			SA		
Female	26	12.42	16.25	14.35±1.3	12.65	16.82	14.8±1.51	0.896
Male	24	12.77	16.99	14.8±1.21	12.82	17.2	14.77±1.81	0.981
			CA			DA		
Female	26	12.42	16.25	14.35±1.3	12.35	16.65	14.81±1.2	0.875
Male	24	12.77	16.99	14.8±1.21	12.8	16.8	14.39±1.25	0.891

age and both sex groups. Tsai SC et al. concluded that physical activity performed during adolescence can contribute significantly to increasing BMD of the athlete (29). Baltacı et al. stated that physical activity stimulates the growth plates and affects bone growth with the effect they create on the bone and provides a stronger bone structure (30). The organic structure of bone is the determinant of bone restructuring and remodeling. It gives bone mechanical and biochemical properties. 90% of the bone matrix consists of type I collagen and 10% consists of various non-collagen proteins. The type I collagen of the bone has the capacity to mineralize with basic phosphate crystals containing carbonate called hydroxyapatite. Growth factors, cytokines, osteonectin, osteocalcin, osteopontin, bone sialoprotein, proteoglycans, phosphoproteins and phospholipids are always included in this structure. These are the factors that regulate bone mineralization and bone-building-destruction pairing (31,32). Bone tissue, like muscle tissue, has a structural and functional adaptability due to mechanical load. Although the increase in bone mass and density as a result of the increase in osteogenesis due to mechanical loading has been shown in many studies, the type, severity and duration of the physical activity that will provide this has not been revealed clearly (33). In a study on girls aged 10-13 before the menarchal period, it was found that having low, medium and high physical activity levels of children affected bone development. In particular, it has been determined that the level of physical activity affects the tibia length at 38% (34). Daly found that in young athletes who do sports, high-impact physical activities develop bone latitudinal, and moderately regulated school-based and recreational physical activities develop bone longitudinal (35). It was determined that 74.3% of those doing sports were in adolescence (Mp3 =). We think that there is no significant difference in

Table 4. The correlation between chronological (CA), skeletal (SA) and dental (DA) age in female-male groups of engaged sports and not engaged sports

	Spearman's rho (p)					
	Engaged in Sports Femal	Engaged in Sports Male	P	Not Engaged in Sports Female	Not Engaged in Sports Male	P
SA- DA	0.845	0.840	0.815	0.840	0.855	0.820
SA- SMI	0.799	0.795	0.755	0.812	0.820	0.780
DA-SMI	0.801	0.800	0.788	0.832	0.840	0.795

Table 5. Evaluation of teeth number 38, according to Demirjian classification

Stage	Groups	Median	ss	P
C	Engaged in Sports Female	12,94	1,50	0.958
	Engaged in Sports male	12,85	1,60	
	Not Engaged in Sports Female	13,19	1,23	
	Not Engaged in Sports male	13,25	1,25	
D	Engaged in Sports Female	14,5	1,8	0.100
	Engaged in Sports male	14,59	1,93	
	Not Engaged in Sports Female	15,17	1,36	
	Not Engaged in Sports male	15,02	1,17	
E	Engaged in Sports Female	14,45	1,88	0.943
	Engaged in Sports male	14,85	1,48	
	Not Engaged in Sports Female	16,04	1,36	
	Not Engaged in Sports male	16,03	1,17	
F	Engaged in Sports Female	16,66	1,06	0,892
	Engaged in Sports male	15,94	0,68	
	Not Engaged in Sports Female	15,97	1,09	
	Not Engaged in Sports male	15,98	0,75	

Table 6. Evaluation of teeth number 48, according to Demirjian classification

Stage	Groups	Median	ss	P
C	Engaged in Sports Female	13,43	1,26	0.507
	Engaged in Sports male	13,39	1,61	
	Not Engaged in Sports Female	12,95	1,76	
	Not Engaged in Sports male	13,80	0,79	
D	Engaged in Sports Female	14,54	0,11	0.828
	Engaged in Sports male	14,83	1,30	
	Not Engaged in Sports Female	15,19	1,81	
	Not Engaged in Sports male	14,85	0,95	
E	Engaged in Sports Female	15,66	1,05	0.945
	Engaged in Sports male	14,85	1,48	
	Not Engaged in Sports Female	15,65	1,58	
	Not Engaged in Sports male	15,82	1,4 5	
F	Engaged in Sports Female	16,20	1,02	0,685
	Engaged in Sports male	16,38	1,06	
	Not Engaged in Sports Female	15,95	0,05	
	Not Engaged in Sports male	15,65	0,12	

* appear to be significantly higher. ($p < 0.05$)

terms of age between those who do sports and those who do not, and that physical activities accelerate growth development by inducing bone maturation. In our study, no statistically significant difference was found in both females and males in terms of dental development of children performing physical activity in development age. Hagg et al. reported that the Demirjian method we used in our study was more reliable in young patients than older patients (36).

Conclusion

As a result, no statistical difference was found between chronological, dental and skeletal age between individuals who do sports and do not. Both ethnic and environmental factors affect skeletal development. More studies are needed on this subject to make comparative evaluations.

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