

Validity of Different Dental Age Estimation Methods in Pakistani Orthodontic Patients

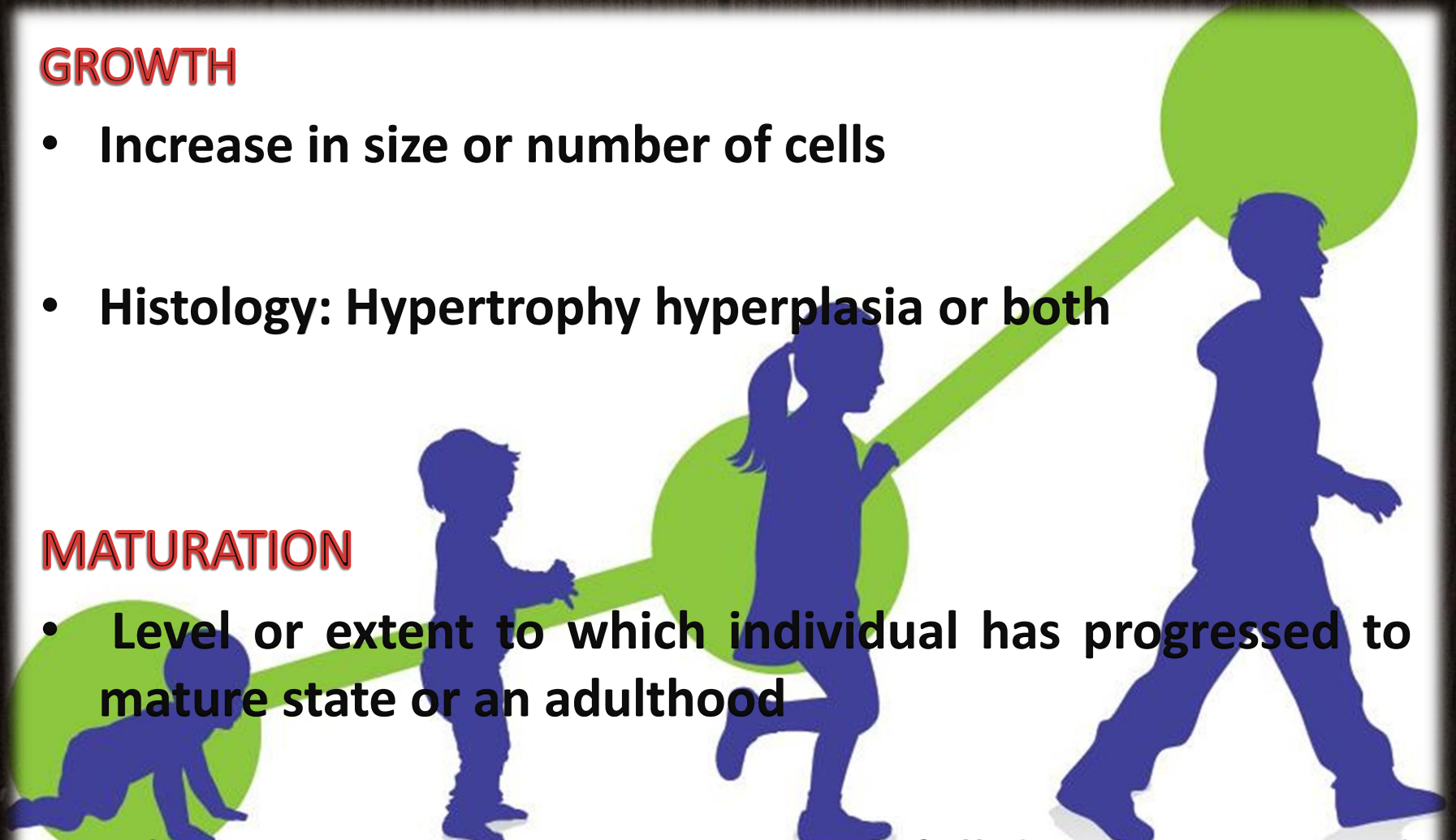
Presenter: Dr. Aisha Khoja
Resident, Orthodontics
Aga Khan University Hospital, Karachi

GROWTH

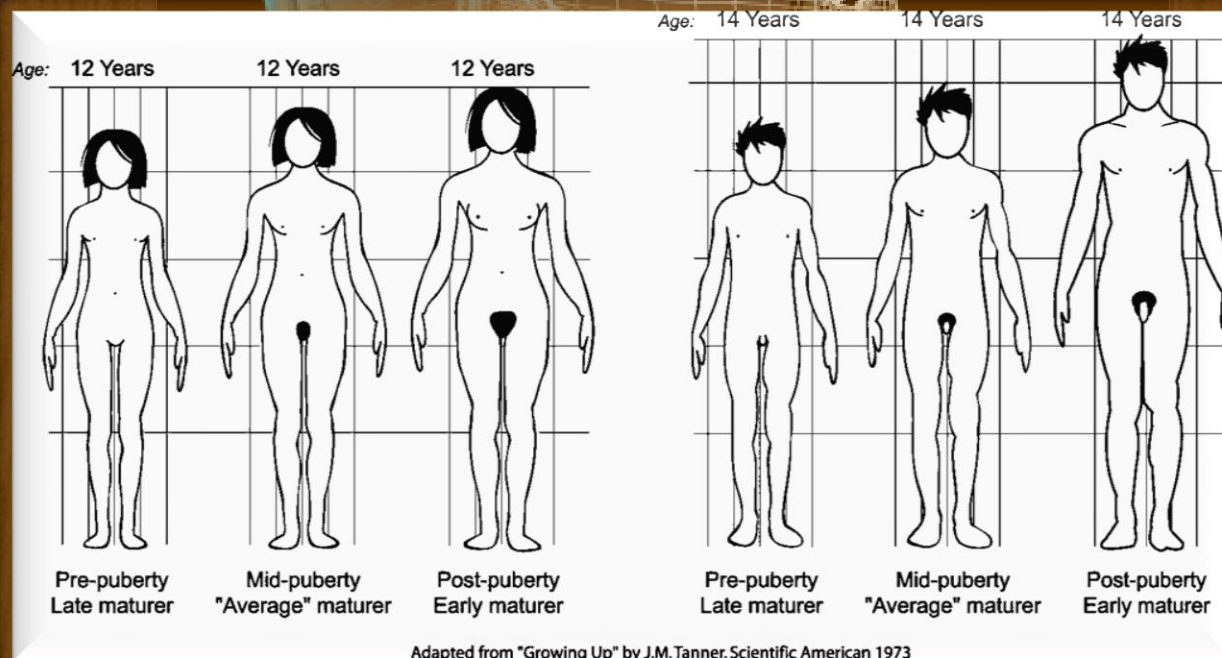
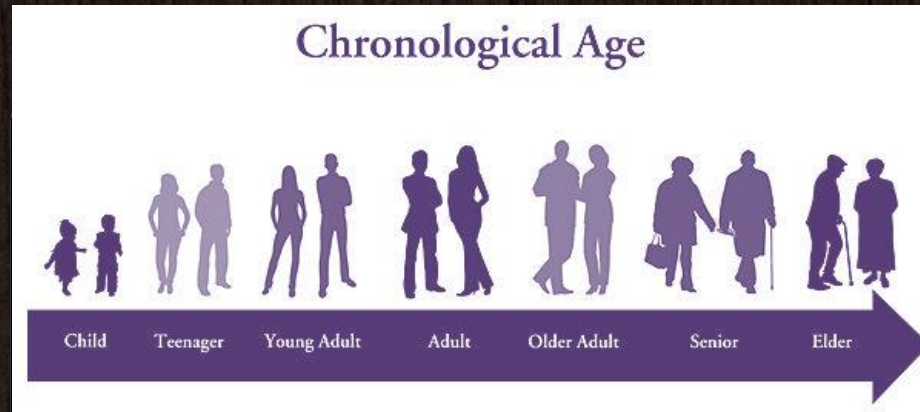
- Increase in size or number of cells
- Histology: Hypertrophy hyperplasia or both

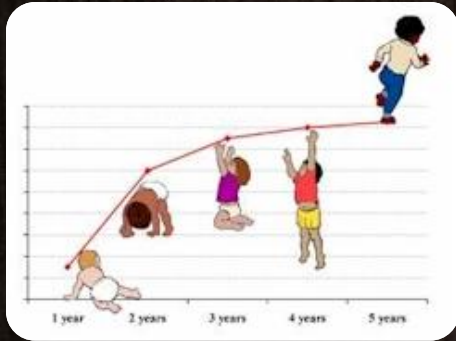
MATURATION

- Level or extent to which individual has progressed to mature state or an adulthood
- It happens as organ systems reach full development and function at an adult level



Biological Vs. Chronological Age

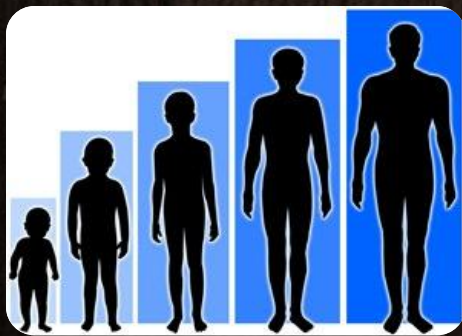




**Biological time
table**

**Period of
accelerated
growth**

**Better
Orthodontic
treatment results**



Biological Maturity Indicators



Chronological Age



Secondary Sexual Characteristics



RELIABILITY? Biological Development



Morphological Age



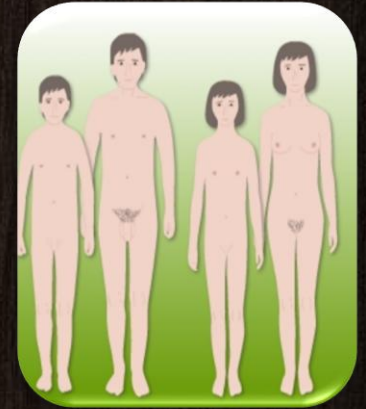
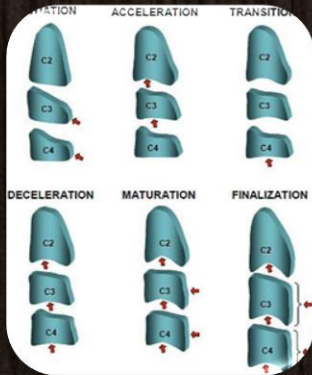
Dental Age



Skeletal Age

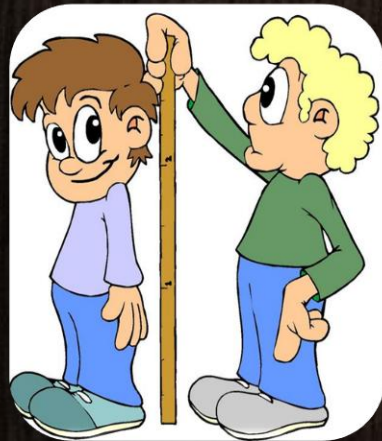


Skeletal Age

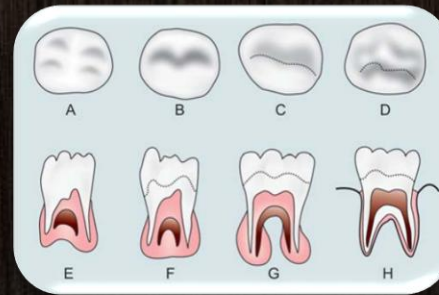
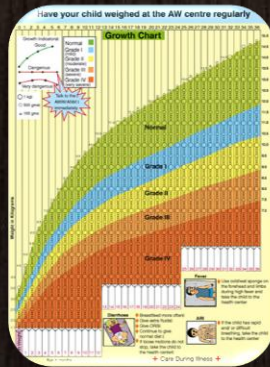


Pubertal Age

ENDOCRINE AND NUTRITIONAL STATUS



Morphological Age



Dental Age

Dental Age Estimation Methods

Age estimation in children and adolescents

- Schour and Masseler method (1940)
- Glesier and Hunt method (1955)
- Nolla's method (1960)
- Moorees, Fanning and Hunt method (1963)
- Demirjian, Goldstein and Tanner method (1971)
- Gustafson and Koch (1974)
- Willems method (2001)

Demirjian, Goldstein and Tanner



	MOLARS	BICUSPIDS	CANINES	INCISORS
A				
B				
C				
D				
E				
F				
G				
H				

Demirjian A, H. Goldstein H and Tanner JM. A new system of Dental age assessment. 1973;45:211-227

Willems Method

- Literature review: consistent overestimation when using Demirjian's technique
- Wilems et al study: Belgian Caucasian population
- Sum of maturity score for different teeth directly gives an estimate of individual's chronological age

A diagram illustrating the Willems Method. It shows a sequence of eight colored circles containing numerical values, connected by plus signs, followed by an equals sign and a final circle containing the sum. The values are: 2.19 (red), 1.64 (green), 1.09 (purple), 2.03 (blue), 0.45 (orange), 2.15 (red), 2 (green), and 11.5 (purple).

$$2.19 + 1.64 + 1.09 + 2.03 + 0.45 + 2.15 + 2 = 11.5$$

Willems G, Van Olmen A, Spiessens B, Carels C. Dental age estimation in Belgian children: Demirjian technique revisited. J Forensic Sci.2001;46:125-7

Willem's Method

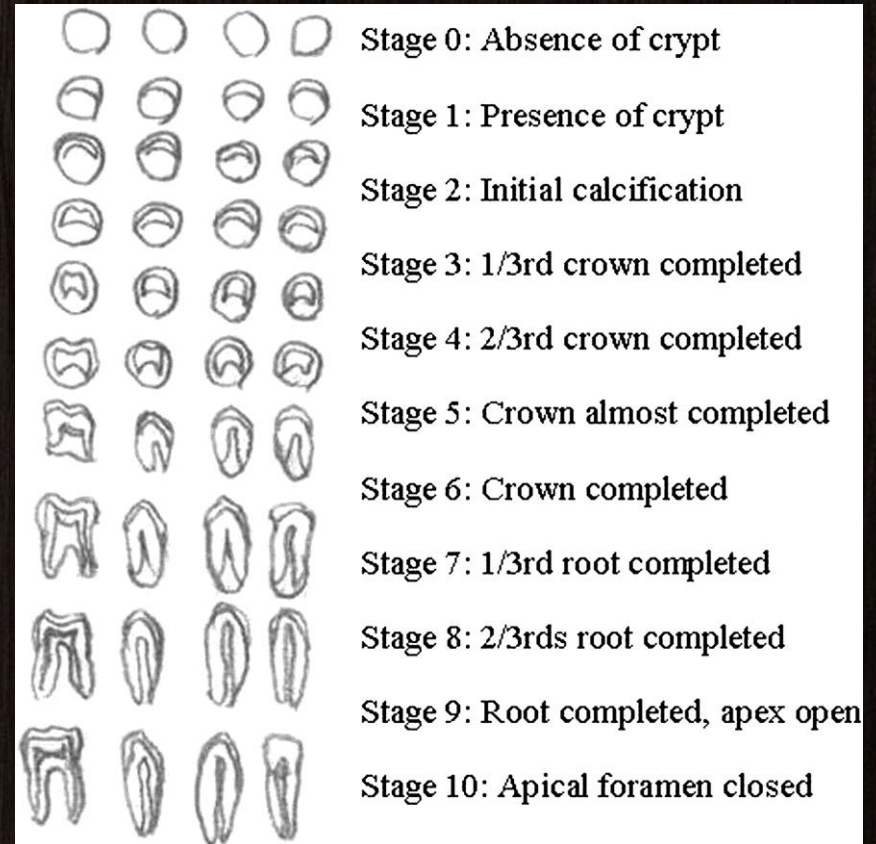
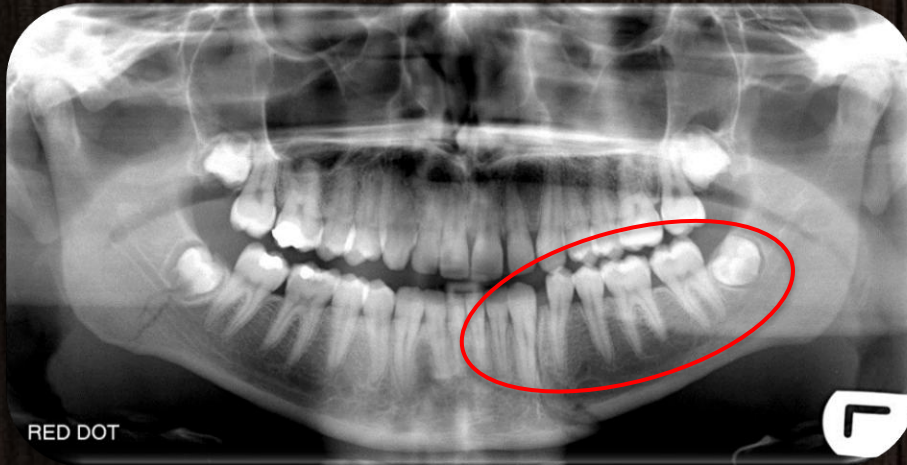
	A	B	C	D	E	F	G	H
31	0.00	0.00	1.68	1.49	1.50	1.86	2.07	2.19
32	0.00	0.00	0.55	0.63	0.74	1.08	1.32	1.64
33	0.00	0.00	0.00	0.04	0.31	0.47	1.09	1.90
34	0.15	0.56	0.75	1.11	1.48	2.03	2.43	2.83
35	0.08	0.05	0.12	0.27	0.33	0.45	0.40	1.15
36	0.00	0.00	0.00	0.69	1.14	1.60	1.95	2.15
37	0.18	0.48	0.71	0.80	1.31	2.00	2.48	4.17

Individual maturity scores for boys expressed in years

	A	B	C	D	E	F	G	H
31	0.00	0.00	1.83	2.19	2.34	2.82	3.19	3.14
32	0.00	0.00	0.00	0.29	0.32	0.49	0.79	0.7
33	0.00	0.00	0.6	0.54	0.62	1.08	1.72	2
34	-0.95	-0.15	0.16	0.41	0.6	1.27	1.58	2.19
35	-0.19	0.01	0.27	0.17	0.35	0.35	0.55	1.51
36	0.00	0.00	0.00	0.62	0.9	1.56	1.82	2.21
37	0.14	0.11	0.21	0.32	0.66	1.28	2.09	4.04

Individual maturity scores for girls expressed in years

Nolla's Method



Importance of Dental Age Estimation

- **Orthodontists:** Useful in diagnosis and treatment planning
- **Pediatricians:** Dental maturity in child with disease has been delayed or advanced
- **Forensic Sciences:** Aid to age identification of deceased child
- **Others:** Employment, social benefits, immigrants and undocumented or missing birth data

Rationale

Applicability of different dental age estimation methods in Pakistani orthodontic patients

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graph TD; A[Applicability of different dental age estimation methods in Pakistani orthodontic patients] --> B[Prediction of proper timing for particular treatment modality]; B --> C[Take an advantage of maximum growth]; C --> D[Optimal and stable results];
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Prediction of proper timing for particular treatment modality

Take an advantage of maximum growth

Optimal and stable results

Research Study

Validity of Different Dental Age Estimation
Methods in Pakistani Orthodontic Patients

Objectives

- To evaluate the validity of Demirjian's (1973), Nolla's (1960) and Willems (2001) methods of dental age estimation in Pakistani orthodontic patients (8-16.9years)
- To address the validity of these methods in determining dental maturity across the gender

Materials and Methods

- **Study Design:** Crosssectional study
- **Study Setting:** AKUH Dental Clinic
- **Study Duration:** April-July'13
- **Sample Size:** 403 subjects (M: 176) (F:227)

Group1: 8-8.9 years

Group 2: 9-9.9 years

Group 3: 10-10.9 years

Group 4: 11-11.9 years

Group 5: 12-12.9 years

Group 6: 13-13.9 years

Group 7: 14-14.9 years

Group 8: 15-15.9 years

Group 9: 16-16.9 years

- **Sampling Technique:** Non-probability purposive

Inclusion Criteria

- Good quality pre-treatment Panoramic radiographs
- Age range 8-16.9 years
- No missing left permanent mandibular teeth

Exclusion Criteria

- Craniofacial anomalies/syndromes
- Dental anomalies of number, size, form and position
- Any systemic illness affecting development of teeth

Data Collection Tools

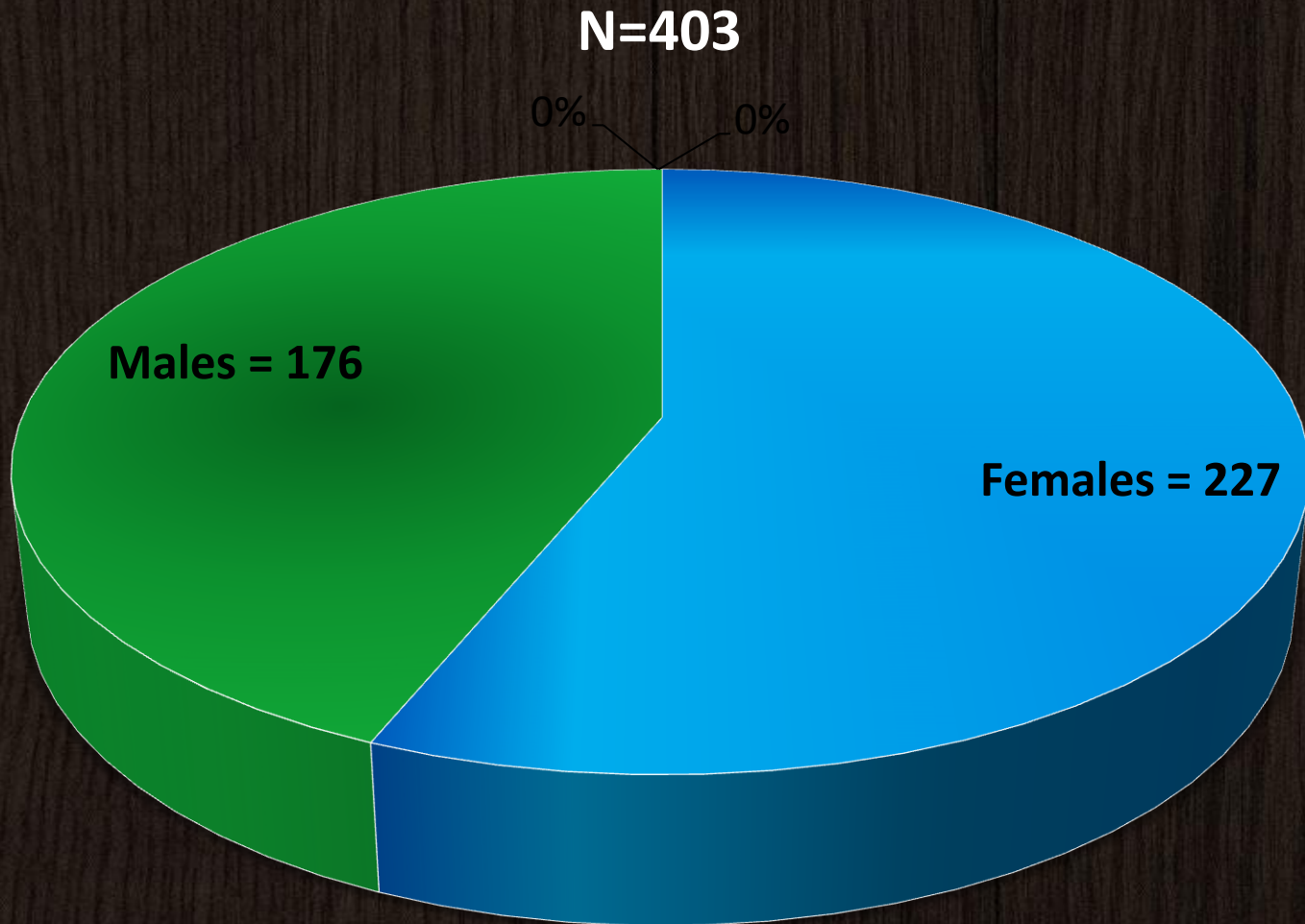


Data Analysis

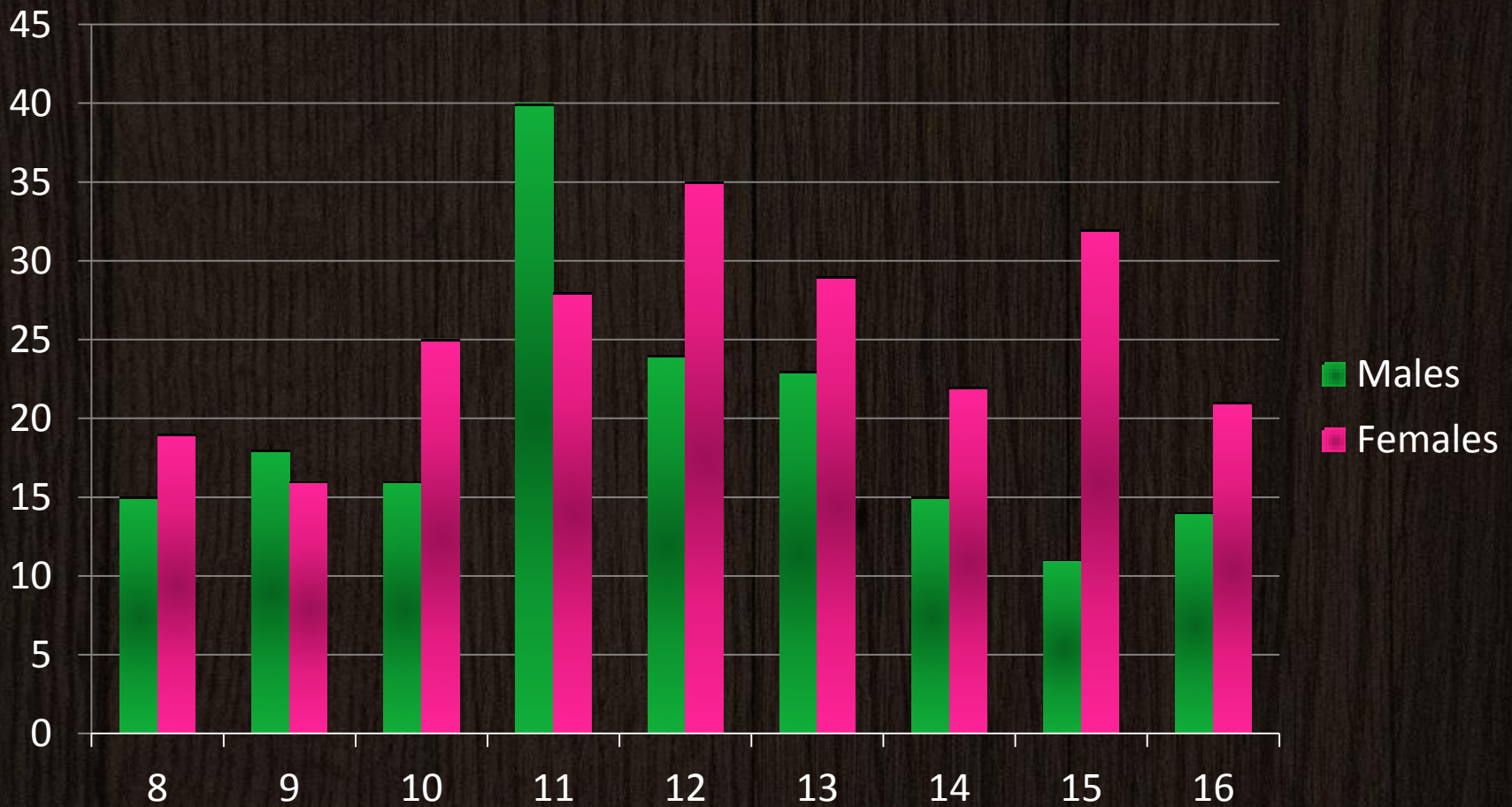
- SPSS version 19.0
- Descriptive statistics
- Paired sample t-test
- Spearman's Correlation
- P value ≤ 0.05

Results

Gender Distribution



Distribution of Subjects according to Chronological Age



Difference b/w Chronological & Dental Age by Demirjian Method in Males

Age Group	Age range (years)	CA (Mean & SD)	DA (Mean & SD)	DA-CA (Mean & SD)	p-value
1 (n=15)	8-8.9	8.36 ± 0.37	9.22 ± 0.45	0.86 ± 0.22	0.000
2 (n=18)	9-9.9	9.47 ± 0.27	10.12 ± 1.73	0.86 ± 1.35	0.015
3 (n=16)	10-10.9	10.44 ± 0.24	11.07 ± 1.00	0.57 ± 1.04	0.046
4 (n=40)	11-11.9	11.49 ± 0.25	11.90 ± 1.00	0.40 ± 1.03	0.017
5 (n=24)	12-12.9	12.39 ± 0.28	12.52 ± 1.18	0.13 ± 1.13	0.567
6 (n=23)	13-13.9	13.53 ± 0.28	13.67 ± 1.58	0.14 ± 1.54	0.654
7 (n=15)	14-14.9	14.41 ± 0.35	14.58 ± 1.63	0.17 ± 1.59	0.686
8 (n=11)	15-15.9	15.19 ± 0.28	15.32 ± 0.79	0.13 ± 0.72	0.547
9 (n=14)	16-16.9	16.57 ± 0.44	16.00 ± 0.00	-0.57 ± 0.44	0.000

Paired Sample t-test

CA= Chronological Age; DA= Dental Age

p ≤ 0.05

N= 403

Difference b/w Chronological & Dental Age by Demirjian Method in Females

Age Group	Age range (years)	CA (Mean & SD)	DA (Mean & SD)	DA-CA (Mean & SD)	p-value
1 (n=19)	8-8.9	8.40 ± 0.28	9.13 ± 1.01	0.73 ± 0.98	0.005
2 (n=16)	9-9.9	9.47 ± 0.34	10.12 ± 1.73	0.65 ± 1.74	0.157
3 (n=25)	10-10.9	10.44 ± 0.38	11.07 ± 1.00	0.62 ± 0.94	0.003
4 (n=28)	11-11.9	11.43 ± 0.25	12.12 ± 1.07	0.69 ± 1.02	0.001
5 (n=35)	12-12.9	12.37 ± 0.30	12.65 ± 1.20	0.27 ± 1.18	0.175
6 (n=29)	13-13.9	13.45 ± 0.28	14.45 ± 1.51	1.00 ± 1.53	0.001
7 (n=22)	14-14.9	14.27 ± 0.25	15.20 ± 1.24	0.93 ± 1.31	0.003
8 (n=32)	15-15.9	15.36 ± 0.31	14.99 ± 1.23	-0.36 ± 1.11	0.070
9 (n=21)	16-16.9	16.15 ± 0.24	15.21 ± 1.02	-0.94 ± 0.92	0.000

Paired Sample t-test

CA= Chronological Age; DA= Dental Age

$p \leq 0.05$

N= 403

Difference b/w Chronological & Dental Age by Nolla's Method in Males

Age Group	Age range (years)	CA (Mean & SD)	DA (Mean & SD)	DA-CA (Mean & SD)	p-value
1 (n=15)	8-8.9	8.36 ± 0.37	7.27 ± 0.45	-1.09 ± 0.32	0.000
2 (n=18)	9-9.9	9.47 ± 0.27	7.56 ± 1.04	-1.91 ± 1.00	0.000
3 (n=16)	10-10.9	10.44 ± 0.24	8.87 ± 1.45	-1.57 ± 1.47	0.001
4 (n=40)	11-11.9	11.49 ± 0.25	10.42 ± 1.65	-1.07 ± 1.65	0.000
5 (n=24)	12-12.9	12.39 ± 0.28	11.38 ± 1.34	-1.02 ± 1.32	0.001
6 (n=23)	13-13.9	13.53 ± 0.28	12.26 ± 2.15	-1.27 ± 2.14	0.009
7 (n=15)	14-14.9	14.41 ± 0.35	14.27 ± 1.83	-1.15 ± 1.68	0.736
8 (n=11)	15-15.9	15.19 ± 0.28	14.91 ± 1.30	-0.28 ± 1.21	0.459
9 (n=14)	16-16.9	16.57 ± 0.44	16.71 ± 0.72	0.13 ± 0.61	0.420

Paired Sample t-test

CA= Chronological Age; DA= Dental Age

p ≤ 0.05

N= 403

Difference b/w Chronological & Dental Age by Nolla's Method in Females

Age Group	Age range (years)	CA (Mean & SD)	DA (Mean & SD)	DA-CA (Mean & SD)	p-value
1 (n=19)	8-8.9	8.40 ± 0.28	8.68 ± 1.10	0.27 ± 0.97	0.226
2 (n=16)	9-9.9	9.47 ± 0.34	9.69 ± 1.92	0.21 ± 1.85	0.653
3 (n=25)	10-10.9	10.44 ± 0.38	10.16 ± 1.57	-0.28 ± 1.44	0.333
4 (n=28)	11-11.9	11.43 ± 0.25	12.21 ± 1.39	0.78 ± 1.33	0.005
5 (n=35)	12-12.9	12.37 ± 0.30	12.77 ± 1.23	0.39 ± 1.17	0.057
6 (n=29)	13-13.9	13.45 ± 0.28	14.08 ± 1.34	0.62 ± 1.35	0.019
7 (n=22)	14-14.9	14.27 ± 0.25	15.18 ± 2.92	0.91 ± 2.89	0.155
8 (n=32)	15-15.9	15.36 ± 0.31	14.72 ± 1.65	-0.64 ± 1.54	0.024
9 (n=21)	16-16.9	16.15 ± 0.24	15.86 ± 1.27	-0.30 ± 1.31	0.305

Paired Sample t-test

CA= Chronological Age; DA= Dental Age

p ≤ 0.05

N= 403

Difference b/w Chronological & Dental Age by Willems Method in Males

Age Group	Age range (years)	CA (Mean & SD)	DA (Mean & SD)	DA-CA (Mean & SD)	p-value
1 (n=15)	8-8.9	8.36 ± 0.37	8.86 ± 0.20	0.50 ± 0.41	0.000
2 (n=18)	9-9.9	9.47 ± 0.27	9.89 ± 1.38	0.41 ± 1.34	0.207
3 (n=16)	10-10.9	10.44 ± 0.24	10.63 ± 1.13	0.19 ± 1.11	0.505
4 (n=40)	11-11.9	11.49 ± 0.25	12.18 ± 0.94	0.69 ± 0.93	0.000
5 (n=24)	12-12.9	12.39 ± 0.28	12.71 ± 1.10	0.32 ± 1.05	0.146
6 (n=23)	13-13.9	13.53 ± 0.28	13.78 ± 1.49	0.24 ± 1.46	0.429
7 (n=15)	14-14.9	14.41 ± 0.35	14.67 ± 1.45	0.25 ± 1.29	0.456
8 (n=11)	15-15.9	15.19 ± 0.28	15.26 ± 0.88	0.70 ± 0.84	0.786
9 (n=14)	16-16.9	16.57 ± 0.44	16.03 ± 0.00	-0.54 ± 0.44	0.001

Paired Sample t-test

CA= Chronological Age; DA= Dental Age

p ≤ 0.05

N= 403

Difference b/w Chronological & Dental Age by Willems Method in Females

Age Group	Age range (years)	CA (Mean & SD)	DA (Mean & SD)	DA-CA (Mean & SD)	p-value
1 (n=19)	8-8.9	8.40 ± 0.28	8.97 ± 0.91	0.50 ± 0.98	0.021
2 (n=16)	9-9.9	9.47 ± 0.34	10.38 ± 2.02	0.91 ± 2.04	0.094
3 (n=25)	10-10.9	10.44 ± 0.38	10.79 ± 1.11	0.34 ± 1.03	0.108
4 (n=28)	11-11.9	11.43 ± 0.25	11.74 ± 2.21	0.31 ± 2.16	0.451
5 (n=35)	12-12.9	12.37 ± 0.30	12.75 ± 1.14	0.37 ± 1.14	0.059
6 (n=29)	13-13.9	13.45 ± 0.28	14.40 ± 1.36	0.95 ± 1.39	0.001
7 (n=22)	14-14.9	14.27 ± 0.25	15.03 ± 1.34	0.76 ± 1.39	0.017
8 (n=32)	15-15.9	15.36 ± 0.31	14.98 ± 1.10	-0.37 ± 1.04	0.048
9 (n=21)	16-16.9	16.15 ± 0.24	15.14 ± 1.05	-1.012 ± 0.96	0.000

Paired Sample t-test

CA= Chronological Age; DA= Dental Age

$p \leq 0.05$

N= 403

Correlation between Chronological and Dental Age for Different Methods

Method	Gender	Correlation Coefficient	p-value
Nolla's Method	Males	0.870	0.000
	Females	0.827	0.000
Demirjian Method	Males	0.855	0.000
	Females	0.838	0.000
Wilems Method	Males	0.879	0.000
	Females	0.843	0.000

Spearman's Correlation

$p \leq 0.01$

N= 403

Discussion

Demirjian Method

Sukhia et al:

- Over-prediction of dental age using French-Canadian tables
- Males: 7,11-14 years; Females: all age groups

AKUH:

- Over-predication using Pakistani table in 8-9.9 and 11-11.9 years (males) & 8-8.9, 10-11.9, 13-13.9 years (females)
- Under-estimation in 16-16.9 years for both genders

Demirjian Method

Bagherian A & Sadeghi M:

- Iranian children: Dental age > chronological age by 0.15 years (55 days) in boys and 0.21 (77 days) in girls
- Girls reported earlier dental maturation than boys by 22 days

AKUH:

- Pakistani children: Dental age > chronological age by 0.32 (116 days) in boys and 0.38 (138 days) in girls
- Girls reported earlier dental maturation than boys by 22 days

Bagherian A, Sadeghi M. Assessment of dental maturity of children aged 3.5 to 13.5 years using the Demirjian method in Iranian population. Journal of Oral Sciences. 2011;53:37-42

Nolla's Method

Nur Bilge et al:

- Turkish population: Under-estimation of dental age in 6-6.9 and 8-11.9 years (males) & 7-10.9 & 12-12.9 years (females)
- Overall, girls mature earlier than boys

AKUH:

- Under-estimation in 8-13.9 years (males) & overestimation in 11-11.9 and 13-13.9 years (females)
- Overall, girls mature earlier than boys

Nur Bilge, Kusgoz Adem, Bayram Mehmet, Ceilikoglu Mevlut, Nur Metin, Kayipmaz Saadettin et al. Validity of demirjian and nolla methods for dental age estimation for Northeastern Turkish children aged 5-16 years old. Med Oral Patol Oral Cir Bucal.2012;5:871-77

Willem's Method

Rai B & Anand SC:

- Indian population: Dental age over-prediction with mean difference between chronological and dental age to be 0.25 years (91 days) for boys and 0.24 years (88 days) for girls
- Boys were dentally advanced than girls

AKUH:

- Dental age over-prediction with mean difference between chronological and dental age to be 0.32 years (116 days) for boys and 0.29 years (106 days) for girls
- Boys were dentally advanced than girls

Rai Balwani, Anand SC. Tooth developments: An accuracy of age estimation of radiographic methods. World Journal of Medical Sciences.2006;1:130-2

Correlation b/w Chronological and Dental Age

Nur Bilge et al:

- Dental age was strongly correlated with chronological age in males and females according to Demirjian ($r=0.93$, $r=0.913$) and Nolla ($r=0.92$, $r=0.91$) methods

AKUH:

- Dental age was strongly correlated with chronological age in males and females according to Demirjian ($r=0.855$, $r=0.83$), Nolla ($r=0.87$, $r=0.82$) and Willems ($r=0.87$, $r=0.84$) methods

Nur Bilge, Kusgoz Adem, Bayram Mehmat, Ceilikoglu Mevlut, Nur Metin, Kayipmaz Saadettin et al. Validity of demirjian and nolla methods for dental age estimation for Northeastern Turkish children aged 5-16 years old. Med Oral Patol Oral Cir Bucal.2012;5:871-77

Conclusions

- Dental age correlated better with chronological age and less over-prediction was found using Pakistani tables as compared to French-Canadian standards
- Dental age was under-estimated in males and over-estimated for females using Nolla's method
- Girls reported earlier dental maturation than boys using Demirjian and Nolla's method
- Boys were dentally advanced than girls using Willems method

Conclusions

- Strong and statistically significant correlation was found between chronological and dental age for males and females according to Demirjian, Nolla's and Willems methods
- Comparing all the methods, Willems method is the most valid

Clinical Implications

- Patients with delayed dental maturity, orthodontic treatment may be started at later stage leading to shorter treatment
- Predicting the remaining growth of an individual, we can readily modify it and can achieve better esthetics
- Early treatment should be started in girls to take an advantage of maximum growth spurt
- Dental age strongly correlate with chronological age using any method and hence it is a valuable tool in forensic sciences

Limitations

- Predominantly female sample
- Less sample size in smaller age groups

Recommendations

- Equal gender distribution
- Multi-centered based study should be conducted

Acknowledgements

- Dr. Mubassar Fida
- Dr. Attiya Shaikh
- Dr. Khabir Ahmed
- Mr. Musa Khan
- All dental residents

A close-up photograph of a fountain pen with a black and silver finish, resting on a piece of cream-colored paper. The paper features elegant cursive handwriting in dark ink. The pen is positioned diagonally, with its nib pointing towards the bottom left. The background is a dark, textured surface, possibly wood.

Thank You

"Maturity is not when we start speaking BIG things, it is when we start understanding and appreciating the SMALL things" Anonymous