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Ages and sequence of eruption of permanent teeth in a sample of Pakistani school children

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Abstract

Introduction: The knowledge of ages at which individual teeth erupt in a given ethnic group is essential for the planning of preventive measures and the treatment of malocclusion. Hence the purpose of this study was to ascertain the sequence and ages of eruption of permanent dentition in Pakistani school children and to find the influence of gender on eruption timings.

Material and Methods: The mean ages of eruption of the permanent teeth (except the third molars) were derived from a cross sectional study of 881 school children, aged 5 to 15 years. Children were examined in daylight and emergence through the gingiva was the criterion for eruption.

Results: Except for the premolars, the mandibular teeth erupted earlier than the corresponding maxillary ones in both sexes. Females tended to erupt teeth before males. The mandibular first molar was the first tooth to erupt in boys, while the mandibular central incisor in girls. The last tooth to erupt in both sexes was the maxillary second molar.

Conclusions: It was concluded that the permanent teeth erupt earlier in Pakistani children than in other parts of the world except Africa.

Key words: Eruption timing, tooth emergence, tooth appearance

Introduction

The knowledge of ages at which individual teeth erupt in a given ethnic group is essential for the planning of preventive measures and the treatment of malocclusion. The knowledge of sequence of eruption is of equal importance.[1-3]

What is commonly known as eruption time of a tooth is actually the time of emergence of a tooth through the gingiva. Eruptive movement begins with the onset of root formation well before the appearance of tooth in the oral cavity and continues for as long as the tooth remains in the oral cavity.[2]

The factors affecting tooth eruption can be genetic,[4,5] racial, gender, nutrition, socioeconomic, environmental, climate, pathological and others. Variation in timing and atypical sequence of eruption depends mostly on genetic factors. This view is supported by the high correlation of tooth formation between identical twins ranging from 0.75 to 0.90 compared to 0.30 between fraternal twins or siblings.[6] Genetic differences occur not only between individuals but also between population groups. Non Caucasian races erupt their permanent teeth earlier then Europeans, Australians or North American Whites.[7] So the timings of eruption assessed in other countries cannot be used with confidence in Pakistan because of considerable variation from one country to another. [2,6,8]

A change in the sequence of eruption is a much more reliable sign of a disturbance in the development then generalized delay or acceleration, which should be properly and timely investigated. There are several normal variations in the eruption sequence which have clinical significance. These are:

1. Mandibular second premolar may become blocked out of the arch due to lack of

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space caused by early eruption of mandibular second molar.
2. The maxillary canine may become blocked out of the arch on labial side if maxillary canine and first premolar erupt simultaneously.

According to Nanda[9] there is no association between good occlusion and a particular order of eruption although he could not establish a definitive conclusion due to limited number of cases studied.

The chronological or calanderic age of children with unknown or uncertain birth records is often estimated by evaluating the individual's skeletal maturity.[10] Physiologic age is estimated by the maturation status of one or more tissue systems. The dentition is one of the four tissue systems used in estimation of the chronological age of the children.[11] The other three developmental indicators are bone development, secondary sexual characters and change in body stature and width. According to Moorrees et al[12] tooth formation is superior to tooth eruption for assessing dental maturation because the majority of the teeth can be studied at each examination and also because eruption is influenced by the environmental factors.

Several methods for assessing the dental age based on tooth formation and tooth emergence have been devised. These include Moorrees, Fanning and Hunt method,[12] Liliquist and Lundberg,[13] Gustafson and Kock,[14] Demirjian et al[15,16] and Haavikko method.[17]

In 1985 Hagg and Matsson[10] investigated the accuracy and precision of three methods of assessment of chronological age based on tooth formation. According to them the method proposed by Demirijian et al is the most reliable method due to its comparatively high accuracy and precision.

The correlation between developmental ages and chronological age is quite good,[18] the correlation coefficient being point 0.8. The probability that one can predict developmental age by knowing the chronological age is vice versa 64%.

Nanda[9] also compared age at which all the permanent teeth were present and the age at the maximum rate of circum-pubertal spurt in height and suggested no specific relation between the dental maturation and puberty.

The rationale of this study was to establish the Pakistani norms for the eruption timings, gender influence and sequence of permanent dentition as no such study has ever been done in this part of the world.

Material and Methods

Subjects were 1000 children of three different schools, out of which 517 were male and 483 were female. The investigations were based on a cross sectional sample and the age range was 5-15 years inclusive. All children examined belonged to the middle income class. A child was only included if he or she could be regarded as a Pakistani as determined by the race and the birth place of both the child and the parents. The exclusion criteria were children with craniofacial skeletal deformities like cleft lip and palate or developmental syndromes like cleidocranial dysplasia and Down's syndrome and children having supernumerary teeth. The children for whom accurate birth dates could not be obtained were excluded from the study. These included 50 boys and 69 girls. So the final sample comprised 881 school children, 467 boys and 414 girls. A tooth was considered to have erupted in the oral cavity where any part of its crown had pierced the gingiva.[2,7,19-23] No radiographic check of congenital absence was made and any congenitally missing tooth was recorded as unerrupted.[3,22,24] Extracted teeth were recorded as erupted.[3,7,19,21,22,24-27] As in the result of majority of eruption studies[3,21,24,28,29-32] there are no tendencies of systemic disturbances in eruption timings of homologous teeth on the two sides of the same arch so the data for two sides were pooled. The dates of birth were asked from

the children and later confirmed from the school record. The calculations were done in years and months to the nearest month and more than 15 days were taken as one month. The male and female difference in eruption ages was calculated using students *t* test.

Results

The distribution of children by age and gender (Table I), and mean eruption ages (in years) of of seven maxillary permanent teeth in boys and girls were tabulated (Table II and III). The mean eruption ages (in years) of seven mandibular permanent teeth in boys and girls were also tabulated (Table IV and V).

The difference in mean age ranged from a few days to more than 7 months. In case of maxillary central incisor, 1st and 2nd premolar, and mandibular central and lateral incisors the differences were less than a month. Statistically significant differences emerged in relation to the maxillary lateral incisor, canine and 1st molar and mandibular canine, 1st and 2nd premolar and 1st and 2nd molar. The differences in mean ages of eruption of maxillary and mandibular teeth respectively, standard deviations, standard error of difference between males and females (Tables VIII and IX) and the significance was checked at $P > 0.05$.

On average mandibular first molar was the first tooth to erupt in boys while in girls the mandibular central incisor was the first one. The last tooth to erupt in both sexes was the maxillary second molar. The mean order of eruption in the maxilla was similar in both sexes and the sequence was; 1st molar, central incisor, lateral incisor, 1st premolar, canine, 2nd premolar and 2nd molar (M_1, I_1, I_2, P_1, C, P_2, M_2). In the mandible the sequence was different for both sexes. In boys the order of eruption was same as in maxilla, while in girls the sequence was; central incisor, 1st molar, lateral incisor, canine, 1st premolar, 2nd premolar and 2nd molar (I_1, M_1, I_2, C, P_1, P_2, M_2).

For both sexes almost all of the mandibular teeth erupted earlier than their maxillary counterparts. Only the maxillary first premolar in boys and girls and maxillary second premolar in girls erupted earlier than the mandibular ones. In boys the maxillary and mandibular second premolars erupted at almost the same time.

When the two genders were compared; difference (in months) in the mean ages of eruption between the maxillary and mandibular teeth in boys and girls showed a trend for females to erupt majority of teeth earlier than males (Tables VI and VII). Only the maxillary 1st and 2nd molar, mandibular central incisor, 2nd premolar and 1st molar erupted earlier in males than females.

Table I: Distribution of school children by age group (six monthly) and gender

Age group	Boys	Girls
5	26	37
5.5	29	27
6	35	33
6.5	33	35
7	33	20
7.5	33	23
8	21	24
8.5	23	13
9	20	24
9.5	19	17
10	20	15
10.5	17	24
11	23	15
11.5	17	29
12	31	13
12.5	17	16
13	13	7
13.5	22	14
14	13	11
14.5	12	10
15	10	7
Total	**467**	**414**

Table II: The mean eruption ages (in years) and standard deviations (SD) of maxillary permanent teeth in boys

Tooth	Mean	SD
I_1	6.80	0.58
I_2	7.86	0.45
C	10.58	1.08
P_1	9.46	0.55
P_2	10.69	0.49
M_1	5.85	0.59
M_2	11.28	1.00

Table III: The mean eruption ages (in years) and standard deviations (SD) of maxillary permanent teeth in girls

Tooth	Mean	SD
I_1	6.78	0.58
I_2	7.53	0.58
C	9.93	1.40
P_1	9.41	1.28
P_2	10.66	0.78
M_1	6.19	0.48
M_2	11.37	0.59

Table IV: The mean eruption ages (in years) and standard deviations (SD) of mandibular permanent teeth in boys

Tooth	Mean	SD
I_1	5.82	0.54
I_2	6.94	0.55
C	10.44	0.84
P_1	10.20	0.79
P_2	10.68	0.81
M_1	5.75	0.51
M_2	11.15	0.91

Table V: The mean eruption ages (in years) and standard deviations (SD) of mandibular permanent teeth in girls

Tooth	Mean	SD
I_1	5.85	0.54
I_2	6.93	0.57
C	9.84	0.62
P_1	10.06	0.65
P_2	10.81	0.74
M_1	6.15	0.54
M_2	10.95	0.56

Table VI: The difference (in months) in the mean ages of eruption between the maxillary and mandibular teeth in boys

Tooth	Maxilla	Mandible	Difference
I_1	6.80	5.82	+ 11.76
I_2	7.86	6.94	+ 11.04
C	10.58	10.44	+ 1.68
P_1	9.46	10.20	- 0.74
P_2	10.69	10.68	+ 0.12
M_1	5.85	5.75	+ 1.20
M_2	11.28	11.15	+ 1.56

+ Value denotes earlier eruption ages in mandible.
- Value denotes earlier eruption ages in maxilla.

Table VII: The difference (in months) in the mean ages of eruption between the maxillary and mandibular teeth in girls

Tooth	Maxilla	Mandible	Difference
I_1	6.78	5.85	+ 11.16
I_2	7.53	6.93	+ 7.20
C	9.93	9.84	+ 1.08
P_1	9.41	10.06	- 7.80
P_2	10.66	10.81	-1.80
M_1	6.19	6.15	+ 0.48
M_2	11.37	10.95	+ 5.04

+ Value denotes earlier eruption ages in mandible.
- Value denotes earlier eruption ages in maxilla.

Table VIII: The difference (in months) in the mean ages of eruption of maxillary teeth between males and females

Tooth	Males (years)		Females(years)		Diff. (months) Between means	SE of diff. (months)	Value of *t*
	Mean	SD	Mean	SD			
I_1	6.80	0.58	6.78	0.58	+ 0.24	0.47	0.51#
I_2	7.86	0.45	7.53	0.58	+ 3.96	0.42	9.43*
C	10.58	1.08	9.93	1.40	+ 7.80	1.02	7.64*
P_1	9.46	0.55	9.41	1.28	+ 0.6	0.83	0.72#
P_2	10.69	0.49	10.66	0.78	+ 0.36	0.53	0.68#
M_1	5.85	0.59	6.19	0.48	- 4.08	0.43	-9.49*
M_2	11.28	1.00	11.37	0.59	- 1.08	0.65	-1.66#

+ Value denotes earlier eruption ages in females.
- Value denotes earlier eruption ages in males.
** Significant at $p > 0.05$*
 # Not significant

Table IX: The difference (in months) in the mean ages of eruption of mandibular teeth between males and females

Tooth	Males (years)		Females (years)		Diff. (months) Between means	SE of diff. (months)	Value of *t*
	Mean	SD	Mean	SD			
I_1	5.82	0.54	5.85	0.54	- 0.36	0.44	- 0.82#
I_2	6.94	0.55	6.93	0.57	- 0.12	0.45	0.27#
C	10.44	0.84	9.84	0.63	+ 7.2	0.60	12.0*
P_1	10.20	0.79	10.06	0.65	+ 1.68	0.58	2.90*
P_2	10.68	0.81	10.81	0.74	- 1.56	0.63	- 2.48*
M_1	5.75	0.51	6.15	0.54	- 4.80	0.43	-11.16*
M_2	11.15	0.92	10.95	0.56	+ 2.40	0.61	3.93*

+ Value denotes earlier eruption ages in females.
- Value denotes earlier eruption ages in males.
** Significant at p > 0.05*
 # Not significant

Discussion

The study investigated the mean eruption timings of permanent teeth in a sample of Pakistani school children. All the children examined came from similar socioeconomic class. As investigation of this kind have not previously been carried out in Pakistan, so most of the variables like race, socioeconomic class, nutritional status and somatic growth etc were either kept constant or not taken into account. Only the influence of gender or eruption timing was studied. The primary purpose of this work was to establish the Pakistani norms of eruption ages of permanent dentition. As study was conducted in only one city of Pakistan, so the present norms may not be the true representative of the Pakistani children in general but they do provide the base line data.

The comparison of mean eruption ages of permanent teeth of Pakistani children with that of other ethnic group were tabulated (Table X to XIII). All the comparative studies are cross sectional except the English study of Kochhar and Richardson.[4] The Pakistani children generally show eruption of the permanent teeth earlier than did the Americans,[33] English,[4] Hong Kong Chinese[28] and Iraqis.[3] The data in this study clearly demonstrate advanced eruption for all permanent teeth as compared with that of other ethnic group except the Africans. When the present data was compared with that of Hassan Ali and Odhiambo,[7] the eruption timings of maxillary teeth of males in present study were earlier than Kenyan Africans, while half of the mandibular teeth (central incisor, 2nd premolar, 1st molar and 2nd molar) were earlier and the rest (lateral incisor, canine and 1st premolar) were later than the Africans. In case of the females of the present study the pattern were reverse as more of the teeth of Pakistani females erupted later than those of Kenyan Africans. Comparing the Kenyan Africans and Kenyan Asians of the same study, the Africans were advanced in all of their teeth than Asians. Similarly the mean eruption ages of Zulu Negroes as given by Suk[34] were earlier than present Pakistani sample which in turn are earlier than other ethnic group including Caucasians. Since it is reasonable to assume that the level of nutrition and medical care is substantially superior in the industrialized populations, their late dental eruption compared with Africans and Asians would suggest that the differences might be of genetic origin. At the same time the environmental influences are also operative and the difference in dietary habits (the rough and coarse diet of developing countries as compared with the soft and refined diet of developed countries) may have some influence on eruption timings. Eveleth[35] suggested that the tropical climate have an accelerating effect on maturation. She demonstrated that the White American children living in Brazil, who were fed and cared for in American fashion, had earlier tooth eruption timings than those of comparable group living in United States.

The findings of present study are similar to those of other investigators[3,4,7,9,21,28,36,37] in which the mandibular teeth erupted earlier than the maxillary teeth. The only exception

Table X: The comparison of mean eruption ages of maxillary teeth of males of various ethnic groups

Tooth	Pakistani	American (65)	English (4)	Hong Kong Chinese (27)	Iraqi (3)	Kenyan Asian (9)	Kenyan African (9)	Zulu Negro (66)
I_1	6.80	7.33	7.17	7.36	7.4	7.24	6.91	5.98
I_2	7.86	8.42	8.26	8.67	8.7	8.36	7.99	6.98
C	10.58	11.50	11.33	11.32	11.5	11.24	10.93	10.17
P_1	9.46	10.33	10.76	9.80	10.0	9.97	9.87	10.11
P_2	10.69	11.08	11.44	10.86	10.9	11.10	10.74	10.66
M_1	5.85	6.33	6.40	6.40	6.1	6.67	6.32	5.26
M_2	11.28	12.16	12.09	12.62	12.2	12.20	11.54	11.36

Table XI: The comparison of mean eruption ages of mandibular teeth of males of various ethnic groups

Tooth	Pakistani	American (65)	English (4)	Hong Kong Chinese (27)	Iraqi (3)	Kenyan Asian (9)	Kenyan African (9)	Zulu Negro (66)
I_1	5.82	6.25	6.31	6.22	6.2	6.57	5.83	5.47
I_2	6.94	7.58	7.44	7.52	7.6	7.52	6.86	5.96
C	10.44	10.66	10.63	10.52	10.6	10.58	9.96	9.63
P_1	10.20	10.58	10.65	10.44	10.6	10.58	10.05	10.11
P_2	10.68	11.33	11.50	11.26	11.4	11.37	10.90	10.75
M_1	5.75	6.16	6.37	6.04	5.7	6.47	6.03	5.23
M_2	11.15	11.16	11.80	11.93	11.8	11.90	11.39	11.04

Table XII: The comparison of mean eruption ages of maxillary teeth of females of various ethnic groups

Tooth	Pakistani	American (65)	English (4)	Hong Kong Chinese (27)	Iraqi (3)	Kenyan Asian (9)	Kenyan African (9)	Zulu Negro (66)
I_1	6.78	7.08	7.09	7.16	7.4	6.95	6.55	6.18
I_2	7.53	8.0	8.05	8.25	8.3	7.97	7.71	7.14
C	9.93	11.08	11.0	10.40	10.9	10.60	10.26	9.72
P_1	9.41	9.92	10.48	9.53	10.0	9.74	9.40	9.76
P_2	10.66	10.92	11.23	10.39	10.8	10.69	10.15	10.06
M_1	6.19	6.16	6.40	6.19	6.0	6.27	6.13	5.77
M_2	11.37	12.08	12.14	11.95	11.8	11.54	11.40	10.92

Table XIII: The comparison of mean eruption ages of mandibular teeth of females of various ethnic groups

Tooth	Pakistani	American (65)	English (4)	Hong Kong Chinese (27)	Iraqi (3)	Kenyan Asian (9)	Kenyan African (9)	Zulu Negro (66)
I_1	5.85	6.08	6.27	6.08	6.2	6.34	5.62	5.85
I_2	6.93	7.25	7.40	7.15	7.5	7.19	6.56	6.23
C	9.84	9.66	9.89	9.59	10.0	9.66	9.20	9.12
P_1	10.06	10.08	10.36	9.82	10.2	9.84	9.62	9.76
P_2	10.81	11.08	11.37	10.66	11.0	10.66	10.21	10.24
M_1	6.15	6.0	6.29	5.89	5.7	6.08	5.70	5.49
M_2	10.95	11.41	11.89	11.28	11.4	11.13	11.07	10.61

Table XIV: Interval of rest (in years) between first and second eruption periods of the various ethnic groups

	Pakistani	American (65)	Hong Kong Chinese (27)
Male	3.26	1.91	1.13
Female	2.90	1.66	1.28

was that the 1st and 2nd premolar in both genders and this finding is also consistent with the previous studies.[3,4,7,28,36]

In general the permanent teeth erupted earlier in females than males and the present data confirms the trend suggested by previous studies.[3,4,7,9,21,24-26,28,30,36-39] Although majority of teeth followed the same pattern, but maxillary 1st and 2nd molar and mandibular central incisor, 2nd premolar and 1st molar erupted earlier in boys than in girls.

However in maximum studies all the teeth in females erupted earlier than males. Liversidge and Speechly[39] have concluded that girls not only begin to develop their teeth earlier but they also advance through developmental stages more rapidly.

Hellman[40] divided the process of permanent teeth eruption into two active periods by an interval of rest between them, the 1st period being concerned with the eruption of M_1, I_1 and I_2 and the 2nd period with the eruption of C, P_1, P_2, and M_2. In the present study the interval of rest in the total sample was 3.26

years in boys, and 2.9 years in girls (Table XIV). The interval of rest in the present sample was longer than that of other ethnic groups.

The classic sequence of eruption for both gender as given in the text books for the upper arch is M_1, I_1, I_2, P_1, C,P_2, M_2 and for lower arch it is I_1,M_1, I_2, C, P_1, P_2, M_2. In the present study the mean sequence of eruption followed the classic pattern except for the males in the lower arch which was same as in the upper arch. However cross-sectional study gives only the mean sequence of eruption and exact order of eruption could be found only through a longitudinal study.

Conclusions

1. The permanent teeth erupt earlier in children in Pakistan than in other parts of the world except Africa. As investigation of this kind have not previously been carried out in Pakistan, the results may be regarded as being of value for Dentists, Orthodontists and others concerned with the children's health and development.
2. Norms derived from this study are earlier than the Caucasians norms, which are in use at present, so while planning preventive and interceptive orthodontic measures, the local standards should be applied.
3. Statistically significant differences between the timings of eruption of some permanent teeth of males and females indicated earlier eruption in girls than in boys.
4. All the mandibular teeth erupted earlier than their corresponding maxillary teeth except the premolars.
5. The sequence of eruption favored interceptive orthodontics in crowded maxillary teeth of both sexes and in the mandibular teeth of males only. In females mandibular canines preceded the mandibular first premolars.

References

1. Muniz B. Chronology of permanent teeth eruption in Argentinean children. Rev Assoc Odontol Argent. 1988; 76: 222-8.
2. Hagg U, Taranger J. Timings of tooth emergence. Swed Dent J. 1986; 10:195-206.
3. Ghose LJ, Baghdady VS. Erution time of permanent teeth in Iraqi school children. Arch Oral Biol. 1981; 26: 13-5.
4. Kochhar R, Richardson A. The chronology and sequence of eruption of human permanent teeth in Northern Ireland. Int J Paediatr Dent. 1998; 8:243-52.
5. Saleemi M, Jalil F, Karlberg J, Hagg U. Early child health in Lahore, Pakistan: XIII. Primary teeth emergence. Acta Paediatr. 1993; 390 (Suppl): 159-67.
6. Meinhard R. The eruption of the deciduous teeth. (Factors involved in timing). Enviormental Child Health June. (Special issue) 1973.
7. Hassanali J, Odhiambo JW. Ages of eruption of the permanent teeth in Kenyan African and Asian children. Ann Hum Biol. 1981; 8:425-34.
8. Nykanen R, Espeland L, Kvaal SI, Krogstad O. Validity of the Demirjian method for dental age estimation when applied to Norwegian children. Acta Odontol Scand. 1998; 56: 238-44.
9. Nanda RS. Eruption of human teeth. Am J Orthod. 1960; 46: 363-78.
10. Hagg U, Matsson L. Dental maturity as an indicator of chronological age: the accuracy and precision of three methods. Eur J Orthod. 1985; 7:25-34.
11. Nystrom M, Ranta R, Kataja M, Silvola H. Comparison Of dental maturity between the rural community of Kuhmo in northeastern Finland and the city of Helsinki. Community Dent Oral Epidemiol. 1988; 16: 215-7.
12. Moorrees CFA, Fanning EA, Hunt, Jr EE. Age variation of formation stages for ten permanent teeth. J dent Res. 1963; 42: 1490-1502.
13. Liliequist B, Lundberg M. Skeletal and tooth development. A methodological investigation. Acta Radiol.s 1971; 11:97-112.
14. Gustafson G, Koch G. Age estimation upto 16 years based on dental development. Odontologisk Revy. 1974;25:297-306.
15. Demirijan A, Goldstien H, Tanner JM. A new system of dental age assessment. Ann Hum Biol. 1973;45:211-27.
16. Demirijan A, Goldstien H. New system for dental maturity based on seven and four teeth. Ann Hum Biol. 1976;3:411-21.
17. Haavikko K. Tooth formation age estimated on a few selected teeth. Proc Finn Dent Soc.1974;70:15-9.
18. Anderson DL, Thompson GW, Popovich F. Inter-relationship of dental maturity, skeletal maturity, height and weight from age 4 to 14 years. Growth. 1975;39:453-62.

19. Blankenstein R, Cleaton-Jones PE, Maintry PK, Luk KM, Fatti LP. The onset of eruption of permanent teeth amongst South African Indian children. Ann Hum Biol. 1990; 17: 515-21.
20. Hitchkock NE, Gilmour AJ, Gracey M, Kailis DG. Australian longitudinal study of time and order of eruption of primary teeth. . Community Dent Oral Epidemiol. 1984; 12: 260-3.
21. Pahkala R, Pahkala A, Laine T. Eruption pattern of permanent teeth in a rural community in northeastern Finland. Acta Odontol Scand. 1991; 49: 341-9.
22. Jara , Ondarza A, Blanco R, Valenzuela C. The sequence of eruption of the permanent dentition in a Chilean sample with Down's syndrome. Archs Oral Biol. 1993; 38: 85-9.
23. Adams CP. Changes in occlusion and craniofacial pattern during growth, transaction of the European Orthodontics Society. 1972: 85-96.
24. Helm S. Seidler B. Timing of permanent tooth emergence in Danish children. Community Dent Oral Epidemiol. 1974; 2: 122-9.
25. Friedlaender JS, Bailit HL. Eruption times of the deciduous and permanent teeth of natives of Bougainville Island, territory of New Guinea: A study of racial variation. Hum Biol. 1969; 41:51-65.
26. Magnusson TE. Emergence of permanent teeth and onset of dental stages in the population of Iceland. Community Dent Oral Epidemiol. 1976; 4: 30-7.
27. Magnusson TE. Emergence of primary teeth and onset of dental stages in Icelandic children. Community Dent Oral Epidemiol. 1982; 10: 91-7.
28. Lee MMC, Low WD, Chang KSF. Eruption of the permanent dentition of Southern Chinese children in Hong Kong. Arch Oral Biol. 1965; 10: 849-61.
29. Helm S. Secular trend in tooth eruption. A comparative study of Danish school children of 1913 and 1965. Archs Oral Biol. 1969; 14: 1177-91.
30. Savara BS, Steen JC. Timing and sequence of eruption of permanent teeth in a longitudinal sample of children from Oregon. JADA. 1978; 97: 209-214.
31. Tanguay R, Demirijian A, thibault HW. Sexual dimorphism in the emergence of the deciduous teeth. J Dent Res. 1984; 63: 65-8.
32. Hiedmann J. Comparison of different methods for estimation human tooth-eruption time on one set of Danish national data. Archs Oral Biol. 1986; 31:815-7.
33. Cattell P. Dentition as a measure of maturity. Harvard monographs in education No 9; Boston 1928: Harvard University Press.
34. Suk V. Eruption and decay of permanent teeth in Whites and Negroes. Am J Phys Anthropol. 1919; 2: 351.
35. Eveleth PB. Eruption of permanent dentition and menarche of American children living in the tropics. Ann Hum Biol. 1960; 38: 60-70.
36. Dahlberg AA, Menegaz-Bock RM. Emergence of the permanent teeth in Pima Indian children. J Dent Res. 1958;37:1123-40.
37. Virtanen JI, Bloigu RS, Larmas MA. Timing of eruption of permanent teeth: standard Finnish patient documents. Community Dent Oral Epidemiol. 1994; 22: 286-8.
38. Miler J, Hobson P, Gaskell T J. A serial study of the chronology of exfoliation of deciduous teeth and eruption of permanent teeth. Arch Oral Biol. 1965; 10: 805-18.
39. Liversidge HM, Speechly T. Growth of the permanent mandibular teeth of British children aged 4 to 9 years. Ann Hum Biol. 2001; 28: 256-62.
40. Hellman M. The phase of development concerned with erupting the permanent teeth. Am J Ortho. 1943; 29: 507-26.