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Statistical presentation of eruption age of permanent second molars, premolars and canines in female school children living in Riyadh, Saudi Arabia

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OBJECTIVES: To determine the mean eruption times of permanent canines, premolars and second molars; and the relationship of the eruption times of these teeth with height, weight and Body Mass Index (BMI) in Saudi female school children in Riyadh. ***DESIGN***: Cross-sectional study using stratified cluster random sampling. ***PLACE and DURATION***: The data were collected within one and a half months (September to October 2005) from 10 schools of Riyadh, Saudi Arabia. ***SUBJECTS and METHODS***: The study comprised female school children of grade 4 to grade 9 from primary and intermediate schools in Riyadh. Ten schools (8 public and 2 private) were randomly selected from four regions of Riyadh City. A total of 3186 children were examined of which 889 children were found suitable for the study. Clinical examination was carried out under natural light by direct visual inspection and manual palpation. Height and weight of the selected subjects were recorded. Demographic information on age, educational level, date of birth, place of birth and family name of the children were recorded from the school record. ***RESULTS***: The mean age of 889 subjects was 11.58 ± 1.57 years (R: 8.8 – 16.1 years). Mandibular left canine showed the lowest mean eruption age of 10.5 ± 0.9 years. Maxillary left second molar showed the highest mean eruption time of 13.0 ± 1.3 years. Maxillary second molars and maxillary canines showed significantly late eruption than the corresponding mandibular teeth ($P < 0.0001$). All comparisons of contralateral teeth were insignificant ($P > 0.05$), except the maxillary second molars and second premolars ($P = 0.025$ and $P = 0.012$, respectively). Eruption time was significantly positively correlated, linear as well as partial, with height of the children for all the studied teeth. However, the partial correlation with weight was negatively correlated for all the studied teeth except maxillary right second premolar. There was no statistically significant correlation between eruption time and BMI ($P > 0.05$). ***CONCLUSIONS***: Mandibular left canine showed the lowest mean eruption time, while maxillary left second molar showed the highest mean eruption time. The mandibular teeth erupted before their maxillary counterparts, except right second premolar and left first premolar. Eruption of teeth was positively related to somatic growth (height and weight), while it became negatively correlated with weight, when height was controlled.

INTRODUCTION

Eruption of teeth is a normal physiologic phenomenon which starts with the eruption of primary teeth and then followed by permanent dentition. The first permanent tooth erupts approximately after the age of 5 years. Only few studies[1-3] are published from Middle Eastern countries on the eruption age of permanent teeth. Therefore, the information utilized in the academic and clinical situations on the eruption time of permanent teeth in Middle Eastern countries is still based on American and European standards.[4,5] However, it is indicated in the literature that the standards for tooth emergence time should be derived from the population in which they are to be applied because factors related to emergence time may vary considerably in both dentitions among different populations.[6] It is desirable to have suitable reference standards which ensure international comparability to assist clinicians in diagnosing cases of delayed or early tooth eruption.[7,8] Also an adequate knowledge and timing of emergence is essential for the guidance of dentition development and for the

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diagnosis of developmental disturbances.[9] Furthermore, the information about the timing of permanent tooth emergence is essential for diagnosis and treatment planning in Pediatric Dentistry and Orthodontics.[10] Developmental norms of emergence of permanent teeth also need to be established for anthropological use.[11] Moreover, the information on tooth emergence is also used to supplement other maturity indicators in the diagnosis of certain growth disturbances, and in forensic dentistry to estimate the chronological age of children with unknown birth records.[9,12,13]

In the literature, the eruption time of permanent teeth has been studied among different populations and ethnic groups.[1-3, 9-11, 14-31] The results of these studies showed that variation in permanent teeth eruption time may be attributed to numerous factors of racial differences,[13,14,16,20] sexual maturity, genetics and hormones,[27,30,31] geographical location, tribal identity, gender, as well as socioeconomic status, nutrition and growth parameters.[13,16,17,20,21,35] Few studies have also reported a relationship between the eruption time and the height plus the weight of children.[16,27,38] Consumption of drinking water of different concentration level of fluoride for varying periods of time did not show any discernible influence on times or sequence of eruption.[36] In Saudi Arabia, literature shows that only one study was conducted for primary teeth[37] and two were reported for permanent incisors and first molars of schoolchildren.[1,2] However, there is no information available on the eruption time for other permanent teeth.

The objectives of the present study were to determine the mean eruption time of permanent canines, premolars and second molars, and to find out the relationship of the eruption age of these teeth to the height, weight and BMI of Saudi female school children in grade 4 to grade 9.

SUBJECTS AND METHODS

The population used for this cross-sectional study comprised schoolgirls of grade 4 to grade 9 from primary and intermediate schools of Riyadh, Saudi Arabia. Eight government schools (4 primary and 4 intermediate) were randomly selected from four regions of Riyadh urban area, from the list of schools provided by the Ministry of Education, Riyadh. Since the number of private schools in Riyadh is about 25% when compared to public schools, two private schools (one primary and one intermediate) were therefore also randomly selected to ensure the proportional representation. Prior to the commencement of the study, permission was taken from the Ministry of Education. Letters were sent to the respective heads of the schools stating the aims and objectives of the study. Examiners were trained and calibrated for the clinical examination of just-erupted teeth by showing them clinical pictures. The sampling employed for this study was stratified cluster random sampling. The purpose and procedure were explained and verbal consent was taken from the parents of the children before the screening. All the children from the selected schools were screened and the children who are Saudis and have at least one tooth 'just-erupted' were subjected to further examination. The criterion for 'just-erupted' tooth was a tooth deemed to have emerged if any part of it (incisal edge or cusp of permanent tooth) was visible in the oral cavity.[12] Therefore, if the child were non-Saudi or did not have any tooth 'just-erupted', she was excluded from the study. A total of 3186 children were examined and only 889 of them fulfilled the criteria mentioned above. The data were collected within one and a half months (September 2005 to October 2005).

The clinical dental examination was carried out by three investigators (DS, RJ and RS) under natural light by direct visual inspection and manual palpation with gloves. Sometimes, a dental mirror was also used for the inspection of second maxillary molars. Two investigators (FN and TY) recorded all the information on specially designed form for the study. The teeth extracted due to caries or for orthodontic reason were recorded as having emerged. No radiographs were taken in this study. Height and weight of the selected sample were recorded after the clinical examination. The children were weighed in kilograms using a commercial digital scale after removal of the shoes only. The height of the children was measured using a wall-mounted tailor tape on the child's head with their back and knees completely straight, and their feet together. The height was then rounded to the nearest centimeter. The basic demographic information about the children such as age, educational level, date of birth, place of birth and family name were recorded from their personal files of the school record.

The data were then entered into the computer utilizing the Statistical Package for Social Science (SPSS) program version 10. Descriptive statistics (minimum, maximum, mean, standard deviation, median and range) of eruption time was computed for each tooth. Different percentiles (3^{rd}, 10^{th}, 25^{th}, 75^{th}, 90^{th} and 97^{th}) of the eruption time of studied teeth were also calculated. BMI was calculated using the following formula:

$$BMI = \frac{\text{Weight (kg)}}{(\text{Height (m)})^2}.$$

Independent two-sample 't' test was used to find the significant difference in the mean eruption time of each antagonistic tooth between maxillary and mandibular jaws, and contralateral tooth of right with left quadrants. Only few children in the sample showed 'just-erupted' contralateral or antagonistic teeth at the same time. Since independent two-sample 't' test is not valid for such cases, they were therefore excluded for such statistical analysis. Pearson correlations were determined between eruption time and height, weight and BMI. In addition, partial correlations were also calculated between eruption time and height plus weight.

RESULTS

The mean age of 889 female school children was 11.58 ± 1.57 years (R: 8.8 – 16.1 years). The descriptive statistics (number of cases, minimum, maximum, mean, standard deviation, median and range) with 95% confidence interval of time of eruption for study teeth is shown in Table 1. Mandibular left canine (# 33) showed the lowest mean eruption time of 10.5 ± 0.9 years (R: 8.8 – 14.1 years), followed by mandibular right canine (# 43) of 10.6 ± 1.1 years (R: 8.8 – 14.1 years). Maxillary left 2^{nd} molar (# 27) showed the highest mean eruption time of 13.0 ± 1.3 years (R: 10.1 – 16.1 years) while the maxillary right 2^{nd} molar (# 17) showed the second highest mean value of 12.6 ±1.4 years (R: 9.8 – 16.1years). In the maxillary, the first premolars (# 14 and # 24) showed the lowest range for eruption time of 5.2 years and 5.4 years respectively, while canines (# 13 and # 23) showed the largest range of 7.0 years. However, in the mandible, the right first premolar (# 44) indicated the lowest range of 5.1 years, while the left second premolar (# 35) showed the largest range of 6.1 years. Ninety-five percent of confidence interval of means ranged from 10.3 years to 13.3 years for the teeth. Table 2 showed different percentiles (3^{rd}, 10^{th}, 25^{th}, 75^{th}, 90^{th} and 97^{th}) for the eruption time. Three

Table 1. Descriptive statistics of eruption age (years) of 2nd molars, pre-molars and canines.

Tooth No.	No. of cases	Min	Max	Mean	SD	Median	Range	95% CI of mean (lower, upper)
17	81	9.8	16.1	12.6	1.4	13.1	6.3	(12.9 ,12.3)
15	48	9.4	15.1	11.8	1.4	11.5	5.7	(12.1 ,11.3)
14	90	8.9	14.1	10.7	1.1	10.5	5.2	(10.9 ,10.5)
13	173	9.1	16.1	11.8	1.5	11.6	7.0	(12.0 ,11.6)
23	163	9.1	16.1	11.9	1.5	11.6	7.0	(12.1 ,11.7)
24	100	8.8	14.1	10.8	1.1	10.6	5.4	(10.1 ,10.5)
25	45	9.0	15.1	11.0	1.4	11.1	6.1	(11.4 ,10.6)
27	83	10.1	16.1	13.0	1.3	13.1	5.9	(13.3 ,12.7)
33	98	8.8	14.1	10.5	0.9	10.3	5.4	(10.7 ,10.3)
34	77	9.1	15.1	10.7	1.2	10.5	6.0	(11.0 ,10.5)
35	49	9.0	15.1	11.4	1.6	11.2	6.1	(11.8 ,10.9)
37	179	9.2	15.1	11.9	1.3	11.7	5.9	(12.1 ,11.7)
47	158	9.2	15.1	11.7	1.2	11.5	5.9	(11.9 ,11.5)
45	63	9.3	15.1	11.8	1.4	11.5	5.8	(12.1 ,11.4)
44	76	9.0	14.1	10.8	1.1	10.8	5.1	(11.1 ,10.6)
43	120	8.8	14.1	10.6	1.1	10.4	5.4	(10.8 ,10.4)

percent of the girls in the sample had at least one of their canines erupted by the age of 9.1 years and 97% of the girls had all their four canines erupted by the age of 14.9 years. Ninety-four percent of the girls had all their first maxillary and mandibular premolars erupted between the age of 9.1 years and 14.7 years. Age range for any tooth was within 2.7 years in 50% of the sample (P75 – P25).

Figures 1 and 2 compared the mean values of antagonistic teeth of maxillary with mandibular jaws and contralateral teeth of left with right quadrants. Since few cases were dropped due to the eruption of contralateral or antagonistic teeth to the same child, the mean eruption time shown in the graphs could be fractionally different than the values mentioned in Table 1. Maxillary second molars (# 17 and # 27) and maxillary canines (# 13 and # 23) showed significantly later eruption than the corresponding mandibular teeth ($P < 0.0001$) as shown in Figure 1. All comparisons of right to left quadrants were insignificant ($P > 0.05$) except the maxillary second molars (#17 versus #27) and second premolars (#15 versus #25) ($P = 0.025$ and $P = 0.012$, respectively).

Table 2. Percentiles (3rd, 10th, 25th, 75th, 90th and 97th) for eruption times of 2nd molars, premolars and canines.

Tooth No.	P3	P10	P25	P75	P90	P97
17	10.2	10.9	11.4	13.6	14.1	15.1
15	9.5	9.8	10.5	13.1	14.1	14.6
14	9.0	9.5	9.9	11.3	12.1	13.4
13	9.4	9.8	10.5	13.1	14.1	14.9
23	9.3	10.0	10.8	13.1	14.1	14.2
24	9.1	9.3	9.8	11.4	12.2	13.1
25	9.0	9.2	9.9	11.6	13.1	14.7
27	10.2	11.2	12.2	14.1	14.1	16.1
47	9.4	10.3	10.9	12.4	13.1	14.1
45	9.5	10.2	10.4	13.1	14.1	14.2
44	9.1	9.5	10.0	11.3	12.2	14.1
43	9.1	9.4	9.8	11.3	12.2	13.1
33	9.2	9.6	9.9	11.2	11.7	12.2
34	9.2	9.5	9.9	11.3	12.7	14.1
35	9.l	9.3	10.0	12.4	14.1	14.6
37	9.6	10.3	10.9	13.1	14.1	14.1

Table 3 demonstrated the Pearson linear correlations of eruption time with height, weight and BMI, and partial correlations of eruption time with height and weight. Eruption time was significantly positively correlated, linear as well as partial, with height of the children for all the teeth. Eruption time was also significantly positively and linearly correlated with the weight of the children for all the teeth except right second molar (# 47), right first premolar (# 44), right canine (# 43) and left canine (# 33) of mandibular jaw. The partial correlation with weight became negatively correlated for all the teeth except maxillary right second premolar (# 15). However, it was only statistically significant for maxillary left canine (# 23), mandibular right second molar (# 47) and mandibular canines (# 33 and # 43) ($P < 0.05$). There was no statistically significant correlation between eruption time and BMI ($P > 0.05$).

Table 4 showed the comparison of our data with female children from Sweden, Ghana, Nigeria, Japan, USA, Australia and Iran. It can be seen that the eruption times of permanent teeth of Ghanaian, Nigerian and Japanese female children were earlier than Saudi female children. The Iranian female children showed later

Table 3. Correlations of eruption time of 2nd molars, premolars and canines with height, weight and BMI.

Tooth type	No. of cases	Height				Weight				BMI	
		Pearson correlation		Partial correlation		Pearson correlation		Partial correlation		Pearson correlation	
		r	*P*-value	r	*P*- value	r	*P*- value	r	*P*- value	r	*P*- value
17	81	0.643	<0.0001	0.615	<0.0001	0.266	0.017	-0.134	0.240	0.0	0.999
15	48	0.735	<0.0001	0.652	<0.0001	0.450	0.001	0.067	0.660	0.081	0.588
14	90	0.428	<0.0001	0.390	<0.0001	0.212	0.046	-0.088	0.416	0.015	0.886
13	173	0.669	<0.0001	0.606	<0.0001	0.372	<0.0001	-0.134	0.080	0.075	0.330
23	163	0.656	<0.0001	0.647	<0.0001	0.252	0.001	-0.219	0.005	-0.068	0.387
24	99	0.594	<0.0001	0.572	<0.0001	0.272	0.006	-0.191	0.060	0.014	0.892
25	45	0.663	<0.0001	0.569	<0.0001	0.414	0.005	-0.022	0.887	0.132	0.386
27	83	0.525	<0.0001	0.468	<0.0001	0.273	0.013	-0.029	0.794	0.107	0.338
47	158	0.489	<0.0001	0.517	<0.0001	0.087	0.279	-0.211	0.008	-0.135	0.091
45	63	0.588	<0.0001	0.534	<0.0001	0.303	0.016	-0.089	0.491	-0.018	0.891
44	76	0.320	0.005	0.264	0.022	0.194	0.094	-0.049	0.676	0.081	0.486
43	119	0.504	<0.0001	0.561	<0.0001	0.145	0.116	-0.318	<0.0001	-0.115	0.214
33	98	0.497	<0.0001	0.501	<0.0001	0.196	0.053	-0.208	0.041	-0.062	0.544
34	77	0.489	<0.0001	0.431	<0.0001	0.245	0.033	-0.146	0.213	0.017	0.881
35	49	0.708	<0.0001	0.637	<0.0001	0.429	0.002	-0.164	0.265	0.104	0.479
37	179	0.575	<0.0001	0.532	<0.0001	0.267	<0.0001	-0.083	0.273	0.001	0.993

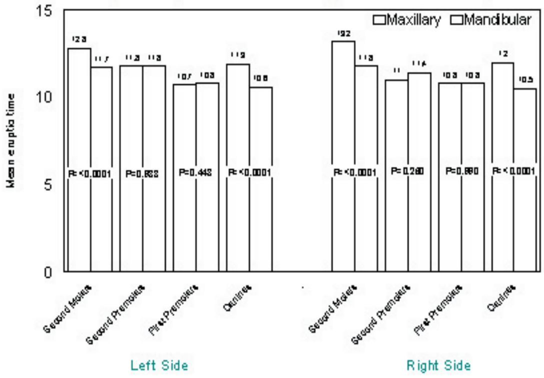

Fig. 1. Comparison of mean eruption time of the corresponding teeth of maxillary and mandibular jaw.

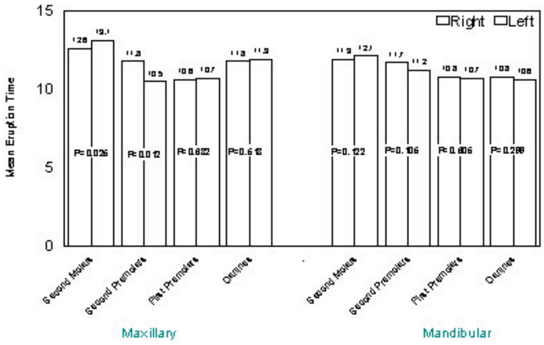

Fig. 2. Comparison of mean eruption time of corresponding teeth of right and left side.

eruption times than Saudi female children except for maxillary second molars (# 17 and # 27) and mandibular canines (# 33 and # 43). Sweden and USA female children showed early eruption than Saudi female children for all the studied teeth except maxillary left second premolar (# 25). The mandibular right second molar (# 47) of Swedish and USA female children showed almost the same eruption time as Saudi female children.

Table 4. Comparison of eruption age of Saudi female children with the female children of other countries.

Tooth No.	Sweden 1986*	Ghana 1967*	Nigeria 1971*	Japan 1984*	USA 1978*	Australia 2003*	Iran 2004*	Saudi Arabia
17	12.0	10.9	11.4	12.3	12.1	12.3	12.5	**12.6**
15	11.0	10.0	10.0	10.3	11.2	11.7	12.5	**11.8**
14	10.3	9.0	10.1	9.3	10.5	10.8	11.0	**10.7**
13	10.8	9.5	10.2	10.3	11.0	11.2	12.1	**11.8**
23	10.8	9.5	10.2	10.3	11.0	11.2	12.1	**11.9**
24	10.3	9.0	10.1	9.3	10.5	10.8	11.0	**10.7**
25	11.0	10.0	10.0	10.3	11.2	11.7	12.5	**11.0**
27	12.0	10.9	11.4	12.3	12.1	12.3	12.5	**13.0**
37	11.6	10.5	10.9	11.5	11.8	11.8	12.4	**11.9**
35	11.2	10.3	10.6	10.4	11.1	11.7	12.5	**11.3**
34	10.3	9.2	9.9	9.7	10.4	10.6	11.0	**10.7**
33	9.5	8.9	9.9	9.2	9.9	10.1	10.0	**10.5**
43	9.5	8.9	9.9	9.2	9.9	10.1	10.5	**10.6**
44	10.3	9.2	9.9	9.7	10.4	10.6	11.1	**10.8**
45	11.2	10.3	10.6	10.4	11.1	11.7	12.6	**11.8**
47	11.6	10.5	10.9	11.5	11.8	11.8	12.4	**11.7**

* Publication year

DISCUSSON

As mentioned earlier, there are no reports available on eruption times for permanent canines, premolars and second molars for Saudi children. Therefore, the present study provides basic information on those permanent teeth in Saudi female school children and the eruption time of their permanent teeth.

In this study, each tooth was marked as 'unerupted', 'just-erupted' or 'erupted'. The investigators were calibrated and trained by the clinical pictures. No casts or subjects were used for inter or intra examiner calibration because it was relatively easy to distinguish the three different conditions for a tooth. Virtanen[38] indicated that the criteria for tooth emergence are so clear that evaluation of the error of the method is not necessary. Kochhar[39] also mentioned that it was relatively simple to decide whether a tooth has emerged or not.

Since the study was not a hospital-based study, radiographs were not available. Consequently, it was not possible to determine the congenitally missing teeth. Holman *et al.*[40] reported the impact on congenitally missing teeth on the mean eruption time. They concluded that estimates of eruption time without considering congenitally teeth were biased upward (always less than 1%) and the standard deviations were consistently overestimated by 3-5%. However, for adequate sample sizes agenesis does not lead to substantially biased estimates. Furthermore, Leroy[10] indicated that frequently congenitally missing teeth is the lateral maxillary incisor and mandibular second premolar. In this study, the sample size was large enough and study teeth did not include one of frequently congenitally missing teeth (incisors). Therefore, the effect of congenitally missing teeth would be very insignificant.

In our study, it was observed that the mandibular teeth erupted earlier than the corresponding maxillary teeth, except for the right first premolars and left second premolars. However, statistically significant difference occurred only between second molars and canines. The results of our study are in agreement with data from several other similar studies carried out in various populations.[9,10,17,18,23,27] This study observed a significant difference between the eruption time of the contralateral maxillary second molar and second premolar. Otherwise, there was no significant difference between any other contralateral teeth of the left and right quadrants. Contrary to our data, most of the studies did not find any significant difference between the eruption time of any of the teeth of the left and the right sides because the differences observed were very small.[10,16-18,28,29,41]

In our study, it was observed that eruption of teeth was positively related to somatic growth (height and weight) and the results are in agreement with Billewicz[16] and Agarwal[27]. The partial correlations between eruption times with heights (controlling the weights) were not very much different to the Pearson linear correlations (without controlling the weight). Pearson linear correlations of eruption times with weight (without controlling height) were all positive and statistically significant. However, when partial correlations with weights were computed (controlling the height), all the values became negative except for one tooth and four of those negative correlations were statistically significant. Therefore the children, who are tall, are expected to have delayed eruption, irrespective of their weight. However, if they are heavy, it would be early eruption if they are not tall and delayed eruptions if they are tall because the results showed highly significant positive correlation between height and weight of the children. Due to these conflicting outcomes of height and weight, the BMI did not show any significant correlation. The mean eruption times of Saudi children were later than those reported in children from Ghana[15], Nigeria[19] and Japan[28]. Furthermore, Swedish and USA females also showed earlier eruption time than Saudi female children except maxillary left second premolar and mandibular left second molar. Whereas, Iranian[23] children showed later eruption time than Saudi children, except for maxillary second molars and mandibular canines. Several studies[13,24,41,43] indicated that African and African-American children showed early eruption than Indian or Caucasians. However, Saudi females showed even later eruption than Caucasians but early eruption than Iranian females. Stated in another way, Saudi female children showed different eruption times than African, Caucasian and Iranian children. Several studies in various populations have thought that factors like nutrition, socio-economic status, genetics, sexual maturity and geographic location could influence the emergence time of teeth.[15,19,27,30,42-43] Clemens *et al.*[31] claimed in their study that mean emergence time was earlier in the children with higher socio-economic status. Our study cannot answer the question whether the differences of Saudi female school children are mainly due to genetic or environmental factors. However, the numerous racial differences in the literature for eruption time of permanent teeth may be real.

As many other studies[44,45] have shown that caries prevalence is high among Saudi children and a high percentage of them are untreated, consequently the carious deciduous teeth are lost without treatment. Hence, crowding occurred due to early loss of deciduous teeth and therefore other teeth erupted late. One study[46] showed that children with loss of primary molars before 7½ years developed more crowding than children without losses and losses after 7½ years had little effect on the relative space.

The study was limited to the female school children, as it was conducted by female dentists in all-female primary schools only because of the socio-religious norms of Saudi Arabia. Nevertheless, the study has provided useful information about the mean eruption times of permanent second molars, premolars and canines in female primary school children of grade 4 to grade 9 in Riyadh City. These findings may be helpful to the academicians and health educationists to modify the teaching materials in Saudi Arabia and possibly in the other Middle Eastern countries.

A large scale study covering all the regions of Saudi Arabia and age groups is recommended for a large baseline data set which could confirm these findings. Furthermore, a longitudinal study could be designed to explore the possible disturbing factors, such as caries, crowding and early loss of deciduous teeth,[47] on the eruption time of permanent teeth.

CONCLUSIONS

- The maxillary right first premolar had the lowest eruption times of 10.3 years followed by mandibular canines (10.4 years) respectively. Whereas, maxillary and mandibular second molars were the last teeth to erupt.
- The mandibular teeth erupted before their maxillary counterparts except right second premolar and left first premolar.
- There was no statistically significant difference observed in mean eruption times between left and right corresponding study teeth except maxillary second premolars and second molars.
- A positive correlation of eruption time was observed with height and weight of the children.

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