

Timing of Permanent Teeth Emergence and Dental Caries among Jatsikh Children of Public and Government Schools of Patiala District

Inderjeet Kaur, P. Singal and D.P. Bhatnagar

Department of Human Biology, Punjabi University, Patiala 147 002, Punjab, India

KEYWORDS Teeth Emergence. Caries. Socio-Economic Level. School Children. Public Schools. Government Schools

ABSTRACT The purpose of this study is to establish the median timing of permanent teeth emergence in a low to high socio-economic level school children. A sample of 1648 Jat-Sikh children which includes 821 children (452 boys, 369 girls) from public schools and 827 children (377 boys, 460 girls) from government schools forms the basis of this study. Each child has been studied for permanent dental eruption and dental caries. The median emergence times have been found in general relatively advanced in public school children with few exceptions although differences are not to the level of significance when compared with government school children. The girls from both public and government schools have been found to be relatively advanced in their emergence times except for first maxillary molar and mandibular central incisors which make their appearance earlier in public school boys and the differences have been found to be statistically non significant. Therefore no differences in dental eruptions between Govt. and Public schools have been observed. No bilateral differences and no sex differences in eruption timings have been observed. The incidence of dental caries has been found to be high in public school children i.e. 7.30% in boys and 8.94% in girls as compared to government school children, where the percentage has been found to be 6.36% in boys and 5.77% in girls

INTRODUCTION

Growth, development and maturity in human population can be studied by understanding different physiological processes. These processes which may vary with age and sex can be measured through various maturity measures – morphological, dental, skeletal, secondary sex characters and mental age. Dental maturity can be assessed through the age of eruption of teeth. Some of the studies have reported data on time and sequence of eruption of permanent teeth. (Clements et al. 1955; Eveleth 1966; Malcom 1970; Sidhu and Gupta 1973; Kaul 1975; Garcia-Goday 1983; Bhatnagar and Kumar 1986; Kaur 1990; Virtanen et al. 1994; Limbu 1996; Rasmussen and Kotsaki 1997; Eskeli et al. 1999; Parner et al. 2002; Rousset et al. 2003; Gaur and Singhal 2005 and Friedrich et al. 2006). Man is provided with two sets of teeth, which make their appearance at different period of life. The first set of dentition is called temporary or deciduous dentition. Deciduous teeth erupt from 6 months to 2 years of age and are 20 in number, whereas the permanent teeth erupt between 5 to 16 years of age and M_3 completes its eruption by about 25 years of age.

Teeth eruption is generally defined as the time when any part of the crown has emerged through

the gingival surface. The age and order of eruption of permanent teeth show as much marked variation between one individual and other as among the different racial groups within the same region and outside. There are definite genetic factors that influence the entire dentition (Singh 1980 and Reddy 1984).

An accurate knowledge of contemporary dental emergence pattern is important for monitoring occlusal development, diagnosing malocclusions and efficiently planning the dental treatment of children and adolescents. The eruption of teeth is related to the chronological age, sex and ethnic origin (Demirjian and Levesque 1980 and Virtanen et al. 1994). An increased variance related to ethnic groups, socio-economic status a phenomenon of secular trends has been reported (Harris 1991; Virtanen et al. 1994; Eskeli et al. 1999; Campus et al. 2001; Parner et al. 2002 and Psoter et al. 2005). Adler and Charzewski (1963) have shown that the children living in urban area are ahead of their counterparts from rural areas while studying dental eruption. Lee et al. (1965) observed that the time of eruption of 28 teeth was not significantly different in children of three socio-economic classes in Hong Kong. In 1990, Harris and Mckee demonstrated accelerated emergence in black American of lower-socio-economic status.

In general dental development appeared to be accelerating but there is an inherited "general maturation factor" association with early or late emergence patterns (Rasmussen and Kotsaki 1997). A substantial variation of tooth emergence pattern may be an indication of compromised systemic health (Kjellberg et al. 2000).

Nandanovsky and Sheiham (1995) described how socio-economic variables had influenced caries experiences in 18 countries throughout the 1970s and early 1980s and demonstrated that the biological factors acting on caries development are firmly correlated with social variable as well. Nicolau et al. (2003) also reported association between socio-economic and biological factors in very early life and levels of caries in adolescents.

In the last 25 years, caries prevalence in the USA and most North-West European countries has declined dramatically (Marthaler et al. 1996). The presence of comprehensive care system has played an important role in the caries decline (Benn et al. 1998 and Utriainen et al. 1998). Tickle et al. (1999) reported that behavioral and the socio-economic status of family has direct influence on parental attitudes towards dental care. Tickle et al. (2003) also reported that families living in deprived areas have shown more dental care than their more affluent counterparts.

In the present study an attempt has been made to study the dental age and dental caries in relation to socio-economic status.

Aims and Objectives

The present research work has been conducted with following aims and objectives:

1. To study the sequence and age of eruption of permanent teeth in Jatsikh children of public and government schools.
2. To study bilateral and maxillo-mandibular differences in the eruption of teeth.
3. To study the sex differences in the sequence and age of eruption of teeth.
4. To study the prevalence of dental caries and liability of individual tooth to caries.

MATERIAL AND METHOD

The present study is based on a cross-sectional data collected on 1648 children, 821 from public schools (452 boys, 369 girls) and 827 from government schools (377 boys and 450 girls) ranging in age from 5 to 16 years. All the subjects

of the present study are of Punjabi origin and belonging to one endogamous group i.e. Jat Sikh. The data have been collected from public and government schools situated in urban areas of Patiala district. Date of birth was obtained from the parents and the subjects and then verified from the school records and doubtful cases were excluded from the study. On the basis of the date of birth of the subjects and date of examination, the decimal age of the subjects has been calculated up to three decimal places. To calculate the decimal age, decimal calendar given by Tanner et al. (1969) was used. The data collected have been grouped in various age groups of one year duration, from 5 to 16 years. For example, the age group 5 includes all subjects from 4.500-5.499 years, the age group 6 from 5.500-6.499 and so on. The data have been arranged in 12 age groups. The number of subjects studied in various age groups and mean age in each age group for public and government school children belonging to both the sexes have been presented in table 1.

Dental age has been determined on the basis of permanent teeth eruption. The eruption of M_3 has not been studied in present investigation as the age range of the present sample is between 5 to 16 years. Permanent dentition has been recorded as follows:

Right	Left
$\underline{M_3, M_2, P_2, P_1, C, I_2, I_1}$	$= \underline{I_1, I_2, C, P_1, P_2, M_1, M_2, M_3}$
$M_3, M_2, P_2, P_1, C, I_2, I_1$	$= I_1, I_2, C, P_1, P_2, M_1, M_2, M_3$

A tooth has been considered to be erupted only when a portion of the crown of the tooth, however, small, has penetrated the gingiva. Gingival emergence has been used as the criterion of the eruption. Wooden spatule have been used to open the mouth to see the eruption of posterior teeth. Prevalence of Caries or any dental congenital malformation if present, has also been recorded. Probit analysis has been applied to calculate the median age of eruption and standard error of median age for all the teeth erupted.

RESULTS AND DISCUSSION

Age and Sequence of Permanent Dentition

The median age of eruption and standard error of median age of all the teeth of both the sides and of both the jaws in the children of both the

Table 1: Number of subjects studied in various age groups and mean age in each age group for public and government school children belonging to both the sexes

Age-group (in years)	Public School				Government School			
	No. of sub.	Mean age (Boys)	No. of sub.	Mean age (Girls)	No. of Sub.	Mean age (Boys)	No. of sub.	Mean age (Girls)
4.500-5.499	31	5.199	30	5.088	30	5.147	30	5.154
5.500-6.499	30	5.932	34	6.013	32	6.187	30	6.157
6.500-7.499	33	7.031	30	7.011	30	7.237	30	7.031
7.500-8.499	30	8.020	31	7.988	37	8.091	30	8.012
8.500-9.499	30	8.984	30	8.993	34	8.970	32	9.008
9.500-10.499	30	10.054	30	10.123	31	10.011	30	9.886
10.500-11.499	40	11.112	31	11.125	3	10.717	33	11.001
11.500-12.499	45	11.982	30	11.891	30	12.035	35	12.037
12.500-13.499	44	13.008	30	13.030	30	12.987	39	13.086
13.500-14.499	56	13.998	32	13.978	30	13.988	62	14.040
14.500-15.499	46	15.059	31	14.920	30	15.129	60	15.011
15.500-16.499	37	15.952	30	16.066	31	15.957	39	15.895

sexes, belonging to public and government school have been calculated (Table 2 and 3). In the present study the eruption of permanent dentition starts at a median age of 4.70 years in public school boys and by 12.50 years of age all the permanent teeth have erupted excluding M_3 . In government school boys this range varies from 5.12 years to 12.86 years. Among girls, in public school girls eruption of permanent teeth starts at a median age of 4.85 years and the last second molar erupt at 12.40 years of age and in the government school girls this range varies from 4.64 years to 12.21 years

The sequence of eruption of various permanent teeth, in children of both the sexes, of both the groups has been found to be M_1 , I_1 , I_2 , P_1 , C , P_2 and M_2 . Exception has been found among

government school boys for mandibular left side, where canine erupt earlier to first premolar. These sequences of eruption are in conformity with the results of Kaul (1975), Bhatnagar and Kumar (1986), Singal et al. (1987), Kumar (1989), Kaur (1990) and Limbu (1996) (Table 2 and 3).

Bilateral Symmetry: Table 4 represents the bilateral differences in the eruption of permanent dentition in boys and girls of public and government schools.

From the result it has been concluded that most of the upper jaw teeth erupt earlier on right side and in lower jaw erupt earlier on left side but the bilateral differences in both the groups have been found to be non-significant for all the teeth. These results are in accordance with the results of Sidhu and Gupta (1973), Garcia-Godey et al.

Table 2: Sequence and median age of eruption of permanent dentition in boys

Tooth	Public School				Government School			
	Right side		Left side		Right side		Left side	
	Median Age	± S.E.M.	Median Age	± S.E.M.	Median Age	± S.E.M.	Median Age	± S.E.M.
Maxilla								
Central incisor	6.89	0.621	7.00	0.57	7.10	0.66	7.20	0.67
Lateral incisor	8.23	0.74	8.30	0.84	8.10	0.80	9.10	0.75
Canine	10.65	0.17	10.90	0.40	10.80	0.85	10.90	0.78
First premolar	9.96	0.52	9.98	0.72	10.40	1.13	11.52	0.90
Second premolar	11.43	0.90	11.30	1.00	11.80	0.90	11.80	0.90
First molar	5.68	0.60	5.68	0.51	6.13	0.64	5.90	0.64
Second molar	12.50	0.64	12.50	0.69	12.84	0.78	12.86	0.86
Mandible								
Central incisor	5.87	0.38	6.05	0.52	6.30	0.59	6.30	0.62
Lateral incisor	7.42	0.68	7.34	0.79	7.42	0.68	7.50	0.79
Canine	10.70	0.84	10.50	0.80	10.67	1.00	10.60	0.92
First premolar	9.94	0.94	9.90	1.00	10.10	0.31	9.97	0.80
Second premolar	11.64	1.00	11.40	1.00	11.64	0.84	11.62	1.10
First molar	5.24	0.53	4.70	0.66	5.12	0.66	5.12	0.66
Second molar	12.37	0.72	12.50	0.70	12.75	0.98	12.65	0.99

Table 3: Sequence and median age of eruption of permanent dentition in girls

Tooth	Public School				Government School			
	Right Side		Left Side		Right Side		Left Side	
	Median Age	± S.E.M.	Median Age	± S.E.M.	Median Age	± S.E.M.	Median Age	± S.E.M.
<i>Maxilla</i>								
Central incisor	6.70	0.57	6.70	0.52	7.04	0.74	7.20	0.95
Lateral incisor	8.10	1.10	8.30	1.00	8.39	0.79	8.60	0.77
Canine	10.30	0.81	10.30	0.81	10.89	1.10	10.50	0.91
First premolar	9.80	0.78	9.90	0.74	9.80	0.52	9.80	0.52
Second premolar	11.01	0.83	11.03	0.81	11.50	1.00	11.30	1.00
First molar	5.79	0.62	5.80	0.67	5.80	0.56	5.89	0.69
Second molar	12.30	0.86	12.40	1.00	12.20	0.81	12.20	0.81
<i>Mandible</i>								
Central incisor	6.50	0.68	6.57	0.69	6.57	0.74	6.53	0.77
Lateral incisor	7.50	0.85	7.60	0.79	7.80	0.80	7.90	0.80
Canine	10.09	0.20	10.09	0.20	10.50	1.00	10.40	1.50
First premolar	9.80	0.78	9.80	0.78	10.22	0.81	10.00	0.60
Second premolar	11.10	0.77	11.01	0.80	11.20	1.20	11.20	1.20
First molar	5.03	0.74	4.85	0.60	4.64	0.72	4.64	0.75
Second molar	12.20	1.20	11.90	0.86	12.21	0.85	12.10	0.81

Table 4: Bilateral differences in public and government schools boys girlstest of significance 't'

Tooth	Public School		Government School		Public School		Government School	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
	<i>Maxilla</i>				<i>Mandible</i>			
Central incisor	-0.13	0.00	-0.01	-0.13	-0.27	0.96	0.00	0.03
Lateral incisor	-0.06	-0.13	-0.91	-0.19	0.07	-0.08	-0.08	-0.11
Canine	-0.57	0.00	-0.08	0.27	0.17	0.00	0.05	0.05
First premolar	-0.02	-0.09	-0.77	0.00	0.02	0.00	0.15	0.91
Second premolar	0.09	-0.01	0.00	0.11	0.16	-0.08	0.01	0.00
First molar	0.00	-0.01	0.25	-0.01	0.63	0.18	0.00	0.00
Second molar	0.00	-0.07	-0.01	0.00	-0.12	0.20	0.07	0.09

(1983), Bhatnagar and Kumar (1986), Rousset et al. (2003) and Gaur and Singhal (2005).

Maxillo-Mandibular Differences: Among public school boys teeth erupt earlier in lower jaw except for second premolar and right canine and in government school boys all mandibular teeth erupt earlier, although in both the groups differences are not statistically significant (Table 5).

Among girls also from both public and government schools mandibular teeth erupt earlier than maxillary teeth except right second premolar in public school girls and first premolar (for both right and left side) and right second molar in government school girls, and in both groups differences have been found to be statistically non significant (Table 5). Sidhu and Gupta (1973), Bhatnagar and Kumar (1986), Kumar (1989), Gaur and Singhal (2005) and Friedrich et al. (2006) also reported early emergence of mandibular teeth than maxillary teeth.

Table 5: Maxillo-mandibular differences in public and government schools boys girlstest of significance 't'

Tooth	Public School		Government School	
	Right	Left	Right	Left
<i>Boys</i>				
Central incisor	1.40	1.23	0.90	0.98
Lateral incisor	0.80	0.83	0.64	1.46
Canine	-0.05	0.44	0.09	0.24
First premolar	0.01	0.06	0.25	1.28
Second premolar	-0.15	-0.07	0.12	0.13
First molar	0.54	1.17	1.09	0.84
Second molar	0.13	0.00	0.07	0.16
<i>Girls</i>				
Central incisor	0.19	0.15	0.44	0.54
Lateral incisor	0.43	0.54	0.52	0.63
Canine	0.25	0.25	0.26	0.05
First premolar	0.00	0.09	-0.43	-0.25
Second premolar	-0.07	0.01	0.19	0.06
First molar	0.78	1.05	1.27	1.22
Second molar	0.06	0.37	-0.01	0.08

Sex Differences: While studying sex differences, it has been found that in both public and government school children most of the teeth erupt earlier in girls as compared to boys. In both groups sex differences have been found to be statistically non-significant. (Table 6).

Sidhu and Gupta (1973) reported that in both the upper and lower jaw the mean eruption times of every tooth with the exception of M_1 is later for the boys than for the girls. Garcia Godoy (1983) reported that girls are relatively advanced in their emergence time except for canine and second premolar in the maxilla and the first premolar in the mandible. Kumar (1989) also reported statistically non-significant sex differences. Demirjian and Levesque (1980), Hagg and Taranger (1981, 1985, 1986), Bhatnagar and Kumar (1986), Kaur (1990), Virtanen et al. (1994) and Limbu (1996) also reported earlier eruption in girls. Rousset et al. (2003) reported that the teeth of girls erupted before those of boys, with exception of mandibular

second premolars and maxillary second molar, where eruption time is same, while maxillary second premolar erupted earlier in boys. Friedrich et al. (2006) also reported earlier tooth eruption in females than males.

Group Differences: It is evident from the (Table 2 and 3) that both boys and girls from public school are ahead of their counterparts from government school in dental development with only exception of maxillary lateral incisor, mandibular first molar and canine (all teeth on right side) in case of boys. Maxillary canine (left) and mandibular lateral incisor(right) and second premolar (right) erupt at the same times in boys from both the groups. Although for each tooth differences have been found to be statistically non-significant (Table 7).

In case of girls it has been found that most of the teeth erupt earlier in public school girls. Right maxillary first premolar erupt at the same time in both public and government school girls. For the

Table 6: Sex differences in public and government schools boys girlstest of significance 't'

Tooth	Public School		Government School		Public School		Government School	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
	Maxilla				Mandible			
Central incisor	0.22	0.38	0.06	0	-0.8	-0.6	-0.28	-0.23
Lateral incisor	0.09	0	-0.25	0.46	-0.07	-0.23	-0.36	-0.35
Canine	0.42	0.66	-0.06	0.33	0.7	0.49	0.12	0.11
First premolar	0.17	0.77	0.48	1.65	0.11	0.07	-0.13	-0.03
Second premolar	0.34	0.2	0.22	0.37	0.42	0.3	0.3	0.25
First molar	-0.12	-0.14	0.38	0.01	0.23	0.16	0.49	0.48
Second molar	0.18	0.08	0.56	0.55	0.12	0.54	0.41	0.45

Table 7: Group differences in public and government schools boys girlstest of significance 't'

Tooth	Boys		Girls	
	Right	Left	Right	Left
	Maxilla			
Central incisor	-0.23	-0.22	-0.36	-0.46
Lateral incisor	0.11	-0.71	-0.21	0.23
Canine	-0.17	0.00	-0.43	-0.16
First premolar	-0.35	-1.33	0.00	0.11
Second premolar	-0.29	-0.37	-0.37	-0.20
First molar	-0.51	-0.26	-0.01	-0.09
Second molar	-0.32	-0.33	0.08	0.15
	Mandible			
Central incisor	-0.61	-0.30	-0.06	0.03
Lateral incisor	0.00	-0.14	-0.25	-0.26
Canine	0.22	-0.08	-0.40	-0.20
First premolar	-0.16	-0.05	-0.37	-0.20
Second premolar	0.00	-0.14	-0.07	-0.13
First molar	0.14	-0.44	0.37	0.21
Second molar	-0.31	-0.13	-0.06	-0.16

eruption of all teeth the differences have been found to be statistically non-significant. The findings of the present study are in accordance with Clements et al. (1955), Lall (1972), Bhatnagar and Kumar (1986) and Kumar (1989).

Dental Caries

The incidence of dental caries have been found to be higher in public school children i.e. 7.30% in boys and 8.94% in girls as compared to government school children, where the percentage has been found to be 6.36% in boys and 5.77% in girls (Table 8). Nandonovsky and Sheiham (1995), Rijkom et al. (1998) and Nicolau (2003) have also reported that more caries have been found in higher socio-economic group children. Tickle (2003) also reported that families from lower socio-economic

Table 8: Percentage of caries in public and Government schools children

Percentage of Caries			
Public School		Government School	
Boys	Girls	Boys	Girls
7.30%	8.94%	6.36%	5.77%

background are more particular about dental care as compared to families from high socio-economic background. Sidhu and Gupta (1973) have reported more dental caries in boys than in girls. Mejjire et al. (1999) have reported that up to 19 years of age, females have been found to have more caries than males after 19 opposite has been observed. Lukas and Largaespada (2006) reported that females (8.8%) are found to exhibit higher prevalence rate than males (4.5%).

The teeth with caries show higher incidence at the age group between 15 to 16 years among both the sexes for public and government schools. The percentage of caries in mandibular teeth has been found to be higher as compared

Table 9(a): Liability of individual tooth to caries (in %) boys

Tooth	Public School		Government School	
	Right	Left	Right	Left
<i>Maxilla</i>				
First premolar	0.00	0.22	0.00	0.53
Second premolar	0.00	0.44	0.00	0.00
First molar	1.80	4.42	2.10	3.50
Second molar	0.00	0.22	0.27	0.00
<i>Mandible</i>				
First premolar	0.22	0.22	0.00	0.27
Second premolar	0.22	0.66	0.00	0.00
First molar	0.22	4.00	1.30	2.07
Second molar	0.00	0.22	0.53	0.27

Table 9 (b): Liability of individual tooth to caries (in %) girls

Tooth	Public School		Government School	
	Right	Left	Right	Left
<i>Maxilla</i>				
First premolar	0.54	0.81	0.22	0.88
Second premolar	0.54	0.27	0.22	1.30
First molar	1.60	5.10	0.88	4.20
Second molar	0.00	0.27	0.00	0.44
<i>Mandible</i>				
First premolar	0.54	0.81	0.22	1.10
Second premolar	0.81	0.54	0.22	1.30
First molar	1.60	4.90	0.66	3.30
Second molar	0.00	1.10	0.00	0.44

to maxillary teeth in all the children. The tooth which has been recorded to be most affected by dental caries is M_1 followed by P_2 , P_1 , and M_2 in all the four groups except government boys here M_1 is followed by P_1 and M_2 to the same extent. Caries have been found to be more prevalent in children of higher age group as compared to younger children but variations have been found in all the four groups. (Table 9 A and 9 B). Sidhu and Gupta (1973) also reported more prevalence of caries in molars and premolars.

CONCLUSION

Dental development as evaluated on the basis of eruption of teeth has been found earlier in public school children except for maxillary lateral incisor (right) and mandibular first molar and canine (right) in boys and maxillary first premolar (left), second molar, mandibular lateral incisor (left), first molar and central incisor (left) in girls. The differences are not up to the level of significance in both boys and girls. The sequence of eruption has been found to be as M_1 , I_1 , I_2 , P_1 , C , P_2 and M_2 with the only exception in government school boys for mandibular left side, where canine has erupted earlier to first premolar. All the permanent teeth have erupted between the median ages of 4.70 years to 12.50 years in public and between 5.12 years to 12.86 years in government school boys. Among girls all permanent teeth have erupted between the median ages of 4.85 years to 12.40 years in public and between 4.64 years to 12.21 years in government school girls.

In all the children from both public and government schools, in the upper jaw most of teeth erupt earlier on right side, while in lower jaw most of teeth erupt earlier on left side. All the bilateral differences have been found to be non-significant.

Among public school boys all the teeth have erupted earlier in lower jaw except for second premolar on both sides and canine on right side and in government school boys, all mandibular teeth from both left and right side have erupted earlier. The differences in both groups are not up to the level of significance. In girls also all mandibular teeth have erupted earlier except for second premolar (right) in public and first premolar on both sides and second molar (right) in government school girls. Although the differences have been found to be non-significant.

Eruption of permanent teeth has been found to be earlier in girls as compared to boys with few exceptions in both public and government school children, but the differences have been found to be statistically non-significant.

Dental Caries have been found to be more in public school children as compared to government school children. In public schools, girls are more affected by caries, while in government school, boys are more affected by caries. The percentage of caries in mandibular teeth has been found to be higher as compared to maxillary teeth in all the children. The teeth which has been recorded to be most affected by caries is M_1 in all the four groups, followed by P_2 , P_1 and M_2 . The teeth with caries show higher incidence at the age between 15-16 years in all the children.

REFERENCES

- Adler P 1958. Studies on the eruption of the permanent teeth. *Acta Genet Statist Med*, 8: 78-94.
- Benn DK, Dankel DD, Kostewicz SH 1998. Can low accuracy disease risk predictor models improve health care using decision support systems? *Proc AMIA Symp*, 577-581.
- Bhatnagar DP, Kumar A 1986. The differences in eruption of permanent dentition among the individuals of two social group of Punjabi origin. *Acta Med Auxol*, 18: 129-134.
- Campus G, Lumbau A, Lai S, Solinas G, Castiglia P 2001. Socio-economic and behavioural factors related to caries in twelve-year-old Sardinian children. *Caries Res*, 35: 427-434.
- Charzewski J 1963. Some problems of the cutting of permanent teeth in children and youth in rural and urban environment. *Prace I Materialy Naukowe IMD*, 1: 65-80.
- Clements E M B, Davies-Thomas E, Pickett KG 1955. Time of eruption of permanent teeth in British children. *Br Med J*, 1: 1421.
- Demirjian A, Levesque GY 1980. Sexual differences in dental development and prediction of emergence. *J Dent Res*, 59: 1110-1122.
- Eskeli R, Laine-Alava, MT Hausen H, Pahakala R 1999. Standards for permanent tooth emergence in Finnish children. *Angle Orthod*, 69: 529-533
- Eveleth PB 1966. Eruption of permanent teeth and menarche of American children living in the tropics. *Hum Biol*, 38: 60-70.
- Friedrich RE, Katerji H, Wedl JS, Scheuer HA 2006. Eruption times of permanent teeth in children and adolescents of Paderborn, Westphalia, Germany. *Arch Kriminol*, 217: 20-35.
- Garcia-Godoy F, Diaz AN, Valle JMD, Arana EJ 1982. Timing of permanent tooth emergence in a South Eastern. Dominican school children population sample. *Community Dent Oral Epidemiol*, 10: 43-46.
- Gaur R, Singhal T 2005. Stature, Weight and BMI in relation to permanent tooth emergence among Rajput boys of Theog area, Himachal Pradesh. *Ind J Phys Anthropol and Hum Genet*, 24: 199-211.
- Hagg U, Tranger J 1981. Dental emergence stages and the pubertal growth spurt. *Acta Odontol Scand*, 39: 295-306.
- Hagg U, Tranger J 1985. Dental development, dental age and tooth counts. *Angle Orthod*, 55: 93-100.
- Hagg U, Tranger J 1986. Timing and tooth emergence. A prospective longitudinal study of Swedish urban children from birth to 18 years. *Swed Dem J*, 10: 195-206.
- Harris EF, McKee JH 1990. Tooth mineralization standards for blacks and whites from the middle southern United States. *J Forensic Sci*, 35: 859-872.
- Harris J Keene 1991. On heterochrony in heterodonty: A review of some problems in tooth morphogenesis and evolution. *American Journal of Physical Anthropology*, 34: 251-282.
- Kaul S 1975. Emergence of permanent teeth in school children in Chandigarh. India. *Arch Oral Biol*, 20: 587-593.
- Kaur G 1990. *Physical Growth, Physiological Maturity and Body Composition in Brahmins of Punjab*, Ph.D. Thesis, unpublished. Patiala: Punjabi University.
- Kjellberg H, Beiring M, Albertsson Wikland K 2000. Craniofacial morphology, dental occlusion, tooth eruption and dental maturity in boys of short stature with or without growth hormone deficiency. *Eur J Oral Sci*, 108: 359-67.
- Kumar A 1989. *Physical Growth, Physiological Maturity and Development Age in Children Belonging to Two Socioeconomic Groups*. Ph.D. thesis, Unpublished. Patiala: Punjabi University.
- Lall S 1972. *Physical Growth in Punjabi School Children with Special Reference to Socio-Economic Groups and Social Status*. M.D. Thesis, Unpublished. Patiala: Punjabi University.
- Lee MMC, Low WD, Chang KSF 1965. Eruption of the permanent dentition of Southern Chinese children in Hong Kong. *Arch Oral Biol*, 10: 849-861.
- Limbu DK 1996. Eruption of permanent teeth among the Gallong of Arunachal Pradesh. *J Hum Ecol*, 7: 221-222.
- Lukas JR, Largaespada LL 2006. Explaining sex differences in dental caries prevalence: Saliva hormones and life history etiologies. *Am J Hum Biol*, 18: 540-555.
- Malcom LA 1970. Growth and development of the Bundi child of the New Guinea. *Hum Biol*, 42: 293-328.
- Marthaler TM, Brunelle J, Dowener MC, Konig KG, Truin GJ, Kunzel VO, Mullane DM, Moller IJ, Feher V, Vrbic Fr V 1996 The prevalence of dental caries in Europe 1990-1195. *Caries Res*, 30: 237-255.
- Mejire I, Kallestall C, Stenlund H 1999. Incidence and progression of approximal caries from 11 to 12 year of age in Sweden: A prospective radiographic study. *Caries Res*, 33: 39.
- Nadanovsky P, Sheiham A 1995. The relative contribution of dental services to the change in caries levels of 12- years old children in 18 industrialized countries in the 1970s and early 1980s. *Community Dent Oral Epidemiol*, 25: 331-339.
- Nicolau, B, Marceles W, Bartley M, Sheiham A 2003. A

- Life Course Approach to Assessing Causes of Dental Caries Experience: The Relationship between Biological, Behavioural, Socio-Economic and Psychological Conditions and Caries in Adolescents *Caries Research*, 37: 319-326.
- Parner ET, Heidmann JM, Kjaer I, Vaeth M, Poulsen S 2002. Biological interpretation of the correlation of emergence times of permanent teeth. *J Dent Res*, 1(4): 51-54.
- Psoter WJ, Reid BC, Katz RV 2005. Malnutrition and Dental Caries: A Review of the Literature. *Caries Res*, 39: 441-447.
- Rami Raddy V 1984. *Dimensions of Anthropology*. New Delhi: B.R.Publications, pp. 3-15
- Rasmussen P, Kotsaki A 1997. Inherited retarded eruption of permanent dentition. *J Clin Pediatr Dent*, 21.
- Rijkom VH, Truin GH, Hof van't MA 1998. A meta-analysis of clinical studies on the caries-inhibiting effect of fluoride gel treatment. *Caries Res*, 32: 83-92.
- Rousset MM, Boualam N, Delfosse C, Roberts WE 2003. Emergence of permanent teeth: secular trends and variance in a modern sample. *J Dent Child (Chic)*, 70: 208-214.
- Sidhu LS, Gupta P 1973. Sequence and age of eruption of permanent teeth in the Punjabi population of Patiala. *Eastern Anthropologist*, 26: 261.
- Singal, P, Sidhu LS, Bhatnagar DP, Sodhi HS, Kumar A 1987. Criteria for determination of age through dental eruption for participation in sports. *Sports Sciences, Health Fitness and Performance*, Patiala: IASSPE Publication pp. 93-100.
- Singh SP 1980. Physical growth of Gaddi Rajputs of Dhaura Dhar Range of Himalaya. *Z Morph Anthropol*, 71: 65-81.
- Tanner JM 1969. *Growth at Adolescence*. 2nd Edition. Oxford: Blackwell Scientific Publications.
- Tickle M, Kay EJ, Bearn D 1999. Socio-economic status and orthodontic treatment need. *Community Dent Oral Epidemiol*, 27: 413-418.
- Tickle M, Milson KM, Humphris GM, Blinkhorn AS 2003. Parental attitudes to the case of the carious primary dentition. *British Dental Journal*, 195: 451-455.
- Utriainen P, Pahkala K, Kentala J, Laippala P, Mattila K 1998. Changes in the oral health of adolescents treated by the Finnish public dental services between the ages of 13 and 15 years. *Community Dent Oral Epidemiol*, 26: 149-154.
- Virtanen JI, Bloigu RS, Laemas MA 1994. Timing of eruption of permanent teeth: Standard Finnish patient documents. *Community Dent Oral Epidemiol*, 22: 286-288.