Check for updates

OPEN ACCESS

DOI: 10.46903/gjms/22.01.1373

ORIGINAL ARTICLE

TIME OF ERUPTION AND RELATIONSHIP WITH BODY FATNESS OF PAKISTANI CHILDREN FROM A COUNTRY-WIDE STUDY

Nazeer Khan[1], Hasham Khan[2], Mujib ur Rehman Baloch[3]

[1]Department of Biostatistics, Baqai Medical University, Karachi, [2]Department of Pediatric Dentistry, Khyber College of Dentistry, Peshawar, [3]Department of Dentistry, Bolan Medical College, Quetta, Pakistan

ABSTRACT

Background: Teeth emergence is ordinal, chronological, and age-specific.[1,3] Most of the time, the permanent teeth start erupting at the age of 6 years and complete the process by the age of 12 years. The objective of this study were to determine the time and sequence of eruption of permanent teeth of the four ethnic groups of Pakistan and compare them with the body fatness.

Materials & Methods: This study was conducted in four cities of Pakistan (Karachi, Larkana, Peshawar and Quetta) from January 2022 to March 2023 to determine the time and sequence of eruption of permanent teeth of Pakistani children. Systematic cluster random sampling was applied to choose the participants. A total of 8787 children with at least one 'just erupted tooth' were collected from 163 schools in the above-mentioned cities. Each selected child was examined under a bright light in a sitting position and each tooth was recorded as either unerupted, just erupted, or erupted. Height and weight were measured using a digital scale without the shoe. The age of the child was taken from the schools' register. A questionnaire containing demographic information and some dietary habits was completed. A total of 8550 cases were collected and analyzed. Kruskal-Wallis non-parametric ANOVA, Tukey/Dunnett's T3 postHoc, and chi-square tests were applied for statistical analysis.

Results: Out of 8550 children, 4526 (52.9%) were males. The percentage of underweight, normal, overweight, and obese children were 4.2%, 78.2%, 11.8%, and 5.8% respectively. Overweight and obese children were significantly higher than the internationally assigned percentage in those categories. Most of the teeth in central incisors, lateral incisors, and canines were erupted between the ages of 6-7 years, 7-8 years, and 9-11 years, respectively. Most of the posterior teeth erupted between 9-10 years (first pre-molars), 9-11 years (second pre-molars), 5-7 years (first molars), and 10-12 years (second molars). The sequence of the eruption was seen as Maxillary: FM, CI, LI, FPM, SPM, C, SM; Mandibular: FM, CI, LI, C, FPM, SPM, SM. Children of Quetta and Karachi showed late eruption as compared to children of Larkana and Peshawar. Mean values of overweight or obese children showed lower mean values than underweight and normal children.

Conclusions: This multi-center study showed that the children of Karachi were exposed to the late eruption in most of the teeth as compared to children of Larkana, Quetta, and Peshawar. Furthermore, except for the first molars, all other teeth showed early eruption for overweight and obese children as compared to underweight and normal-weight children. This trend is comparable to the international findings.

KEY WORDS: Time of eruption; Permanent teeth; nutrition status.

Cite as: Khan N, Khan H, Baloch MUR. Time of eruption and relationship with body fatness of Pakistani children from a country-wide study. Gomal J Med Sci 2024 Jan-Mar;22(1):23-31. https://doi.org/1046903/gjms/22.01.1373

INTRODUCTION

The eruption of teeth is a dynamic and natural movement of teeth from the intraosseous location to the functional position of the oral cavity. The process of eruption of permanent teeth covers the formation of root development, the materialization of the periodontium, and the emergence of occlusion location.[1,2] Teeth emergence is ordinal, chronological, and age-specific.[1,3] Most of the time, the permanent teeth start erupting at the age of 6 years and complete the process by the age of 12 years, excluding the 3rd molars.[1,3] Many factors such as gender, race, genetics, low birth weight, prematurity, hormonal factors, endocrinology condition, socioeconomic attributes, geographical locations, malnutrition, obesity, and

Corresponding Author:

Prof. Dr. Nazeer Khan
Professor of Biostatistics and Director ORIC
Baqai Medical University
Karachi, Pakistan.
E-mail: nazeerkhan54@gmail.com

Date Submitted: 09-07-2023
Date Revised: 10-01-2024
Date Accepted: 02-02-2024

nutritional aspects may affect early or delayed tooth emergence.[1,4-6] Literature indicates that the PTHR1 gene and mutations in GNAS a related to the failure of supraosseous eruption and eruption defects.[5,6] In addition the dental emergence could also be affected by dentigerous cysts and craniofacial deformities.[7,8]

The time and sequence of eruption of permanent teeth have been studied in most countries all over the globe.[9,10] As indicated above, many factors influence the time of eruption. However, in most of the studies, only the effect of gender has been discussed. The other significant factor such as dietary habits or nutrition status did not receive too much attention.[4,11]

Nutrition status depends upon the type of food intake, absorption, and nutrition value of the food,[12] and affects body growth and development. The inadequate amount and low nutritional value of food impede the growth of the body, size, and chemical composition and reduce the quality of some tissues, such as bones and teeth.[12,13] Many new methods have been introduced to determine the nutrition status in the literature, however, body mass index (BMI) is still very popular, due to its simplicity in calculation and categorization the individuals into underweight, normal, overweight, and obese groups.[1,14]

Malnutrition is stated by Word Health Organization (WHO) as 'deficiencies or excesses in nutrient intake, imbalance of essential nutrients or impaired nutrient utilization'.[15] Malnutrition is the major cause of death, inferior health, and inadequate growth in children and infants, especially in developing countries.[12,15] Contrary to malnutrition, overweight and obesity is another major problem among adults and children and is an epidemic of the 21st century. Childhood obesity not only affects the growth process and development but also becomes a risk factor for hypertension, diabetes, sleeping disturbance, and psychological and social problems.[13,16]

Studies have been conducted to relate the eruption of time with nutrition status.[5,12,13,16-28] Most of these studies showed that the permanent teeth of overweight and obese children emerged earlier than the normal nutrient children, while the mal-nutrient children showed delayed eruption. However, some were not statistically significant.[5,6,13,19,21,24,25]

Only a few studies from Pakistan,[10,11,26,27] have presented the relationship between the time of the eruption and nutrition status. But none of them showed any significant differences. All of them were conducted in one of the cities of Pakistan. Pakistan is composed of a multi-racial and multi-cultural population. As it is indicated in the literature due to the biological differences between the different ethnic or racial groups, the time of eruption of teeth may vary.[10,11] Hence, for a national standard, a multi-racial/multi-cultural study is needed. This study was conducted among the four racial groups of Pakistan: Muhajirs (immigrants from India), Sindhis, Pakhtoons, and Baluchis. The data were collected from Karachi, Larkana, Peshawar, and Quetta. These cities have a predominant population of the corresponding ethnic groups, respectively. Therefore, the objectives of the study were to determine the time and sequence of eruption of permanent teeth among the four ethnic groups' children of Pakistan and compare the eruption time with nutrition status, using BMI.

MATERIALS AND METHODS

This study was conducted in four cities of Pakistan (Karachi, Larkana, Peshawar and Quetta) from January 2022 to March 2023 to determine the time and sequence of eruption of permanent teeth in Pakistani children. The study was supported by two research funding from the Higher Education Commission of Pakistan. The ethical approval was obtained from the Institutional Review Board of Dow University of Health Sciences, Karachi ((No. IRB-B-17/DUHS-10). Systematic cluster sampling was used to select the participants. The lists of schools were obtained from the Ministry of Education and Private Schools Administrations. On average 250 students per school were considered using the number of schools and enrollments. The number of cases of 'just erupted tooth' needed for the study from Karachi, Larkana, Peshawar, and Quetta were 4000, 1000, 2000, and 1500, respectively. Therefore, the total number of cases needed for the study was 8500. 'Just erupted tooth' was defined as a tooth deemed to have emerged if any part of it is visible in the oral cavity. The number of schools was selected from the schools' lists using systematic random sampling. Two dentists (one male and one female) and two assistants (one male and one female) were hired for data collection in each study location (cities mentioned above). Calibration and training for the data collecting team (dentists and assistants) were conducted by a reference examiner on the children of a selected school in each study location. Some slides of the just-erupted teeth were sent earlier to the selected data collection team for pre-training. A kappa value of 80% or above was considered satisfactory for the inter-examiner calibration. A consent form written in Urdu was sent to the administration of the selected schools to deliver to the parents of the children. A team of dentists and assistants visited the selected schools on the pre-assigned day and time. Children who brought positive consent from their parents and gave assent to participate in the study were screened for general check-ups. Children with at least one 'just erupted tooth' were taken out of class for further investigation. Each selected child was examined under a bright light in a sitting position. Each tooth was examined and recorded as 'unerupted', 'just erupted', or 'erupted'. Height and weight were measured using a digital scale without the shoe. A questionnaire of demographic information and usual dietary habit were also recorded. The date of birth was taken from the

school's record. A total of 8787 cases were collected from 163 schools from the four centers. However, 237 cases did not have complete information or not having Pakistani nationality. Therefore, the analysis was executed for 8550 cases. The body Mass Index (BMI) of each child was computed and categorized in different categories using the growth child developed by Iftikhar et al.[28] Children with a percentile of less than 5% were assigned as underweight, 5% to 85% as normal, 85% to 95% as overweight and above than 95% as obese. Data was entered and analyzed using SPSS (ver 26). The data were verified for normality assumptions using the one-sample Kolmogorov-Smirnov test. Since the data did not fulfill the normality assumption, therefore Non-parametric Kruskal-Wallis H test was used for comparisons of means. Tukey postHoc test was employed if the Homogeneity of Variance was verified using the Levene statistic, otherwise, Dunnett's T3 postHoc test was used. The chi-square test was used for the goodness of fit of BMI categories ratios.

RESULTS

The number of cases collected with all the information from Karachi, Larkana, Peshawar, and Quetta were 4265 (49.9%), 1157 (13.5%), 1883 (22.0%) and 1245 (14.6%) from 102, 15, 21 and 25 schools, respectively. Four thousand five hundred and twenty-six (52.9%) of the total cases were male children (Figure 1). About 15% of the children participated in each of the grade 1 to grade 5 (Figure 2). The percentage of underweight, normal, overweight, and obese children, using the range of the BMI as indicated in the reference[28] depicted in the Methodology section, were 4.2%, 78.2%, 11.8%, and 5.8% respectively (Figure 1). The percentage of overweight and obese children was significantly higher than their corresponding percentile assigned in the criterion, using chi-square goodness of fit ($P<0.0001$).

The percentage of the teeth erupted by age and gender is shown in Table 1. The maxillary teeth will

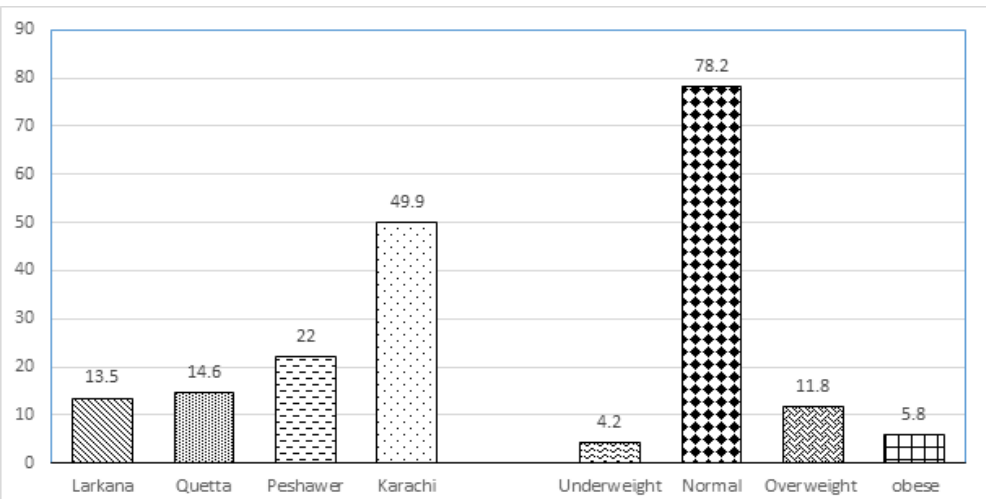

Figure 1: Percentage of samples from study locations and Categorization of BMI

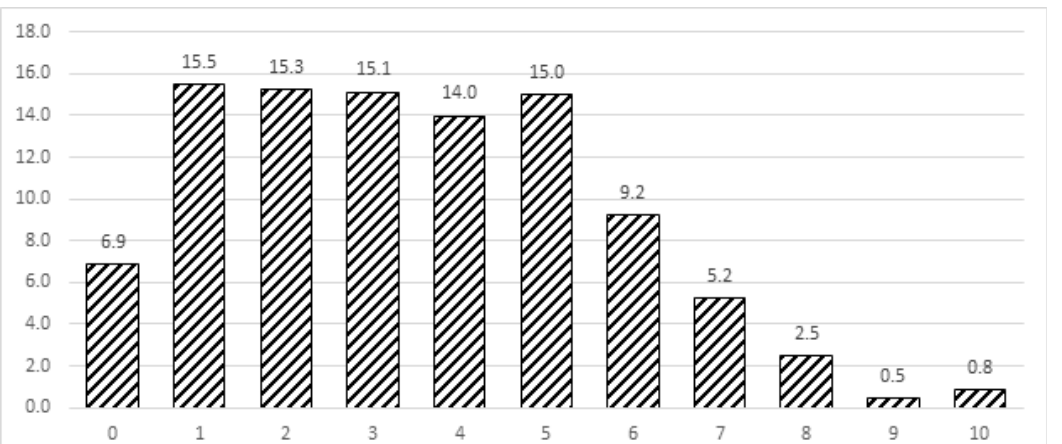

Figure 2: Percentage of samples collected from different grades

be discussed first, followed by the mandibular teeth. The range of time of eruption of the central incisor was from 5 to 9 years. But most of the children have erupted their central incisor at the age of 6 or 7 years (68.8%). Male and female children did not show any clear-cut trend at the time of the eruption. The lateral incisor showed the time of eruption from 5 to 12 years. Most of the maxillary lateral incisors erupted at 7 or 8 years (63.6%). The range of time of eruption of canines was 7 to 13 years. Most of the children showed the time of eruption of this tooth between 9 to 11 years (68%). The time of eruption of the first premolar also ranged from 7 to 13 years. Most of the first premolars erupted at the age of 9 or 10 years (53.4%). The range of time of eruption for the second pre-molar was from 7 to 13 years. Most of the cases belonged from the age of 9 to 10 years (50.3%). The first molar erupted from age 5 to 10 years. But most of the cases erupted from age 5 to 7 years (91%). The range for the time of eruption of the second molar was from 8 to 14 years. Most of the time it erupted from age 10 to 12 years (68.7%). The range of the time of eruption of all the mandibular teeth was almost the same as the maxillary teeth. However, percentages showed that there was an early eruption in mandibular teeth as compared to maxillary teeth.

Carefully looking at Table 1, we observe that the sequence of eruption is the following:

Maxillary: FM, CI, LI, FPM, SPM, C, SM

Mandibular: FM, CI, LI, C, FPM, SPM, SM

Table 2 shows the comparison of the time of eruption of permanent teeth of the children of four study sites. Children of Quetta and Karachi showed late eruption as compared to children of Larkana and Peshawar. Karachi's children showed significantly larger mean values than children of Larkana in all the teeth, except the mandibular central incisor and first molars of both jaws. Children of Quetta showed significantly higher mean eruption time as compared to Larkana children for all the teeth, except central incisors and first molars of both jaws. All the teeth showed significant differences in the mean time of eruption between the four cities. The mean eruption time of anterior teeth of Karachi children is comparatively higher than the mean eruption time of other cities' children.

Different alphabets in the superscript indicate the statistical significance

Table 3 shows the comparison of the mean eruption time of underweight, normal, overweight, and

Table 1: Percentage of eruption of teeth by age and gender

Age in Years	Gender	Maxillary							Mandibular						
		CI	LI	C	FPM	SPM	FM	SM	CI	LI	C	FPM	SPM	FM	SM
5	Male	7.8	1.2	0	0	0	16.9	0	16.4	5.5	0	0	0	19.0	0
	Female	11.1	2.7	0	0	0	21.8	0	16.2	8.3	0	0	0	23.8	0
6	Male	32.2	12.5	0	0	0	60.8	0	44.1	20.9	0	0	0	46.9	0
	Female	31.8	11.1	0	0	0	48.6	0	46.3	23.5	0	0	0	47.5	0
7	Male	40.5	24.5	3.2	5.9	5.9	16.2	0	30.2	40.3	7.7	6.9	5.4	23.3	0
	Female	33.2	30.4	6.6	5.4	5.1	17.6	0	23.6	30.9	9.9	7.2	5.9	17.3	0
8	Male	15.9	37.9	7.8	18.6	13.4	0.8	3.9	6.8	24.6	20.3	13.3	11.5	4.3	4.8
	Female	17.5	34.4	11.1	18.5	9.7	5.6	3.1	10.6	25.7	18.9	17.9	9.6	7.9	6.3
9	Male	3.5	15.6	14.3	27.9	26.0	3.8	6.9	2.5	5.5	19.5	24.8	18.1	5.4	9.6
	Female	6.4	13.0	20.7	30.7	19.5	2.8	10.7	3.2	5.7	29.4	27.5	21.9	2.5	13.9
10	Male	0	5.0	25.3	21.8	23.8	1.5	22.0	0	2.2	23.9	23.6	22.7	1.2	20.9
	Female	0	5.0	24.1	26.3	31.3	3.5	20.1	0	3.8	24.9	26.2	20.3	1.0	23.9
11	Male	0	2.9	28.0	15.4	17.8	0	22.9	0	1.0	17.1	18.0	23.5	0	23.8
	Female	0	1.7	23.6	13.6	17.4	0	24.1	0	2.1	11.5	15.5	23.5	0	24.3
12	Male	0	0.5	14.1	6.8	9.3	0	22.3	0	0	8.8	8.9	13.8	0	20.3
	Female	0	1.7	9.9	5.4	11.3	0	25.9	0	0	4.0	4.8	13.9	0	21.1
13	Male	0	0	7.4	3.2	3.7	0	15.7	0	0	2.9	4.6	5.0	0	16.1
	Female	0	0	3.9	0.2	5.6	0	12.1	0	0	1.4	0.9	4.8	0	8.6
14	Male	0	0	0	0	0	0	6.3	0	0	0	0	0	0	4.4
	Female	0	0	0	0	0	0	4.0	0	0	0	0	0	0	1.8

obese children. All the mean values belonging to underweight children were higher than the mean values of other categories. Ten out of 14 of those mean values were significantly higher than at least one of the other 3 categories. Mean values of overweight or obese children showed lower mean values than underweight and normal children. Most of those means of overweight or obese children were significantly higher than the mean values of underweight children.

DISCUSSION

This study used a significantly larger sample size to determine the time and sequence of eruption of permanent teeth as compared to the other studies indicated in the literature. It covered three out of four provinces of Pakistan. The data were collected from Karachi, Peshawar, Quetta, and Larkana. The first three cities are the provincial capitals of Sindh, Khyber Pakhtunkhwa, and Baluchistan, respectively. Since Karachi is pre-dominated by the Muhajirs, and a few percent of native Sindhis live there, therefore Larkana was added to cover the native Sindhis.

The eruption of a tooth is a natural biological process when it emerges from oral mucosa. It is very obvious for observation and does not need any special training for assessment. However, the field dentists were trained and collaborated against a Co-investigator and received more than 80% agreement using Kappa statistics.

This is a school-based study where no-radiological facilities were accessible. Therefore, congenitally

Table 2: Comparison of time of eruption between four studies locations

	Maxillary										
	Larkana		Quetta		Peshawar		Karachi		P - Value	Total	
	n	±SD	n	±SD	n	±SD	n	±SD		n	±SD
CI	97	6.6 ±1.1[a]	104	6.9 ±0.8[a]	120	7.2 ±1.3[a]	474	7.5 ±1.3[b]	<0.0001	791	7.3±1.2
LI	119	7.8 ±1.4[a]	121	8.4 ±1.2[b]	213	8.3 ±1.6[b]	449	8.4 ±1.3[b]	<0.0001	902	8.3±1.4
C	195	9.6 ±1.6[a]	164	11.1±1.4[b]	392	10.3±2.0[c]	779	10.9 ±1.4[b]	<0.0001	1530	10.6±1.7
FPM	125	9.1 ±1.6[a]	148	10.0±1.3[b]	178	9.5 ±1.7[a]	436	10.1 ±1.4b	<0.0001	887	9.8±1.6
SPM	43	8.9 ±1.7[a]	77	11.3±1.4[b]	78	10.0±2.1[b]	280	10.3 ±1.5[c]	<0.0001	478	10.3±1.6
FM	30	6.6 ±1.5[a]	26	6.4 ±2.0[a]	16	6.5 ±2.1[a]	203	6.8 ±1.1[a]	0.0001	275	6.8±1.3
SM	68	10.1±1.5[a]	67	12.3±1.2[b]	191	10.3±3.0[a]	283	11.7 ±1.5[c]	<0.0001	609	11.2±2.1
Mandibular											
	Larkana		Quetta		Peshawar		Karachi		P - Value	Total	
	n	±SD	n	±SD	n	±SD	n	±SD		n	±SD
CI	58	6.6 ±1.3[ab]	86	6.5±0.77[a]	77	6.8 ±1.4[ab]	287	7.1 ±1.2[b]	<0.0001	508	6.9±1.2
LI	127	7.1 ±1.4[a]	100	7.7 ±1.0[b]	182	7.7 ±1.7[b]	424	7.8 ±1.2[b]	<0.0001	833	7.7±1.4
C	215	9.1 ±1.6[a]	164	9.5 ±1.2[b]	336	9.9 ±1.8[b]	524	10.2±1.6[c]	<0.0001	1239	9.8±1.6
FPM	197	9.1 ±1.6[a]	100	10.2±1.2[b]	271	10.1±1.8[b]	432	10.4 ±1.4[b]	<0.0001	1000	10.0±1.6
SPM	63	9.1 ±1.6[a]	63	11.7±1.1[b]	115	10.1±2.1[c]	227	10.6 ±1.5[c]	<0.0001	468	10.4±1.8
FM	48	6.5 ±1.4[a]	27	7.1±2.7[ab]	107	7.6 ±2.0[b]	293	6.7 ±1.0[a]	<0.0001	475	6.9±1.5
SM	169	9.9 ±1.6[a]	102	12.2±1.0[b]	515	11.7±1.7[c]	547	11.2 ±1.4[d]	<0.0001	1333	11.3±1.6

Table 3: Comparison of time of eruption between four nutrition status

Maxillary											
	Underweight		Normal		Overweight		Obese		P - Value	Total	
	n	±SD	n	±SD	n	±SD	n	±SD		n	±SD
CI	52	7.1 ±1.7ab	635	7.4 ±1.1a	7	6.7 ±0.9bc	26	6.6 ±1.0c	<0.0001	791	7.3±1.2
LI	31	8.3 ±1.3ab	765	8.3 ±1.3a	78	8.0 ±1.2ab	28	7.5 ±1.5b	0.005	902	8.3±1.3
C	51	11.7 ±1.4a	1140	10.6 ±1.5b	220	10.3 ±1.8c	119	9.9 ±2.0c	<0.0001	1530	10.5±1.6
FPM	28	10.7 ±1.7a	721	9.8 ±1.4ab	89	9.3 ±1.8b	49	9.8 ±1.5ab	0.015	887	9.8±1.5
SPM	17	10.7 ±2.3a	378	10.2 ±1.5a	61	10.2 ±1.8a	22	10.3 ±1.8a	0.826	478	10.2±1.6
FM	15	6.9 ±2.3a	218	6.7 ±1.0a	29	7.0 ±2.0a	13	6.7 ±1.7a	0.192	275	6.7±1.2
SM	19	12.1 ±1.7a	418	11.4 ±1.9^{ac}	118	10.2 ±2.4d	54	10.7 ±1.6^{cd}	<0.0001	609	11.1±2.0
Mandibular											
	Underweight		Normal		Overweight		Obese		P - Value	Total	
	n	±SD	n	±SD	n	±SD	n	±SD		n	±SD
CI	43	6.9 ±1.6ab	404	6.9 ±1.1a	42	6.4 ±0.80b	19	6.3 ±1.0ab	<0.0001	508	6.8±1.1
LI	45	7.9 ±1.4a	671	7.7 ±1.2ab	86	7.2 ±1.3bc	31	6.8 ±1.2c	<0.0001	833	7.6±1.3
C	39	10.6 ±1.9a	957	9.8 ±1.5ab	152	9.4 ±1.8c	91	9.4 ±1.8bc	0.003	1239	9.8±1.6
FPM	27	10.8 ±1.8a	769	10.0 ±1.5a	140	9.7 ±1.8b	64	9.8 ±1.8a	0.034	1000	10.0±1.6
SPM	15	11.4 ±1.4a	350	10.4 ±1.6a	63	10.0 ±1.8b	40	10.0 ±2.2a	0.028	468	10.4±1.7
FM	20	7.0 ±2.5a	370	6.8 ±1.3a	57	6.8 ±1.8a	28	6.6 ±1.7a	0.625	475	6.8±1.4
SM	42	11.6 ±1.4a	932	11.3 ±1.6^{ab}	228	11.0 ±1.7b	131	11.0 ±1.6b	0.006	1333	11.3±1.6

Different alphabets in the superscript indicate the statistical significance

missing teeth could not be observed. However, as indicated in Khan[9] the estimation of time of eruption without considering the congenitally is biased upward, but not more than 1%. Nevertheless, if the sample size is large enough, the biased will be insignificant, and this is the position in this study, where the sample size is very large, more than 8500.

Childhood obesity and overweight are one of the major challenges faced by healthcare planners. These problems are associated with many systematic diseases and abnormal child development.[25] This study showed that the percentage of overweight and obese children was 11.8% and 5.8% respectively. According to 'The Centers for Disease Control and Prevention, USA', percentiles for overweight and obese children should be 10% and 5% respectively. Even though these percentages were not very far from the corresponding theoretical percentages, they were statistically significant due to the large sample size. Many studies showed a high prevalence of overweight/obesity among young children, [12-14,16,21,25-28], even up to 30.1% among Hong Kong children as reported by Wing et al[29].

More than 80% of the total children were examined from grade 1 to grade 5 with at least one 'just erupted teeth'. In Pakistan, children are admitted in grade 1 at about the age of 6 years. Therefore, by the grade of 5, the majority of them were 11 years old. It shows that 80% of the teeth erupted by the age of 11 years. Kutesa[5] and Khan[11] also showed the same duration pattern as the collected sample.

Two-thirds of the children showed the eruption of central incisors at the age of 6 or 7. However, the eruption of incisors of mandibular showed in higher percentage in 6 years than in 7 years of maxillary incisors. These eruption times are in agreement with Khan.[3,9-11] However, Kutesa[5] showed a little earlier eruption of incisors than this study.

The majority of the first molars of mandibular and maxillary teeth erupted at the age of 6 years. Khan[9,11], Anu[22], Javed[27], and Garg[29] also showed that the majority of first permanent molars erupted at the age of 6 or 7 in their studies. However, Khan[3] showed that the Saudi male children erupted their first molar between the age of 5.5 years to 6.5 years, and the same results are shown by Kutesa[5] for Ugandan children. Contrary, Khan[10] indicated that the children

of Peshawar showed a late eruption of about 7 years.

About 64% of the children showed that their lateral incisors erupted by the age of 7 or 8 years. Many of the studies[3,5] agreed with this outcome. However, Khan[9] showed higher values for maxillary lateral incisors for Karachi children and Khan[11] showed lower values of mandibular lateral incisors for Larkana children as compared to this study. More than two-thirds of the canines erupted between 9 to 11 years in this study. Most of the studies[5,9-11] follow the same range of eruption as this study.

Fifty-three percent of the first pre-molars in this study erupted at the age of 9 or 10 years. Kutesa[5] and Hassan[26] agree with this result. However, Khan[11] showed early eruption of the first pre-molar as compared to this study, and Khan[9,10] indicated later eruption times for those teeth. More than two-thirds of the second pre-molars erupted between 9 to 11 years. Khan[9,10] showed almost the same time of eruption for those teeth, however, Khan[11] showed early eruption. Sixty-nine percent of second molars showed their eruption between 10 to 12 years. Again Khan[9,10] showed almost the same results, while Khan[11] showed early eruption for those teeth.

The sequence of eruption of maxillary teeth was FM, CI, LI, FPM, SPM, C, SM. This sequence was agreed upon by Khan[9,10] for Karachi and Peshawar children. But, Khan[11] reported early eruption of SPM than FPM for Larkana children. Paz-Cortes[1] showed that CI erupted earlier than FM, and C erupted at the same time as SPM for Spanish children. The sequence of eruption of the mandibular jaw in this study appeared as FM, CI, LI, C, FPM, SPM, SM. This sequence is agreed by Khan[9,11] but Khan[10] and Paz-Cortes[1] showed that CI erupted earlier than FM for Peshawar and Spanish children, respectively. Most of the mandibular teeth erupted earlier than the maxillary teeth. This trend is agreed upon by almost all the studies conducted on this subject.

The sequence of eruption of teeth established by Logan and Kronfield[30] and indicated in textbooks is as follows: Maxillary: FM, CI, LI, FPM, C, SPM, SM; and mandibular: FM, CI, LI, C, FPM, SPM, SM. The sequence of this study is the same, except SPM precedes the C in the maxillary jaw. Therefore, the sequence of eruption of permanent teeth in Pakistani children follows almost the same as internationally established standards.

Larkana children showed early eruption for all the teeth in both jaws, while Karachi children showed late eruption in most of the teeth as compared to other cities of study centers. The physical build of Sindhis is comparatively shorter and thinner than other ethnic groups in Pakistan. As it is mentioned in Khan[3] and Khan[9] that African children who have thinner physical build-up showed early eruption as compared to the children of other populations. This trend is also showed applicable over here. The reason for the late eruption of Karachi children could be the soft dietary habits and low sea level elevation as compared to the children of the other three cities. These factors need further investigation.

Except for the first molars, all other teeth showed early eruption for overweight and obese children as compared to underweight and normal-weight children. Since the first permanent molars are the first teeth that erupt in the oral cavity in about 5 to 7 years, and at this early age overweight/obesity does not influence too much in the development of roots and eruption of teeth. However, as the child grows further, the influence of this health abnormality affects more on the time of the eruption. This combined data of Pakistani children indicated the same inversely proportional trend between BMI and eruption time as shown by Khan[10] for the Karachi children. Arid[12], Reis[13], Evangelista[17], Anu et al[22], and Jawed et al[27] showed the trend of early eruption for obese children as compared to Eutrophic (normal weight) or underweight children for all the teeth, except the first molars. Heinrich-Weltzien[16] showed that stunted and thin children delayed their eruption as compared to eutrophic children. Nicholas[19] showed in a longitudinal study that high BMI at a young age may predict a pattern of early teeth development and continue in the whole process. Dimaisip-Nabuab et al[21] in a multi-center study in three countries showed that Indonesian and Lao children showed significantly early eruption for overweight than eutrophic children, while Cambodian children reported insignificant early eruption in that relationship. Traver-Ferrando et al[25] showed by using multivariate regression that the first molars and mandibular central incisors of overweight/obese Spanish children erupted twice early as compared to the eutrophic children. However, Kutesa[2], Khan[10], and Sindelarova[20] showed either no or a weak relationship between BMI and time of eruption of permanent teeth.

The main mechanism which plays the role of accelerating the teeth eruption due to the increase of adiposity is still not very clear. Literature indicates that it is not the obesity that pushes the teeth for early eruption, but the association of casual factors instead. Many theories have been indicated, such as the somatic growth-promoting effect of adiposity tissues; secretion of insulin-like growth factor of hormonal shift; and modifications in the adjustment of metabolic processes.[18] Causes of early eruption of teeth eruption is due to the close association with many genes and some of them are also related to obesity. Insulin-like growth factor (IGF2) is one of them. The overproduction of fatty cell in the body regulates hormones and metabolic pathways, and end up increasing IGF2 and mineral metabolism and probably affecting the dental eruption.[25] Furthermore, it has been reported that cognitive lack of leptin and its receptor causes fat tissue development in early

obese kids.[31] In addition, tooth development is also associated with Fibroblast growth factors.[25]

Children's overweight/obesity is getting a serious problem all over the world. Many alterations have been developed or are in process in the healthcare sector to compete against the challenges developed due to these physiological changes in children. Dental specialists should also make alterations in their clinical practices to fight against early eruptions due to an increase in overweight/obesity in children. This study did not consider the onset of overweight/obesity, therefore the impact of overweight/obesity on the emergence of teeth is unknown. Further studies could consider this factor in a cause-and-effect relationship. Another limitation of the study belongs to the type of research. It is a cross-sectional study, which is considered low in the family of evidence. However, the outcomes of the study are similar to the longitudinal studies discussed earlier. Furthermore, these results concurred with many other diverse ethical populations.

CONCLUSIONS

This multi-center concluded that the children of Karachi displayed late eruption in most of the teeth as compared to children of Larkana, Quetta, and Peshawar. Furthermore, except for the first molars, all other teeth showed early eruption for overweight and obese children as compared to underweight and normal-weight children. This trend is comparable to the international findings.

REFERENCES

1. Paz-Cortés MM, Muñoz-Cano L, Diéguez-Pérez M. Evaluation of the Relationship between the BMI and the Sequence and Chronology of Eruption in Permanent Dentition in Spanish Population. Healthcare 2022;10(6):1046-56. https://doi.org/10.3390/healthcare10061046
2. Hernández M, Espasa E, Boj J. Eruption chronology of the permanent dentition in Spanish children. J Clinical Pediatric Dent 2008;32(4):347-50. https://doi.org/10.17796/jcpd.32.4.r1gp36615p54w642
3. Khan NB, Chohan AN, Al-Mograbi B, Al-Deyab S, Zahid T, AlMoutairi M. Eruption time of permanent first molars and incisors among a sample of Saudi male schoolchildren. Saudi Dent J 2006;18(1):18-24. https://pesquisa.bvsalud.org/portal/resource/pt/emr-81040
4. Khan H, Khan N, Baloch MUR, Abbasi SA. Effect of diet on eruption times for permanent teeth of children in Peshawar. Pak Oral Dent J 2020;40(1):24-30. http://www.podj.com.pk/index.php/podj/article/view/518
5. Kutesa A, Nkamba EB, Muwazi L, William Buwembo W, Rwenyonyi CH. Weight, height and eruption times of permanent teeth of children aged 4-15 years in Kampala, Uganda. BMC Oral Health 2013;13:15. https://doi.org/10.1186/1472-6831-13-15
6. Kurosaka H, Itoh S, Morita C, Tsujimoto T, Murata Y, Inubushi T, et al. Development of dentition: From initiation to occlusion and related diseases. J Oral Biosci 2022;64:159-64. https://doi.org/10.1016/j.job.2022.02.005
7. Nahajowski M, Hnitecka S, Antoszewska-Smith J, Rumin K, Dubowik M, Sarul M. Factors influencing an eruption of teeth associated with a dentigerous cyst: A systematic review and meta-analysis. BMC Oral Health 2021;21:180. https://doi.org/10.1186/s12903-021-01542-y
8. Almotairy N, Pegelow M. Dental age comparison in patients born with unilateral cleft lip and palate to a control sample using Demirjian and Willems methods. Eur J Orthod 2018;40:74-81. https://doi.org/10.1093/ejo/cjx031
9. Khan N. Eruption time of permanent teeth in Pakistani children. Iranian J Public Health 2011;40(4):63-73. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3481734/
10. Khan N, Khan H, Baloch MR, Abbasi SA. Time of Emergence of Permanent Teeth of the Children of Peshawar, Pakistan. J Pak Dent Assos 2019;28(04):154-61. https://doi.org/10.25301/JPDA.284.154
11. Khan N, Abbasi SA, Khan H, Chohan A. Effect of Dietary Pattern on the Emergence of Permanent Teeth of the Children of Larkana, Pakistan. Ibnosina J Med Bio Sci 2022;14(01):28-34. https://doi.org/10.1055/s-0042-1748671
12. Arid J, Vitiello MC, da Silva RAB, da Silva LAB, de Queiroz AM, Küchler EC, et al. Nutritional status is associated with permanent tooth eruption chronology. Braz J Oral Sci 2017;16:1-7. https://doi.org/10.20396/bjos.v16i0.8650503
13. Reis CLB, Barbosa MCF, Henklein S, Madalena IR, Lima DCDL, Oliveira MAHM, et al. Nutritional status is associated with permanent tooth eruption in a group of Brazilian school children. Glob Pediatr Health 2021;8:1-6. https://doi.org/10.1177/2333794X211034088
14. Hedayati Z, Khalafi NF. Relationship between Body Mass Index, Skeletal Maturation and Dental Development in 6- to 15-Year Old Orthodontic Patients in a Sample of Iranian Population. J Dent Shiraz Univ Med Sci 2014;15:180-6. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4247841/
15. https://www.who.int/health-topics/malnutrition#tab=tab_1; Accessed on 5th November 2022.
16. Evangelista S, Felizardo KR, Xavier TA, Oliveira S, Luiz A, Nelson-Filho P, et al. Timing of Permanent Tooth Emergence is Associated with Overweight/Obesity in Children from the Amazon Region. Braz Dent J 2018;29:465-8. https://doi.org/10.1590/0103-6440201802230
17. Heinrich-Weltzien R, Zorn C, Monse B, Kromeyer-Hauschild K. Relationship between Malnutrition and the Number of Permanent Teeth in Filipino 10- to 13-Year-Olds. Biomed Res Int 2013;2013:1-8. https://doi.org/10.1155/2013/205950
18. Mohamedhussein N, Busuttil-Naudi A, Mohammed H, Uihaq A. Association of obesity with the eruption

of first and second permanent molars in children: a systematic review. Eur Arch Paediatr Dent 2020; 21:13-23. https://doi.org/10.1007/s40368-019-00452-6

19. Nicholas CL, Kevan Kadavy K, Holton NE, Marshall T, Richter A, Southardb T. Childhood body mass index is associated with early dental development and eruption in a longitudinal sample from the Iowa Facial Growth Study. Am J Orthod Dentofacial Orthop 2018;154:72-81. https://doi.org/10.1016/j.ajodo.2017.10.033
20. Sindelarova R, Soukup P, Broukal Z. The relationship of obesity to the timing of permanent tooth emergence in Czech children. Acta Odontol Scand 2018;76:220-5. https://doi.org/10.1080/00016357.2017.1403649
21. Dimaisip-Nabuab J, Duijster D, Benzian H. Nutritional status, dental caries and tooth eruption in children: a longitudinal study in Cambodia, Indonesia and Lao PDR. BMC Pediatr 2018;18:1-11. https://doi.org/10.1186/s12887-018-1277-6
22. Anu V, Brindha JR, Carol PT, Diana PC, Elsy JD, Garima S. Does body mass index affect tooth eruption sequence? A study 6-7 years old schoolchildren in Chennai, India. Int J Clin Pediatr Dent 2020;13:261-3. https://doi.org/10.5005/jp-journals-10005-1762
23. Esan TA, Schepartz LA. Does nutrition have an effect on the timing of tooth formation?. Am J Phys Antropol 2019;171:470-80. https://doi.org/10.1002/ajpa.23987
24. Crowe M, Sullivan MO', Cassetti O, Sullivan AO'. Weight Status and Dental Problems in Early Childhood: Classification Tree Analysis of a National Cohort. Dent J 2017;5:25. https://doi.org/10.3390/dj5030025
25. Traver-Ferrando C, Barcia-González J. Early permanent dental eruption in obese/overweigh schoolchildren. J Clin Exp Dent 2022;14:e199-e204. https://doi.org/10.4317/jced.58568
26. Hassan S, Shahid H. Assessment of eruption of permanent teeth according to age and its relation with body mass index in local population. J Pak Dent Assoc 2018;27(3):127-32. https://doi.org/10.25301/JPDA.273.127
27. Javed S, Baloch MM, Shoaib M, Aslam S, Tahir A, Shaikh AG. Determination of Eruption Timings of Mandibular and Maxillary First Permanent Molar and its Association with BMI of Children. Pakistan Med Health Sci 2022;16(05):1418-20. https://doi.org/10.53350/pjmhs221651418
28. Iftikhar S, Khan N, Siddiqui JS, Baig-Ansari N. Development of growth charts of Pakistani children aged 4-15 years using quantile regression: a cross-sectional study. Cureus 2018;10(2):e2138. https://doi.org/10.7759/cureus.2138
29. Wong HM, Peng SM, Yang Y, King NM, McGrath CP. Tooth eruption and obesity in 12-year-old children. J Dent Sci 2017;12(2):126-32. https://doi.org/10.1016/j.jds.2016.10.004
30. Logan WHG, Kronfield R. Development of the human jaws and surrounding structures from birth to age fifteen. J Am Dent Assoc 1933;20:379-428. https://www.sciencedirect.com/science/article/abs/pii/S1048636433030022
31. Garg S, Dhindsa A, Poddar P, Sharma R, Singla S. Eruption Status of First Permanent Molar and Prevalence of Dental Caries among School Going North Indian Children: An Epidemiological Study. J Dental Health Oral Res. 2022;3(2):1-9. https://doi.org/10.46889/JDHOR.2022.3202

CONFLICT OF INTEREST
Authors declare no conflict of interest.
GRANT SUPPORT AND FINANCIAL DISCLOSURE
Higher Education Commission of Pakistan

AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

Conception or Design:	NK, HK
Acquisition, Analysis or Interpretation of Data:	NK, HK, MURB
Manuscript Writing & Approval:	NK, HK, MURB

All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.