Time of Emergence of Permanent Teeth and Impact of Nutritional Status among 4-15 Years Old Children and Teenagers in Basrah City /Iraq

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ABSTRACT

Background: The timing of eruption of permanent teeth is of considerable importance to the dental health planning for diagnostic, preventive and therapeutic measures for children and teenagers. The purposes of this study were to determine timing of maxillary and mandibular permanent teeth emergence (except third molars) and to evaluate the effect nutritional status by anthropometric measures on the eruption time of permanent teeth, investigations had been done according to jaw and gender variations.

Materials and Methods: This study was conducted among four to fifteen years old children and teenagers from kindergarten and schools in Basrah city in the south region of Iraq. The total sample composed of 1807 children and teenagers that were collected randomly from kindergartens, primary and secondary schools in Basrah city.

The data were statistically analyzed by using probit model in order to compute the median 5th and 95th percentile range of emergence. Athropmetric measures of height and weight were used for the purpose of assessment of nutritional status. The indices include: Weight for age, Height for age and Weight for height; each was considered as in term of standard deviation score (Z – score) as primary indicator of underweight, stunting and wasting respectively. The statistical significance of differences in mean of a normally distributed variable (nutritional indices z score) between 2 groups was assessed by independent samples t-test.

Results: The results showed significant differences ($p<0.05$) between the timing of maxillary and mandibular teeth emergence in girls and boys, with earlier emergence in girls , also the mandibular teeth emerge before their maxillary opposing teeth in both sexes except for premolars .

The prevalence of malnutrition according to height for age, weight for age, and weight for height nutritional status indicators were found to be 7.4 %, 3.7 % and 1.5% respectively.

The results showed that among well-nourished children and teenagers described by height for age nutritional status indicator, most teeth were significantly erupted earlier than stunted except the lateral incisor which erupted earlier in stunted boys than well-nourished boys but the difference was not significantly accepted. The greatest difference of median eruption age of permanent teeth between well -nourished and stunted found in girls in the second molar tooth.

Conclusions: Records indicated that the Iraqi children exhibit variation in their times of permanent teeth emergence when compared with other studies, and among well-nourished children and teenaged described by height for age nutritional status indicator, most teeth were significantly erupted earlier than stunted children and teenagers.

Keywords: Permanent teeth, Tooth eruption, nutritional status. **(J Bagh Coll Dentistry 2016; 28(4):134-140)**

INTRODUCTION

Tooth eruption is a continuous biological activity by which evolving teeth emerge across jaws and the overlying mucosa into the oral cavity [(1)]. The school age period from childhood to adolescent is a critical life stage when health and oral health behaviors develop [(2)].

Many factors associated with eruption have been widely investigated. Suggested factors which causing differences might include race [(3)] gender [(4,5)] hereditary factors [(6,7)] and nutritional status [(8,9).] Many studies have been conducted throughout the world concerning dental development and timing of permanent teeth emergence, all of which agreed that a wide margin of variation existed between population groups [(10-12)].

Also There are many studies conducted in different population and among different ethnic groups all over the world that relate the eruption time with the weight and height as an anthropometric measures of nutritional status [(13,14)]

Khan in 2006 found that children who are within the standard range of height and weight show normal eruption time as compared to those who are below the average [(15)].In a study for the eruption time of permanent teeth in Pakistani children ;the eruption of the teeth is found to be positively related to somatic growth (height and weight) of individuals [(16)].The application of epidemiological methods as a research tool and knowledge about the procedures used for computing the times of permanent teeth emergence from cross-sectional data are necessary to produce a standard tables of teeth emergence time for each population [(17)] .Various statistical procedures have been used for the analysis of data on teeth emergence time, which is usually being expressed as the arithmetic means by using

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Karber's method [18,19], or using Probit's analysis [10-12],Probit analysis is widely used for computing the median (50th percentile), the 5th and 95th percentiles range of tooth emergence because the use of fixed values often create the impression of delay or acceleration in emergence while presentation of ranges of normal variation would create more realistic picture for dental practice and /or for teaching[20].

In Iraq, studies conducted by Al-Farhan in1976, Ghose and Baghdady in 1981, Ghaib in1998 and Daood in 2001[19,21-23], this research is directed towards getting recent records of emergence of all individual permanent teeth except third molars (central incisors, lateral incisors, canines, first premolars, second premolars, first molars and second molars) for Iraqi students which resides in Basrah city by using precise statistical analysis (probit models) and compare the results with those of previous Iraqi studies to evaluate the extent to which alteration in emergence times of permanent teeth might be expected, and to show the influence of nutrition on human dentition because there is no previous Iraqi study concerning the relation between nutritional status and teeth eruption for permanent teeth . Adequate knowledge of timing of permanent tooth emergence is essential for diagnosis and treatment planning in Pediatric dentistry and Orthodontics, the information on tooth emergence is also used to supplement other maturity indicators in the diagnosis of certain growth disturbances; therefore, the specific standards of the time of emergence of teeth considers as an important resource for general dental practitioners, orthodontists and pedodontist [24].

MATERIALS AND METHODS

The investigation based on cross-sectional samples [25,26] gathered randomly from Basrah city in the south part of Iraq, the sample size in this study consists of 1807 children and teenaged from kindergarten, primary and secondary school children, the sample size was estimated after consultation with statistician based on the number of children present in the kindergarten, primary and secondary schools according to Ministry of education census in 2014-2015, also the time available for conducting the study was determined, taking in consideration that a large sample can produce unbiased estimate for permanent teeth emergence times [26]. In order to obtain representative sample the process of random sampling, according to which every member of a population has an equal chance of being included in the sample used [27].

The examination of children and teenaged started from the first of November -2014 to the middle of April -2015.

The examination

After the achievement of the approval from the Ministry of Education to conduct this study, the school authority has been contacted and purposes of the study were explained to them, a child included in the examination if he or she regarded as Iraqi as determined by the race of his parents.

Students were examined in their class room, they were seated in a chair with a tall back near the window to use the natural light in the examination while the examiner standing in front of the chair [28], and the records were written in the case sheet. Accurate birthday was available from the school registrant (personal school chart for each child)and sometimes births supported by birth certificates, if the exact date of child's birth was not available or has any orthodontic appliance, the child not included in the examination. The criteria used:

- The teeth were recorded in the case sheet as emerged or not emerged.
  A tooth was defined as emerged when any part of its crown pierced the gingiva, the probe was used to be sure from crown emergence when any suspension exist [29-31,12].
- Any extracted permanent teeth were recorded as erupted [32].
- Since no radiographical examination was made, any congenital missing tooth was recorded as non-emerged [31].

Nutritional Status Assessment (Anthropometric Measurements)

Measurement of weight

The measurement of weight was done by using scale for weight records nearest to 0.1 kg. The child weighted with minimum clothes without touching anything with 500 gram subtracted from the total weight to compensate for underneath clothes [9].

Measurement of height:

The measurements of height was done by using the ordinary measuring tape fixed at the wall and the child standing up after removing the shoes with feet parallel to each other and pointed forward and the back is straight in upright position. The knees must be straight and the head in position that Frankfort Plane must be horizontal [33].

Classification of Malnutrition

Indices used for the purpose of assessment of nutritional status were: Weight for age, Height for age and Weight for height; each was considered as in term of standard deviation score (Z – score) as primary indicator of underweight ,stunting and wasting respectively ,these computed by percentile, and analyzed with -Z score lines on the growth charts are numbered positively (1, 2, 3) or negatively (-1, -2, -3).

In general, the plotted point that is far from the median in either direction close to the 3 or -3 z-score line may stand for a growth problem; indicators are included in a certain definition by being plotted above or below a particular z-score line. If it is plotted closely on the z-score line, it is considered in the less severe groupusing cut–off point -2 standard deviations.

Analysis procedure

In this study, the emergence ages of permanent teeth agreed to be normally distributed which is the prerequisite of using probit analysis assuming and underlying normal distribution, so probit model employing the method of maximum likelihood was chosen after obtaining more information around calculation and equation arrangement for probit model [20].

Statistical significance of differences in mean of a normally distributed variable (nutritional indices z score) between 2 groups was assessed by independent samples t-test. The statistical significance of differences in mean of a normally distributed variable between more than 2 groups was assessed by ANOVA test .The Chi-square ($\chi 2$) Pearson test was used to assess the statistical significance of association between 2 nominal or ordinal level variables

RESULTS

The total sample consisted of 1807 children and teenaged between ages (4-15) years, 766 of the sample were boys (42.4%) and 1041 were girls (57 .6%) collected from random areas of Basrah City Tables (1) and (2).

The first tooth to erupt is the mandibular first molar and the last tooth is maxillary second molar.

Table (3) showed Median eruption time (in years and months) for each permanent tooth stratified by gender. The results show greatest significant differences with earlier girls median eruption time than boys in the maxillary central incisor and mandibular canine (7 months) at $p < 0.05$. Reverse relationship with (1 month) earlier median eruption time in boys than girls found in the second molar tooth but the results are statistically not significant. The smallest gender differences occurred in eruption of the maxillary second premolar (1month).

Most mandibular teeth (central incisor, lateral incisor, canine, first molar, second molar) emerged significantly earlier than opposing maxillary teeth for both genders ($p < 0.05$).

This trend is reversed with premolar emergence time, the maxillary first premolar emerge significantly (3 months) for girls and (4 months) for boys before their mandibular antagonist. The greatest difference in the eruption time between the jaws for any individual tooth type occurred between the maxillary and mandibular canines of the boys [1(6/12) months] and between maxillary and mandibular canines of the girls [1 (9/12) months]

The smallest difference in eruption time between the teeth of opposite jaws occurred with the eruption of the maxillary and mandibular first molar teeth in boys [(-1/12) months] and the maxillary and mandibular second premolar teeth in girls [(1/12) months].

The prevalence of sever stunting among children and teenagers were found to be 1.9% , The presence of stunting was significantly higher in girls (11.2 %) than in boys (6.7%).

The distribution of sample according to weight for age Z-score indicator found prevalence of 3.7% underweight, and 0.4 % sever underweight ,the percentage of underweight was higher in girls(4.9%)than in boys (3.1%)but the result was not statistically significant .

Wasting malnutrition was severe in 1.6% of sample and 1.5% of sample showed some degree of wasting, the percentage of wasted boys was higher than girls but the result was not statistically significant**.**

Among well-nourished children and teenaged most teeth were significantly erupted earlier than stunted children except the lateral incisor which erupted (1 month) earlier in stunted boys than well-nourished boys but the result was not significantly accepted (Table 5).

The greatest difference of median eruption age of permanent teeth in females between well -nourished and stunted girls was in second molar tooth [1 (1/12)months] , while in boys the greatest difference of median eruption age of permanent teeth between well -nourished and stunted boys was in the second molar tooth [1 (0/12)months].

The greatest relative median potency estimates of mandible to maxilla between well-nourished and stunted boys was in the first premolar tooth (1.037) and the result was statistically significant ($p<0.05$).

Table 1: Distribution of sample by gender

Gender	N	%
Boys	766	42.4
Girls	1041	57.6
Total	1807	100.0

Table 2: Distribution of sample by age groups

Age group (years)	No.	%
4-6	370	20.5
7-9	521	28.8
10-12	461	25.5
13-15	455	25.2
Total	1807	100

Table 3: Median eruption time (in years and months) for each permanent tooth stratified by gender

Arch	Tooth	Girls	Boys
		Median eruption age (in years and months)	Median eruption age (in years and months)
Maxilla	**Central incisor**	6 (11/12)	7 (6/12)
	Lateral incisor	7 (11/12)	8 (3/12)
	Canine	11 (1/12)	11 (6/12)
	First premolar	9 (8/12)	9 (11/12)
	Second premolar	10 (10/12)	10 (11/12)
	First molar	6 (3/12)	6 (6/12)
	Second molar	12 (2/12)	12 (1/12)
Mandible	**Mandible**		
	Central incisor	6 (1/12)	6 (6/12)
	Lateral incisor	7 (1/12)	7 (5/12)
	Canine	9(5/12)	10 (0/12)
	First premolar	9 (11/12)	10 (4/12)
	Second premolar	10 (11/12)	11 (3/12)
	First molar	6 (1/12)	6 (6/12)
	Second molar	11 (6/12)	11 (3/12)

Table 4: Prevalence of malnutrition according to gender

Malnutrition	Gender				P
	Boys (n=766)		Girls (n=1041)		
	N	%	N	%	
Stunting	51	6.7	117	11.2	p<0.001*
Underweight	24	3.1	51	4.9	0.06[NS]
Wasting	25	3.3	20	1.9	0.07[NS]
Any evidence of Malnutrition	82	10.7	142	13.6	0.06[NS]

Table 5: Difference in median eruption time between stunted and acceptable height for age with relative median potency of mandible to maxilla according to gender

	Median Eruption age			Relative Median Potency Estimates of Mandible to maxilla		Significance
	Acceptable HAZ¥	Stunted	Difference	Estimate	95% CI	
Central incisor						
Girls	6.47	6.63	(2/12)	0.899	(0.861 to 0.936)	P<0.05 *
Boys	6.90	7.54	(8/12)	0.88	(0.837 to 0.919)	P<0.05 *
Lateral incisor						
Girls	7.41	7.86	(5/12)	0.899	(0.878 to 0.918)	P<0.05 *
Boys	7.78	7.66	(-1/12) º	0.898	(0.161 to 1.116)	[NS]
Canine						
Girls	10.11	10.76	(8/12)	0.85	(0.823 to 0.866)	P<0.05 *
Boys	10.60	11.17	(7/12)	0.876	(0.85 to 0.9)	P<0.05 *
First premolar						
Girls	9.68	10.05	(4/12)	1.026	(1.009 to 1.045)	P<0.05 *
Boys	10.01	10.90	(11/12)	1.037	(1.015 to 1.061)	P<0.05 *
Second premolar						
Girls	10.76	11.59	(10/12)	1.012	(0.996 to 1.028)	[NS]
Boys	10.96	11.97	1 (0/12)	1.031	(1.012 to 1.051)	P<0.05 *
First molar						
Girls	6.10	6.38	(3/12)	0.967	(0.946 to 0.987)	P<0.05 *
Boys	6.53	7.37	(10/12)	0.97	(0.928 to 1.012)	[NS]
Second molar						
Girls	11.65	12.80	1 (2/12)	0.951	(0.935 to 0.965)	P<0.05 *
Boys	11.90	12.51	(7/12)	0.949	(0.93 to 0.967)	P<0.05 *

*** Significant at p< 0.05, º Negative symbol indicates reverse relationship, ¥ HAZ :Height for Age Z-Score**

DISCUSSION

In the current study, the age range of examined children was chosen in wide scale ranging from 4 to 15 years in order to cover the clinical emergence ages of both maxillary and mandibular permanent teeth except third molar because they have great variability in development, emergence, and time of occlusion [34].

A cross-sectional study was designed because the desired emphasis was on the accuracy of emergence dates of permanent teeth [26], and an attempt to include a greater sample size in order to get sufficient unbiased estimates for the median emergence time using proper statistical method.

The emergence times of the permanent teeth in the right and left sides in both jaws and for each gender have no statistical significant differences and this result in agreement with studies of Helm and Seidler [29], Elkeli et al [12] and Daood [23]. This similarity in permanent teeth eruption in right and left sides indicate a more stability in the permanent dentition development [35],

The timing of emergence of permanent teeth in the present study show differencesin comparison with other Asian study Kanno [17] which conducted for Japanese children especially for canines and premolars..

The emergence time for Iraqi children in the present study found to be earlier when compared with Saudian children for the emergence of canine and premolars [5],some of differences could be attributed to differences in sample size or variation in the environmental factors ,other differences may be related to racial variations.

The results of the present study show that the mandibular teeth emerge significantly ($p < 0.05$) earlier than corresponding maxillary teeth in both genders except for premolars, these results are in agreement with the study of El –Sawaf in Egypt [36], Kanno in Japan [17] .On the other hand the results of the present study disagree with the study of El–Zahid and Hafez [5] in Saudi who found that the maxillary and mandibular premolars have almost the same time of emergence especially for the boys.

The greatest difference in the eruption time between the jaws for any individual tooth type occurred between the maxillary and mandibular canines in the boys [1(6/12) months] and between maxillary and mandibular canines in the girls [1 (9/12) months].

The smallest difference in eruption time between the teeth of opposite jaws occurred with the eruption of the maxillary and mandibular first molar teeth in boys [(-1/12) months] and the maxillary and mandibular second premolar teeth in girls [(1/12) months]. The variation of emergence for maxillary canine could be attributed to its long and tortuous path of eruption during its development, and this

variation in timing of canine eruption should be considered along with its possible effect on the alignment with the other maxillary teeth [37], less variability reported for the first molar which have no deciduous predecessors behind the second deciduous molar, as these teeth emerge they are guided the first molar into its position in the oral cavity [38] .

In general the advancement of mandibular permanent teeth in their emergence than corresponding maxillary permanent teeth could be attributed to the earlier formation of mandible during its embryonic development than maxilla [39], therefore the mandibular teeth expected to form and emerge before the maxillary teeth, while the emergence of maxillary premolars before the mandibular premolars in the present study could be due to the local factors.

Gender differences could be explained by the fact that girls exhibit earlier physical development than boys, also the girls permanent teeth found to have a complete root formation earlier than boys permanent teeth [31,40].

The emergence of permanent teeth for Iraqi children in both genders began with the appearance of mandibular first molar in and ended by emergence of maxillary second molar. During permanent dentition development ,the mandibular first molar have rapid rate of formation (formation of enamel matrix and dentin begins at birth and enamel completed at 2-3 years), while the maxillary second molar start its calcification about 2-3 years and completion of crown occurs about 7-8 years [38].

The general trends of permanent teeth emergence in this research are similar to those of previous Iraqi studies [19,21-23].

The differences between the life style nowadays and a few decades ago, including the texture of food, the general health care and other external factors that may lead to changes in the development of human dentitions as a whole. So the demonstrated differences in the emergence pattern between the sample of 1976 and 2014 could be interpreted to represent a trends in the emergence of permanent dentition and these changes may be associated with a different relations between timing of dental and general development in the earlier and cotemporary generations or due to genetic variations [8].

The results of permanent teeth emergence times (except third molar) in this research are approximately the same for those reported by Ghose and Baghdady [21] and Daood [23], but earlier than those reported by Ghaib [22]. But the precise comparison is difficult to done because only years of child birth was used without consideration of any month intervals except study done by Daood [23] by collecting the samples from Baghdad city and the researcher used a statistical method (Probit analysis) differ than Karber method used in previous Iraqi studies, the Karber method gives a later estimate for the emergence times in such situation.

Therefore, the permanent teeth emergence remain as an example of growth parameter and both earlier and later emergence of permanent teeth emergence in both genders which found in the present research compared with previous Iraqi studies could be in general reflect variations during the stages of teeth formation.

In the present study the prevalence malnutrition according to height for age, weight for age , and weight for height nutritional status indicators were found to be 7.4 %, 3.7 % and 1.5% respectively .The comparison of malnutrition of present study with other studies is difficult because of using of different criteria in classification of malnutrition or different age ranges of sample.

The prevalence of chronic malnutrition (stunting) was found to be higher than the prevalence of underweighting and wasting malnutrition, with more prevalence among girls than boys, the higher prevalence of stunting among younger girls children could be due to the effect of extension of cultural preference for boys [41].

Some children have more than one type of malnutrition status, this combines information about linear growth retardation, as wasting and stunting are varying only in terms of timing or intensity, and all three malnutrition status (stunting, wasting and underweight) share some common causes as dietary inadequacy.

The present study revealed that there were significant differences in the eruption time of permanent teeth among well-nourished and stunted with an earlier eruption of permanent teeth in well-nourished children and teenaged in both genders.

Among well-nourished children and teenaged described by height for age nutritional status indicator, most teeth were significantly erupted earlier than stunted children except the lateral incisor which erupted earlier in stunted boys than well-nourished boys but the result was not significantly accepted. The greatest difference of median eruption age of permanent teeth between well -nourished and stunted found in girls in the second molar tooth which was [1 (2/12)months] , Eruption of teeth is a growth process of the body and therefore have a relation with other processes of the body especially height and weight [42].

REFERENCES

1. Almonaitiene R, Balciuniene I, Tutkuviene J. Factors influencing permanent teeth eruption. Part one–general factors. Stomatologija 2010; 12(3): 67-72.

2. Parkash H, Mathur V P, Duggal R, Jhuraney B. Dental workforce issues: a global concern. J Dental Education 2006; 70(11 suppl): 22-6.
3. Moyers RE. Handbook of Orthodontics. 4th ed. Chicago Yearbook. Med Publish Inc.; 1988. pp. 140.
4. Hagg U, Taranger J. Timing of tooth emergence. Swed Dent J 1986; 10: 195-206.
5. El-Zahid H, Hafez S. Sequence of eruption of maxillary and mandibular permanent canines and premolars for a group of Saudi children. Egyptian Orthod J 1993; (7): 321-7.
6. Pytlik W. Primary failure of eruption; a case report. Int Dent J 1991; 41(5): 274-8.
7. Rasmussen P, Kotaski .Inherited primary failure of eruption in the primary dentition. J Dent Child 1997; 64 (1): 43-7.
8. Alvarez JO. Nutrition, tooth development, and dental caries. Am J Clinical Nutrition1995; 61(2): 410S-6S.
9. Diab BS. Nutritional status in relation to oral health condition among 6-10 years primary school children in the middle region of Iraq. Ph.D. Thesis, College of Dentistry, University of Baghdad, 2003.
10. Blankenstein R, Cleaton-Jones PE, Maistry PK, Luk K M, Fatti LP. The onset of eruption of permanent teeth amongst South African Indian children. Annals of human biology, 1990; 17(6): 515-21.
11. Virtanen JI, Bloigu RS, Larmas MA. Timing of eruption of permanent teeth: Standard Finnish patient documents. Comm. Dent. Oral. Epidemiol 1994; 22: 286-8.
12. Eskeli R, Laine MT, Hasen H. Standard for permanent teeth emergence in Finnish children. Angle Orthod 1999; 69(6): 529-33.
13. Billewicz WZ, McGregor IA. Eruption of permanent teeth in West African (Gambian) children in relation to age, sex and physique. Ann Hum Biol 1975; 2: 17-28.
14. Diamanti J. Townsend GC. New standards for permanent tooth emergence in Australian children. Australian Dent J 2003; 48(1): 39-42.
15. Khan NB, Chohan AN, Al-Mograbi B, Al-Deyab S, Zahid T, Al-Moutairi, M. Eruption time of permanent first molars and incisors among a sample of Saudi male schoolchildren. Saudi Dent J 2006; 18(1): 18-24.
16. Khan N. Eruption time of permanent teeth in Pakistani children. Iranian J Public Health 2011; 40(4): 63.
17. Kanno R. Estimation of median for the eruption time of permanent teeth. Memories Liberal Arts Sciences 1995; 11: 6-17.
18. Krumholt L, Petersen B, Pindborg JJ .Eruption times of the permanent teeth in 622 Ugandan children. Archs Oral Biol 1971; 16: 1281-8.
19. Al-Farhan S. Aspects of oral health in Iraq. A mater thesis, University of Dundee, 1979.
20. Kanno R. On the linearization of eruption series of the permanent teeth. The Bulletin of Tokyo Dental College 1997; 38(4): 269-281.
21. Ghose LJ, Baghdady VS. Eruption time of permanent teeth in Iraqi school children. Arch Oral Biol 1981; 26(1): 13-15.
22. Ghaib N. Eruption time permanent teeth Iraqi school children. J Coll Dentistry 2002; 12: 94-7.
23. Daood ZH. Chronology of permanent teeth emergence for Iraqi children /Baghdad city (Across-sectional study). A master Thesis, College of dentistry; University of Baghdad, 2001.
24. Mugonzibwa EA, Kuijpers AM, Laine MT, Van't Hof MA. Emergence of permanent teeth in Tanzanian children. Community Dentistry Oral Epidemiol 2002; 30(6): 455-462.
25. Dahlberg AA, Menegaz-Bock RM. Emergence of permanent teeth in Pima India children. J Dent Res.1958; 37:1123-40.
26. Holman DJ, Jones RE. Longitudinal analysis of deciduous tooth emergence: II. Parametric survival analysis in Bangladeshi, Guatemalan, Japanese, and Javanese children. Am J Phys Anthropol 1998; 105(2): 209-30.
27. Spiegel MR. Statistics-theory and problem. London: McGraw-Hill Book Co.; 1972. pp. 188-195.
28. World Health Organization. Oral Health surveys basic methods. 4th ed. WHO. Geneva; Switzerland, 1997.
29. Helm S, Seidler B. Timing of permanent tooth emergence in Danish children. Comm Dent Oral Epidemiol 1974; 2: 122-9.
30. Boesen P, Haven J, Helm S .Timing of permanent tooth emergence in two Greenland Eskimo population. Community Dent Oral Epidemiol 1967; 4: 244-7.
31. Jaswal S. Age and sequence of permanent tooth emergence among Khasis. Am J Phys Anthropol1983; 62: 177-186.
32. World Health Organization. Basic methods for oral health survey. 3rd ed. WHO. Geneva, 1987.
33. Buckler JM. Variations in height throughout the day. Arch Disease Childhood 1978; 53: 762.
34. Proffit WR, Fields HW. Contemporary orthodontics. 3rd ed. St. Louis: Mosby Inc.; 2000.
35. Mayhall JT, Belier PL, Mayhall MF. Canadian Eskimo permanent tooth emergence timing. Am J Phys Anthropol 1978; 49: 211-16.
36. El-Sawaf AA. Chronology of permanent teeth emergence among a group of Egyptian children. A mater thesis, Faculty of Oral and Dental Medicine, Cairo University, 1985.
37. Dean JA, Avery DR, McDonald RE. McDonald and Avery's. Dentistry for the child and adolescent. 9th ed. Missouri: Mosby/Elsevier; 2011. pp: 190-200.
38. Scott J H, Symons N B. Introduction to Dental Anatomy. 9th ed. Churchill Livingston; 1961. pp: 103-133.
39. Brash JC. The growth of the alveolar bone and its relation to the movements of the teeth, including eruption. Inter J Orthodontia Oral Surgery and Radiography 1991; 14(6): 487-504.
40. Farah ME. The orthodontic examination of children aged 9 and 10 years from Baghdad, Iraq-A clinical and radiographic study. A master thesis. College of Dentistry, University of Baghdad.1988.
41. Senbanjo IO, Oshikoya KA, Odusanya OO, Njokanma OF. Prevalence of and risk factors for stunting among school children and adolescents in Abeokuta, Southwest Nigeria. J Health Population Nutrition 2011; 29(4): 364.
42. Jones PC, Richardson BD, Granath L, Fatti L P, Sinwell R, Walker A R, Mogotsi M. Nutritional status and dental caries in a large sample of South African children. South African Medical Journal-cape town-medical association of South Africa 2000; 90(8; supp/2): 80-3.