Original article

J Nepal Health Res Counc 2020 Jul-Sep;18(48): 386-93

DOI: https://doi.org/10.33314/jnhrc.v18i3.2237

Occlusal Characteristics of Primary Dentition among School Going Children

Amita Rai,[1] Bandana Koirala,[2] Mamta Dali,[2] Sneha Shrestha,[2] Ashish Shrestha,[3] Surya Raj Niraula[4]

[1]Dental department, Kanti Children's Hospital, Maharajgunj, Kathmandu, Nepal, [2]Department of Pedodontics and Preventive Dentistry, College of Dental Surgery, B.P. Koirala Institute of Health Sciences, Dharan, Nepal, [3]Department of Public Health Dentistry, College of Dental Surgery, B.P. Koirala Institute of Health Sciences, Dharan, Nepal, [4]School of Public Health and Community Medicine, B.P. Koirala Institute of Health Sciences, Dharan, Nepal.

ABSTRACT

Background: Certain characteristics of the primary dentition have been described that may be required in the smooth transition from primary to permanent dentition and therefore development of ideal occlusion in permanent dentition. The objectives of this study were to assess different occlusal characteristics of primary dentition among school going children of Dharan, Nepal and to compare these occlusal characteristics based on gender and race.

Methods: A community based cross-sectional study was conducted among 625 school children of Mongolian and Caucasian race, aged 3 to 7 years, and having complete set of primary dentition. A close-ended questionnaire was developed to gather demographic information followed by the examination of occlusal and soft tissue parameters.

Results: The result showed 77.2% of the children had developmental spaces and 83.1% had primate spaces. Flush terminal plane molar and class I canine relationships were present in 68.8% and 81.6%, respectively with normal overjet (53.5%), normal overbite (41.1%), straight facial profile (86.7%) and competent lips (98.6%). Crowding was present in 35.4%, midline discrepancy in 11.3%, crossbite in 7.2%, scissor bite in 0.6% and open bite in 2.1% of the children examined.

Conclusions: Most of the occlusal characteristics were desirable but with the existence of some malocclusion traits, necessitating timely recognition and correction through early screening. Gender and racial influences were also observed and it emphasizes the need for treatment plan based on them.

Keywords: Gender; occlusal characteristics; primary dentition; race

INTRODUCTION

Certain characteristics of the primary dentition like presence of developmental spaces, primate spaces, flush terminal plane, class I incisors and canines relationship are required in the smooth transition from primary to permanent dentition and therefore development of ideal occlusion.[1,2]

Malocclusion traits present in primary dentition will be reflected or worsened in permanent dentition.[1] This study will help in early recognition of malocclusion in primary dentition and implementation of preventive treatment strategies, which helps in eliminating or reducing the severity of malocclusion in permanent dentition, thereby reducing the orthodontic treatment duration and cost.

Although few studies deciphering the occlusal characteristics have been reported, racial variation of occlusal characteristic have not been studied. Hence, the objectives of this study were to assess the different occlusal characteristics of primary dentition among school going children of Dharan, and to compare the distribution of occlusal characteristics based on gender and race.

METHODS

A community based cross-sectional study was conducted in randomly selected nine different schools of Dharan sub-metropolitan city, within a period of 15th March-

Correspondence: Dr Amita Rai, Dental Department, Kanti Children's Hospital, Maharajgunj, Kathmandu, Nepal. Email: amitarai2013@gmail.com, Phone: +9779819203326.

31st December 2017. Children studying in Nursery to class one were enrolled in the study using purposive sampling method. Ethical approval was obtained from the Institutional Review Committee. Informed consent was obtained from parents or their legal guardian, and assent was obtained from the children involved in the study.

Participants with complete set of primary dentition belonging to Mongolian and Caucasian race were included in the study. Children with fractured, anomalous, grossly decayed tooth/teeth; cleft of lip/palate; history of orthodontic treatment and parents/children not willing to participate in the study were excluded. The study population was categorized as Mongolian and Caucasian race according to Ethnicity.[3,4] The sample size consisted of 625 children (95 percent confidence interval=1.96, permissible error of 14% and 10% for non-response), which was estimated based on the prevalence of developmental spaces in the mandibular arch (25.7%) from the study conducted by Bhayya & Shyagali.[1]

Training and calibration was conducted for the examiner by an expert. An intra-examiner reliability test was performed by examining a group of 25 children, at two different time periods of one week apart. Cohen's Kappa statistical analysis revealed that the Kappa coefficient for various occlusal characteristics ranged from 0.80 to 0.82.

A questionnaire addressing demographic data to characterize the sample and history of orthodontic treatment was sent to parents/legal guardians. Occlusal characteristics of the participant was examined by a single examiner under natural day-light. Each child was asked to sit on a chair and the entire oral cavity was visualized using mouth mirror no. 4 and straight probe.

Occlusal parameters measured were; developmental spaces, primate spaces, crowding, molar relationship, canine relationship, midline discrepancy, crossbite, scissor bite, overjet, overbite and open bite.

Developmental spaces were recorded as any space other than primate spaces between the primary teeth. Primate spaces were recorded as spaces between primary lateral incisor and canine in the maxillary arch, and spaces between the primary canine and the first molar in the mandibular arch.[5-7]Crowding was recorded when incisors showed signs of overlapping or rotation or complete lack of space. [1,5,8]Midline discrepancy was assessed by using a dental floss, passing from the forehead along the midline of the nose, down to the chin while the child parted the lips and the dentition was in centric occlusion. [9,10]

While recording crossbite, anterior cross bite was recorded when one or more of the maxillary incisors and/or canines occluded lingually to the mandibular incisors. Posterior cross bite was recorded when one or more of the maxillary molars occluded lingual to the buccal cusps of the opposing mandibular teeth.[9,11-13]Scissor bite was recorded when lingual cusps of one or more maxillary molars occluded buccally to the buccal surfaces of corresponding mandibular teeth.[9,11]

Overjet was recorded as the linear measurement in millimeters between labial surfaces of the maxillary and mandibular central incisors in centric occlusion, with the help of a stainless-steel scale. Overjet was graded as: 0–2 mm, 2–4 mm and >4 mm.[1,8,9]

While recording overbite, labial surface of the mandibular central incisor was marked with a sharp pencil at the level of the incisal edge of the maxillary central incisor in centric occlusion. The distance of this mark from the incisal edge of the mandibular central incisor was measured as overbite with the help of a stainless-steel scale. Over-bite was graded as: 1–2 mm, 2–4 mm and >4 mm.[1,9]

While recording open bite, anterior open bite was recorded as the reverse of an overbite, with lack of occlusion of anterior teeth. Posterior open bite was recorded when there was lack of occlusion of the posterior teeth.[1,8,9]

Soft tissue parameters recorded were; facial profile and lip competency. Facial profile was recorded as; straight, when maxilla was properly oriented relative to other skeletal structures, base of the upper lip was on or near the vertical line, soft tissue chin was slightly behind the reference line, and the mandible was of proper size and in the correct position; convex, when maxilla was positioned significantly in front of the vertical reference line and if mandible was positioned significantly behind the vertical reference line or if both condition were present; concave, when maxilla was substantially behind the vertical reference line and if mandible was positioned significantly in front of the vertical reference line or if both condition were present.[5,12,13]

Lip competency was recorded as competent when both upper and lower lips were in contact with each other, and incompetent when separated by more than 3-4 mm at rest. [14,15]

Collected data was entered into Microsoft Excel 2008 and converted into Statistical Package for the Social Sciences (SPSS) 11.0 version for statistical analysis. For

descriptive statistics, mean, standard deviation and percentage were calculated. The comparison of categorical data was done using Chi square or Fisher's Exact test. Fisher's exact test was used when cells had expected count of less than 5. Probability of significance was set at 95% confidence interval, where p≤0.05.

RESULTS

A total of 625 children were examined among which 56.5% were male and 43.5% were female. Race wise 61.1% were Mongolian and 38.9% were Caucasian (Table 1).

Table 1. Gender and race wise distribution of the study sample.

Race	Frequency (%)	Gender	
		Male (%)	Female (%)
Mongolian	382 (61.1)	216 (56.5)	166 (43.5)
Caucasian	243 (38.9)	137 (56.4)	106 (43.6)
Total	625 (100)	353	272

Developmental spaces were present in 77.2% of the children examined. Males had significantly higher prevalence of developmental spaces in both arches (56.9% vs 44.9%) (P=0.003) as compared to females, whereas, absence of developmental spaces was significantly higher in females (26.8 % vs 19.8%) (P=0.039). Primate spaces was present in 83.1% of the children. Females (31.3%) had significantly higher prevalence of maxillary primate spaces as compared to males (22.4%) (P=0.012), whereas, primate spaces in both arches was significantly higher in males (58.1% vs 44.9%) (P=0.001). Crowding was absent in 64.6% of the children. There was significant association (P<0.005) between presence of mandibular crowding (22.8% vs 14.2%), absence of crowding (69.7% vs 58.1%), and gender. The prevalence of midline discrepancy was 11.3% (Table 2).

Majority of the children had flush terminal plane molar (68.8%), and class I canine (81.6%) relationships. Mesial step molar relationship was significantly higher (P=0.015) in Mongolian (29.3%) as compared to Caucasian (20.6%) children. There was significant association between class III (12.3% vs 4.9%) (P=0.002), asymmetric canine relationship (3.7% vs 1.3%) (P=0.049) and race. Anterior crossbite was significantly higher (P=0.005) in Mongolian children (7.9% vs 2.5%). Overjet of 0-2 mm was significantly higher in Mongolian (57.9% vs 46.1%) (P=0.004), whereas, >4 mm overjet was significantly higher in Caucasian (8.2% vs 3.1%) (P=0.005)(Table 3).

Majority of the children had acceptable overbite (1-2 mm: 41.1%, 2-4 mm: 48.3%). Only 2.1% of the children examined had open bite (Table 4).

Majority of the children had straight facial profile (86.7%) and competent lips (98.6%)(Table 5).

DISCUSSION

Table 2. Prevalence of intra-arch alignment and midline discrepancy, and comparison according to gender and race.

	Frequency (%) N=625	Gender		p-value	Race		p-value
		Male (%) N=353	Female (%) N=272		Mongolian (%) N=382	Caucasian (%) N=243	
Developmental spaces							
Maxillary	91 (14.6)	44 (12.5)	47 (17.3)	0.091	59 (15.4)	32 (13.2)	0.432
Mandibular	68 (10.9)	38 (10.8)	30 (11.0)	0.916	42 (11.0)	26 (10.7)	0.908
Both arches	323 (51.7)	201 (56.9)	122 (44.9)	0.003*	194 (50.8)	129 (53.1)	0.575
Absent	143 (22.9)	70 (19.8)	73 (26.8)	0.039*	87 (22.8)	56 (23.0)	0.937
Primate spaces							
Maxillary	164 (26.2)	79 (22.4)	85 (31.3)	0.012*	108 (28.3)	56 (23.0)	0.148
Mandibular	29 (4.6)	15 (4.2)	14 (5.1)	0.597	19 (5.0)	10 (4.1)	0.619
Both arches	327 (52.3)	205 (58.1)	122 (44.9)	0.001*	191 (50.0)	136 (56.0)	0.145
Absent	105 (16.8)	54 (15.3)	51 (18.8)	0.252	64 (16.8)	41 (16.9)	0.969
Crowding							
Maxillary	26 (4.2)	14 (4.0)	12 (4.4)	0.782	16 (4.2)	10 (4.1)	0.964

Mandibular	112 (17.9)	50 (14.2)	62 (22.8)	0.005*	71 (18.6)	41 (16.9)	0.586
Both arches	83 (13.3)	43 (12.2)	40 (14.7)	0.356	50 (13.1)	33 (13.6)	0.860
Absent	404 (64.6)	246 (69.7)	158 (58.1)	0.003*	245 (64.1)	159 (65.4)	0.741
Midline discrepancy							
Maxillary	11 (1.8)	8 (2.3)	3 (1.1)	0.273	7 (1.8)	4 (1.6)	1.000
Mandibular	56 (9.0)	32 (9.1)	24 (8.8)	0.916	34 (8.9)	22 (9.1)	0.948
Both	3 (0.5)	1 (0.3)	2 (0.7)	0.583[f]	1 (0.3)	2 (0.8)	0.563[f]
Absent	555 (88.8)	312 (88.4)	243 (89.3)	0.708	340 (89.0)	215 (88.5)	0.838

*Statistically Significant; [f]Fisher's exact test

Table 3. Prevalence of sagittal and transverse occlusal parameters, and comparison according to gender and race.

	Frequency (%) N=625	Gender		p-value	Race		p-value
		Male (%) N=353	Female (%) N=272		Mongolian (%) N=382	Caucasian (%) N=243	
Molar relationship							
Flush	430 (68.8)	243 (68.8)	187 (68.8)	0.981	253 (66.2)	177 (72.8)	0.082
Mesial Step	162 (25.9)	94 (26.6)	68 (25.0)	0.645	112 (29.3)	50 (20.6)	**0.015***
Distal Step	21 (3.4)	8 (2.3)	13 (4.8)	0.084	13 (3.4)	8 (3.3)	0.940
Asymmetric	12 (1.9)	8 (2.3)	4 (1.5)	0.472	4 (1.0)	8 (3.3)	0.090
Canine relationship							
Class I	510 (81.6)	291 (82.4)	219 (80.5)	0.539	307 (80.4)	203 (83.5)	0.318
Class II	42 (6.7)	23 (6.5)	19 (7.0)	0.816	23 (6.0)	19 (7.8)	0.381
Class III	59 (9.4)	29 (8.2)	30 (11.0)	0.233	47 (12.3)	12 (4.9)	0.002*
Asymmetric	14 (2.2)	10 (2.8)	4 (1.5)	0.254	5 (1.3)	9 (3.7)	0.049*
Crossbite							
Anterior	36 (5.8)	20 (5.7)	16 (5.9)	0.908	30 (7.9)	6 (2.5)	0.005*
Posterior unilateral	7 (1.1)	4 (1.1)	3 (1.1)	1.000[f]	3 (0.8)	4 (1.6)	0.440[f]
Posterior bilateral	2 (0.3)	1 (0.3)	1 (0.4)	1.000[f]	0 (0.0)	2 (0.8)	NA
Absent	580 (92.8)	328 (92.9)	252 (92.6)	0.897	349 (91.4)	231 (95.1)	0.081
Scissor bite							
Present	4 (0.6)	3 (0.8)	1 (0.4)	0.636[f]	4 (1.0)	0 (0.0)	NA
Absent	621 (99.4)	350 (99.2)	271 (99.6)		378 (99.0)	243 (100)	
Overjet							
0-2 mm	333 (53.5)	197 (55.8)	136 (50.0)	0.149	221 (57.9)	112 (46.1)	0.004*
2-4 mm	260 (41.6)	142 (40.2)	118 (43.4)	0.427	149 (39.0)	111 (45.7)	0.099
>4 mm	32 (5.1)	14 (4.0)	18 (6.6)	0.136	12 (3.1)	20 (8.2)	0.005*

Table 4. Prevalence of vertical occlusal parameters and comparison according to gender and race.

	Frequency(%) N=625	Gender		p-value	Race		p-value
		Male (%) N=353	Female (%) N=272		Mongolian(%) N=382	Caucasian(%) N=243	
Overbite							

1-2 mm	257 (41.1)	151 (42.8)	106 (39.0)	0.338	162 (42.4)	95 (39.1)	0.412
2-4 mm	302 (48.3)	164 (46.5)	138 (50.7)	0.289	186 (48.7)	116 (47.7)	0.816
>4 mm	66 (10.6)	38 (10.8)	28 (10.3)	0.849	34 (8.9)	32 (3.2)	0.091
Open bite							
Anterior	11 (1.8)	9 (2.5)	2 (0.7)	0.161	7 (1.8)	4 (1.6)	1.000
Posterior	2 (0.3)	1 (0.3)	1 (0.4)	1.000[f]	1 (0.3)	1 (0.4)	1.000[f]
No open bite	612 (97.9)	343 (97.2)	269 (98.9)	0.223	374 (97.9)	238 (97.9)	0.975

Table 5. Prevalence of soft tissue parameters and comparison according to gender and race.

	Frequency(%) N=625	Gender		p-value	Race		p-value
		Male (%) N=353	Female (%) N=272		Mongolian(%) N=382	Caucasian(%) N=243	
Facial profile							
Straight	542 (86.7)	307 (87.0)	235 (86.4)	0.835	330 (86.4)	212 (87.2)	0.759
Convex	66 (10.6)	36 (10.2)	30 (11.0)	0.737	39 (10.2)	27 (11.1)	0.721
Concave	17 (2.7)	10 (2.8)	7 (2.6)	0.843	13 (3.4)	4 (1.6)	0.287
Lip competency							
Competent	616 (98.6)	346 (98.0)	270 (99.3)	0.337	378 (99.0)	238 (97.9)	0.491
Incompetent	9 (1.4)	7 (2.0)	2 (0.7)		4 (1.0)	5 (2.1)	

In the present study, 77.2% of the children presented with developmental spaces. Majority of the children had developmental spaces in both the arches (51.7%) indicating the normal development which was preferable. Among the children examined, 22.9% revealed absence of developmental spaces which reflects the possibility of crowding in the permanent dentition of those children. Overall prevalence of the developmental spaces in the present study was in agreement with the findings of Zakirulla in Saudi Arabian[16] but higher (61.1%) as compared to the studies by Bhayya & Shyagali[1], Fernandes et al. (56.7%)[17] in Indian, and Zhou et al. (44.8%)[18] in Chinese children.

Majority of the children had primate spaces in both the arches (52.3%) which indicates the normal development. Overall, 83.1% of the children had primate spaces. However, lower prevalence was reported by Bhayya & Shyagali (60.5%)[1], Fernandes et al. (71.3%)[17] in Indian and Otuyemi et al. (25.2%)[19] in Nigerian children. This variations could be due to the differences in the ethnicity of the population being examined.

Crowding of both the arches was present in 13.3% of the children which predicts the possibility for crowding in the permanent dentition and this result is lower as compared to the study by Otuyemi et al.[19] in Nigerian (18.1%), Bhayya & Shyagali (6.3%)[1], Fernandes et al.(1.3%)[17] in Indian, Zhou et al. (6.5%)[18] in Chinese and Zakirulla (6%)[16] in Saudi Arabian children.

The present study reveals that 68.8% of the children had flush terminal plane which indicates the normal development of both arches. Mesial step, distal step molar relationships were present in 25.9% and 3.4% which suggest the chance of class I or class III molar relationship and class II malocclusion, respectively in the permanent dentition. The distribution of molar relationship was comparable to the study done by Shavi et al.[20] in Indian children, Otuyemi et al.,[19] and Onyeaso & Sote[21] in Nigerian Children. Prevalence of flush (55.35%) terminal plane was higher but mesial step (43.34%) terminal plane was lower as compared to the study done by Baral et al.[22] in Nepalese children residing in Kaski district. Prevalence of asymmetric molar relationship was 1.9% which was comparable to the results in studies of Bhayya & Shyagali[1] in Indian and Otuyemi et al.[19] in Nigerian children. There was significant association between mesial step molar relationship and race (P=0.015) which is in agreement with the study of Baral[23] done among Mongolian and Aryan population of eastern Nepal with permanent dentition. This finding may suggest that the mesial step molar relationship of our study population have a probability to develop into class III malocclusion in permanent dentition eventually.

Majority of the children had class I canine relationship (81.6%) which indicates the normal development of both arches. The prevalence of class I canine relationship in this study was comparable to the reports of Bhayya & Shyagali[1] but higher as compared to the reports of

Onyeaso & Sote[21] (64.7%), Zhou et al.[18] (57%) and Abu Alhaija & Qudeimat[24] (57%), and lower (95.8%) as compared to the reports of Fernandes et al.[17]. In the studies done by Zhou et al. in Chinese[18], Abu Alhaija & Qudeimat[24] in Jordanian, and Bhayya & Shyagali[1] in Indian children, Class II canine relationship was more common than Class III canine relationship but in our study, class III canine relationship was more common that class II. Majority of the children had no midline discrepancy which indicates the normal development of both maxillary and mandibular arches. These findings were in accordance with the study of Bhayya & Shyagali[1] in Indian population.

In this study, crossbite was found in 7.2%. Cavalcanti[25] in their study showed 18.4% of the Brazilian children with crossbite which was higher than the result of our study. Prevalence of anterior crossbite in our study (5.8%) was higher as compared to the result of Bhayya et al.[26] in Indian children (1.6%), Baral P et al. (3%)[22] in Nepalese children residing in Kaski district, and Zakirulla[16] in Saudi Arabian children (0.7%) but lower as compared to the result of Zhou et al.[18] in Chinese children (8%). Prevalence of anterior crossbite was comparable to the results of Shah P et al. (5.2%)[27] in the study conducted among Nepalese children residing in Kathmandu district. We found significant association between anterior crossbite and race (P=0.005) which is similar to the study by Baral[23] among Mongolian and Aryan population of eastern Nepal with permanent dentition suggesting that the crossbite present in primary dentition might persist in succeeding dentition also. Scissor bite was present in 0.6% of the children in our study which was equal to the reports of Bhayya & Shyagali[1] in Indian children. In the present study, none of the Caucasian children had scissor bite whereas, Tschill, Bacon & Sonko[28] reported the prevalence in French Caucasian children to be 0.4%.

Overjet of 0-2 mm was commonest (53.5%) followed by 2-4 mm (41.6%) and >4 mm (5.1%). Overjet of 0-2 mm was lesser (84.5%) but overjet of 2-4 mm was higher (11.9%) in comparison to the reports of Bhayya & Shyagali[1], and Yadav et al.[29] (92.4% and 6.4%) in Indian children. These findings may indicate an absence of deleterious habits or skeletal discrepancies in the majority of the children examined. Mongolian children had significantly higher prevalence of 0-2 mm overjet (P=0.004) whereas, Caucasian children had significantly higher prevalence of >4 mm overjet (P=0.005).

Prevalence of 1-2 mm overbite was 41.1%, 2-4 mm was 48.3%, and >4 mm was 10.6%. In present study, lesser prevalence of 1-2 mm overbite was observed as compared to the reports by Bhayya & Shyagali (81.6%)[1] and Yadav et al. (68.4%)[29] whereas, higher prevalence of 2-4 mm and >4 mm overjet was higher as compared to the study of Bhayya & Shyagali (15.7% and 2.7%)[1] and Yadav et al. (12.4% and 0%)[29] in Indian children.

Open bite was present in 2.1%, showing very low prevalence of vertical malocclusion. Anterior open bite was more common (1.8%) than posterior open bite (0.3%) and the results were similar to the study of Bhayya & Shyagali[1] and Fernandes et al.[17] in Indian children but lower as compared to the study by, Yadav et al. (14.4%)[29] in Indian children. Prevalence of anterior open bite was comparable to the results of Shah P et al. (1.6%)[27] in the study conducted among Nepalese children residing in Kathmandu district.

Straight facial profile was commonest followed by convex, and concave profile (86.7%, 10.6% and 2.7%) which was in accordance with the reports of Yadav et al. (74.8%, 24.4% and 0.8%)[29]and Fernandes et al. (63.2%, 35.2% and 1.6%)[17] in Indian children, but Bhayya & Shyagali (37.1%, 58.9% and 4%)[1] reported convex profile to be more common in their study which was also conducted among Indian children. This may be due to ethnic variation in different geographic locations. The prevalence of lip incompetency in this study (1.4%) was lesser as compared to the reports of Bhayya & Shyagali (4.5%)[1], and Yadav et al. (19.2%)[29] in Indian children.

CONCLUSIONS

This study showed that most of the occlusal characteristics were desirable but with the existence of some occlusal traits that deviate from the norm with both the gender and racial influence. These deviations observed were undesirable as they may ultimately lead to the development of malocclusion. These findings indicate the need for early screening and correction of the malocclusion traits, and also emphasizes the need for treatment plan of these children based on their gender and race.

REFERENCES

1. Bhayya DP, Shyagali TR. Gender influence on occlusal characteristics of primary dentition in 4- to 6-year-old children of Bagalkot City, India. Oral Health Prev Dent. 2001;9(1):17–27. [PubMed]
2. Foster TD. The development of the occlusion of the teeth. In: A Textbook of Orthodontics. 3rd ed. London: Blackwell Scientific Publications. 1991:44-74. [FullText]
3. Gurung H, Gurung Y, Chidi CL. Nepal atlas of ethnic and caste groups. National foundation for development of in-

digenous nationalities; Sanepa, Lalitpur. 2005. [FullText]

4. Population monograph of Nepal, Volume 2, Government of Nepal National Planning Commission Secretariat Central Bureau of Statistics Ramshah Path, Kathmandu, Nepal. 2014. [FullText]
5. Casamassimo PS, McTigue DJ, Fields HW, Nowak AJ. Examination, Diagnosis, and Treatment Planning. In: Pediatric Dentistry, Infancy through adolescence 5th ed. St. Louis Missouri: Elsevier. 2013:258-78.
6. Abu Affan AH, Abd-Alrahman RM. Occlusal characteristics of primary dentition in Sudanese children in Khartoum State. J Braz Dent Sci. 2014;17(2):3-9. https://doi.org/10.14295/bds.2014.v17i2.945
7. Vegesna M, Chandrasekhar R, Chandrappa V. Occlusal characteristics and spacing in primary dentition: a gender comparative cross-sectional study. Int Sch Res Notices. 2014:1-7. [FullText]
8. Bervian J, Feldens CA, Kramer PF, Pavinato LCB. Assessment of occlusal characteristics of the primary dentition: a cross-sectional study in Brazilian preschool children. RFO, Passo Fundo. 2016;21(2):224–230. https://doi.org/10.5335/rfo.v21i2.6172
9. Mathewson RJ, Primoch RE. Occlusal assessment. In: Fundamentals of Pediatric Dentistry. 3rd ed. USA: Quintessence Books. 1995:25-34.
10. Narmada S, Senthil Kumar KP, Raja S. Management of midline discrepencies: A review. J Indian Acad Dent Spec Res. 2015:2:45-8. [FullText]
11. Chandorikar H, Nagrik A, Bhad WA, Chavan SJ, Doshi UH. Early correction of unilateral scissor bite using transforce appliance and modified twin block appliance. J Orthodont Sci. 2017;6:76-80. [FullText]
12. Stewart RE, Barber TK, Troutman KC, Wei SHY. Etiology and classification of malocclusions. In: Pediatric Dentistry Scientific Foundation and Clinical Practice. 1st ed. St. Louis, Missouri: Mosby Company. 1982:270-283.
13. Rajesh P, Sindhu H, Mamatha, Sunil PC, Raju AS, Jayashekar. Facial profiles relevance in Dentistry. Carib J Scitech. 2014;2:560-3. [FullText]
14. Proffit WR, Fields HW, Ackerman JL. Orthodontic diagnosis: The problem-oriented approach. In: Contemporary Orthodontics. 6th ed. St. Louis, Philadelphia: Mosby Company. 2007:150-219.[FullText]
15. Sharanesha RB, Penumatsa NV. Correlation of lip prints and lip competence in children. J Pharm Bioallied Sci. 2015;7(Suppl 2):580-2. [FullText]
16. Zakirulla M. Malocclusion in deciduous dentition of saudi children: a cross-sectional study. BJMS. 2012;11(4):343-6. [FullText]
17. Fernandes S, Patel DG, Ranadheer E, Kalgudi J, Santoki J, Chaudhary S. Occlusal traits of primary dentition among pre-school children of Mehsana district, North Gujarat, India. J Clin Diagn Res. 2017;11(1):92–6. [PubMed]
18. Zhou X, Zhang Y, Wang Y, Zhang H, Chen L, Liu Y. Prevalence of malocclusion in 3-to 5-year-old children in Sanghai, China. Int J Environ Res Public Health. 2017;14(328):1-10. [PubMed]
19. Otuyemi OD, Sote EO, Isiekwe MC, Jones SP. Occlusal relationships and spacing or crowding of teeth in the dentitions of 3-4-year-old Nigerian children. Int J Paediatr Dent. 1997;7(3):155–60. [PubMed]
20. Shavi GR, Hiremath NV, Shukla R, Bali PK, Jain SK, Ajagannanavar SL. Prevalence of spaced and non-spaced dentition and occlusal relationship of primary dentition and its relation to malocclusion in school children of Davangere. J Int Oral Health. 2015;7:75–8. [FullText]
21. Onyeaso CO, Sote EO. A study of malocclusion in the primary dentition in a population of Nigerian children. Niger J Clin Pract. 2002;5(1):52–6. [Link]
22. Baral P, Budathoki P, Bhuju KG, Koirala B. Prevalence of occlusal traits in the deciduous dentition of children of Kaski district, Nepal. J Nepal Med Assoc. 2014;52(195):862-65. [Link]
23. Baral P. Prevalence of malocclusion in permanent dentition in Aryan and Mongoloid races of Nepal- A Comparative study. Pak Orthod J. 2013;5(2):57–9. [FullText]
24. Abu Alhaija ESJ, Qudeimat MA. Occlusion and tooth/arch dimensions in the primary dentition of preschool Jordanian children. Int J Paediatr Dent. 2003;13(4):230–9. [PubMed]
25. Cavalcanti AL, Bezerra PKM, Moura C, Bezerra PM, Granville-Gracia AF. Relationship between malocclusion and deleterious oral habits in preschool children in Campina Grande, PB, Brazil. Serbian Dental J. 2008;55(3):154–162. [FullText]
26. Bhayya DP, Shyagali TR, Dixit UB, Shivaprakash. Study of occlusal characteristics of primary dentition and the prevalence of maloclusion in 4 to 6 years old children in India. Dent Res J. 2012;9(5):619–623. [PubMed]
27. Shah P, Acharya J, Khanal S. Occlusal traits of primary dentition among children visiting a Dental hospital in Kathmandu, Nepal. Nepal Med Coll J. 2019; 21(2): 122-7. [Link]
28. Tschill P, Bacon W, Sonko A. Malocclusion in the deciduous dentition of Caucasian children. Eur J Orthod.

1997;19:361–7. [PubMed]

29. Yadav NR, Prasad S, Rajashekharappa CB, Tandon S. Gender influence on occlusal characteristics in the primary dentition. APOS Trends Orthod. 2014;4(4):87-92. [FullText]