Available online on 15.03.2020 at <http://ujpr.org>
Universal Journal of Pharmaceutical Research
 An International Peer Reviewed Journal

Open access to Pharmaceutical research
 This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial Share Alike 4.0 License which permits unrestricted non commercial use, provided the original work is properly cited

Volume 5, Issue 1, 2020

RESEARCH ARTICLE

OCCLUSAL CHARACTERISTICS OF THE PRIMARY DENTITION AMONG A SAMPLE OF YEMENI PRE-SCHOOL CHILDREN

Lamia A.T. Bin Yehia¹ , Khaled A AL-Haddad¹ , Mohammed A Al-labani¹ ,
 Hassan Abdulwahab Al-Shamahy² , Hussein M Shaga-aldeen¹

¹Orthodontics, Pedodontics and Prevention Department Faculty of Dentistry, Sana'a University, Yemen.

²Departement of Basic Sciences, Faculty of Dentistry, Sana'a University, Republic of Yemen.

ABSTRACT

Objective: The occlusal features change dynamically in the growing children and any disruption in the complex craniofacial growth process may lead to malocclusion, which is a major concern for the pediatric community because of its effects on dental function and beauty, as well as on the child's psyche. The aim of the present study was to study the prevalence of different occlusal traits in the primary dentition of the randomly selected pre-school children from three to five years in the city of Sana'a, Yemen.

Methods: The study includes 1106 pre-school children subjected to a dental examination performed in the school premise, using the Foster and Hamilton criteria for occlusal traits. As well as inter- and intra-calibration tests were conducted for assessing the degree of agreeability.

Results: Results of the study showed that the Bilateral flush terminal molar relationship was found in 60%, bilateral mesial step in 27.9%, asymmetrical relationship in 8.5% and distal step in 3.5% of tested children. The Bilateral canine class I was detected in 62.8%, asymmetrical relationship (13.6%), class II (12.5%) and class III (11.1%). Normal over-jet (OJ) of 1-3 mm was identified in 39.2%, decreased OJ <1 mm (32.7%) and edge-to-edge (8.8%). Ideal over-bite (OB) of 1-50% was detected in 64.5% and increased OB of > 50% (19.7%).

Conclusion: In conclusion the Bilateral flush terminal molar, class I canine relationships, normal overjet (OJ) of 1-3mm were the most commonly found sagittal occlusal traits in the current study. Ideal over-bite (OB) of 1-50% were identified in more than half of the children.

Keywords: Occlusal characteristics, primary dentition, pre-school children, Yemen.

Article Info: Received 2 January 2020; Revised 5 February; Accepted 6 March, Available online 15 March 2020

Cite this article-

Bin Yehia LAT, AL-Haddad KA, Al-labani MA, Al-Shamahy HA, Shaga-aldeen HM. Occlusal characteristics of the primary dentition among a sample of yemeni pre-school children. Universal Journal of Pharmaceutical Research 2020; 5(1): 25-31.

DOI: <https://doi.org/10.22270/ujpr.v5i1.359>

Address for Correspondence:

Prof. Hassan A. Al-Shamahy, Faculty of Dentistry, Sana'a University, P.O. Box 775 Sana'a, Yemen. Tel: +967-1-239551, E-mail: shmahe@yemen.net.ye

INTRODUCTION

Occlusal traits in the primary dentition are known to have an important bearing on the occlusal relationships in the secondary dentition^{1,2}. Malocclusion is ranked third worldwide in dental public health second only to dental caries and periodontal disease³. The assessment of the occlusal traits of primary dentition will aid in the prediction of certain malocclusions such as; crowding, cross-bites, and anterior open-bites. This will enable an enhanced and effective preventive and interceptive measures to be constructed at an individual as well as in a larger scale level, all of which would ultimately reduce the degree of malocclusion in the permanent dentition. Therefore, shorten the time taken and simplify the performance of comprehensive orthodontic treatment which can be reflected as a

reduction in the psycho-social and monetary impact on the patient and patient's parents³. It is important to note that the difference in occlusal traits can be attributed to the differences in the criteria used to define them with differences in their interpretation^{4,5,6}. Numerous studies have been conducted on the occlusion in the primary dentition in children of different age groups in different regions of the world⁷. However, by comparison, few studies have been published in the Arab region. By reviewing these studies, one can conclude that the prevalence of different occlusal traits in primary dentition varies between different age groups, populations, and ethnicities around the world^{2,7}. As for Yemen, the only published study was directed towards the assessment of occlusal traits among the Yemeni adolescents using canine and incisor classifications⁸.

However, no published study was found to reflect on the incidence of occlusal traits in the primary dentition of the Yemeni children. The objective of the current study is as follows: to assess the occlusion in sagittal, transverse and vertical planes namely: the terminal molar relations on the right and left side of the jaw, the primary canine relationship on the right and left side of the jaw, the over-jet (OJ) and over-bite (OB).

SUBJECTS AND METHODS

This was a cross-sectional study conducted in six of the ten randomly selected administrative regions in Amanat Al Asimah, Sana'a City, Yemen. The target population of the study was preschool children aged 3 to 5 years, who attended a randomly selected public and private kindergartens, during the 2018-2019 school time period based on data collected from the Ministry of Education, Sana'a City, Yemen.

The sample size (n) required for this study was calculated to be 369 and this was through the utilization of the WHO formula for sample estimation which states that

$$n = z^2 p(1-p)/e^2$$

Where “n” represents the sample size. “p” as the expected prevalence of malocclusion. “z” as the standard score of 1.96 (95% CI: confidence level). e = maximum tolerable error 5%. For the purpose of increasing the significance level of the findings of this study the sample size was increased from 369 to 1106 pre-schoolers. To calculate the sample, the spread (P) was adopted by 60%^{3,9,10}. In addition, a 1.5 (CF) correction factor was used to compensate the number of students who refused to participate in the study. The study sample (n=1106) was determined through a two-stage sampling technique. In the first stage, a random sample was selected from several primary schools (public and private) from each of the six aforementioned provinces. It is followed by the second stage which involves random sampling of pupils from each of the aforementioned selected schools.

The inclusion criteria: Healthy Yemeni children. 3-5 years with primary dentition. Pre-school children whose parents / guardians agree.

Figure 1: Bar chart showing the distribution of the different molar relationships among the sample population (n=1106).

The exclusion criteria: Those with a permanent first molar tooth erupting. Those who have missing teeth due to trauma, extraction, and tooth decay. Preschool children who have received interceptive and preventive orthodontic treatment. Prior to collecting data, medical ethical approval was obtained from the Ethics and Research Committee at the University of Sana'a, followed by approval of education offices in the different administrative district to conduct this study in the schools assigned to them in their respective areas^{11,12,13}. Approval was obtained from school officials and parents of students who were randomly chosen through the school's mediator (principal or teacher) to explain the purposes of the study and the type of exam to be taken for their children^{14,15}. The child's permission was obtained before a dental examination. The examiner was trained and calibrated under the guidance of the supervisor at the Department of Pedodontics at the University of Sana'a to reduce the variability of the examiner during data collection. A total of 20 children were examined for both: the intra-examiner and inter-examiner reliability tests. The results were analysed statistically through the utilization of the Cohen's Kappa coefficient¹⁶. The overall Kappa co-efficient for the inter-examiner and

intra-examiner reliability shows a high level of agreement scoring 0.868 and 0.877 respectively.

The dental examination was carried out under natural daylight in the school premise. Disposable examination gloves and single use sterile mouth mirrors and explorer as well as sterile metallic mm rulers were made available for each child during the dental examination. Occlusion was assessed while each child was biting on his or her posterior teeth with the jaws in centric relation (maximal inter-cuspation).

The criteria of Foster and Hamilton (1969) was used for defining the occlusion^{11,12,13}. Occlusal norms were determined based on numerous studies found in the literature^{17,18,19}. All of the examined students found to be suffering from malocclusion that would benefit from early interceptive paediatric or orthodontic dental treatment were referred to the paediatric dental clinic at the University of Sana'a, Faculty of Dentistry, to receive the required dental care.

Statistical analysis

The collected data was coded, inserted and analysed using IBM SPSS statistics for Windows, Version 21.0. Armonk, NY: IBM Corp, released 2012. The data were presented using tables, graphs, and pie charts. Basic standard descriptive statistics were calculated in the

form of frequency and percentage to describe the qualitative variables. Pearson chi-square with Yate correction and Fisher tests were used to show the significance of the association between the outcome and its risk factors at a level of significance 0.05. *P*-value of less than 0.05 was considered as a statistically significant value. Odd ratio (OR) was calculated in addition to, the 95% confidence interval (CI).

RESULTS

Table 1: Explains the distribution differences of different molar relationship according to age, gender and type of school (n=1106).

Variables	Molar relationships								χ^2	<i>p</i> -value*
	Flush terminal freq.	%	Distal step freq.	%	Mesial step freq.	%	Asymmetrical freq.	%		
Age (year)										
3 yrs. (n=109)	70	64.2	7	6.4	24	22.0	8	7.3	15.74	0.015
4 yrs. (n=308)	177	57.5	18	5.8	82	26.6	31	10.1		
5 yrs. (n=689)	417	60.5	14	2.0	203	29.5	55	8.0		
Gender										
Boy (n=589)	340	57.7	27	4.6	171	29.0	51	8.7	5.70	0.127
Girl (n=517)	324	62.7	12	2.3	138	26.7	43	8.3		
School Type										
Public School (n=370)	241	65.1	16	4.3	82	22.2	31	8.4	10.06	0.018
Private School (n=736)	423	57.5	23	3.1	227	30.8	63	8.6		
Total	664	60.0	39	3.5	309	27.9	94	8.5		

*Based on Pearson's chi-square test (χ^2). Significant at *p*-value < 0.05.

Figure 2: Bar Chart Showing the Prevalence of the Different Canine Relationships among the Study Participants (n=1106).

Table 1 shows a significant correlation based on the Pearson's chi-square test between the different molar relationships distribution with the age and school type of the participants but no significant association was found with the gender of the study participants. Table 2 shows that the flush terminal was significantly associated with class I canine, normal OJ (of 1–3 mm sagittal overlap) and ideal OB (of 1–50% vertical overlap), where it was observed in 71.1%, 68.4% and 62.8%, correspondingly. The distal step molar relationship was most frequently seen in pre-schoolers with class II canine, increased OJ (of >3mm) and increased OB (of >50%), where 24.6%, 12.3% and 10.6% were affected, respectively. As for the mesial step molar relationship, it was found to be more commonly associated with class III canine (69.1%) and anterior reverse-bite (66.7%). The asymmetrical molar relationship was most frequently associated with the

In this study, a bilateral dental examination was performed on a total number of 1106 children aged three to five years old. Figure 1 illustrates that; the Bilateral flush terminal molar relationship was found in 60% (664 out of 1106) of the pre-schoolers. Followed by: bilateral mesial step (27.9%), asymmetrical relationship (8.5%) and distal step (3.5%). Present in 309, 94 and 39 out of the 1106, respectively.

asymmetrical canine relationship and increased OJ of > 3mm and anterior open-bite, affecting 53.3%, 12.3% and 15.1%, in that order. The Bar chart illustrated in Figure 2 shows that the Bilateral canine class I was detected in 62.8% of the study sample. Ensued by: asymmetrical relationship, class II and class III. Which were detected in 13.6%, 12.5% and 11.1%, respectively. However, as shown in Table 3, no statistically significant affiliation between the distribution differences of the canine relationships with the age, gender, and school type of the study participants. The majority of the study sample (Figure 3 and Table 4) possess normal OJ of 1-3 mm, which was identified in 39.2% (433 out of 1106) of the children followed by decreased OJ <1 mm (32.7%-362 out of 1106), increased OJ of >3 mm (16.9% - 187 out of 1106), edge-to-edge (8.8% -97 out of 1106) and reverse-bite (2.4%-27 out of 1106).

Table 2: Shows an association between different molar relationships and occlusal traits such as: different canine relationship, incisor relationship and over-jet (n=1106).

Variables	Molar relationships										χ^2	P-Value
	Flush Terminal		Distal Step		Mesial Step		Asymmetrical		Total			
	freq. (664)	% (60)	freq. (39)	% (3.5)	freq. (309)	% (27.9)	freq (94)	% (8.5)	freq.	%		
Canine Relationship												
I	494	71.1	4	0.6	186	26.8	11	1.6	695	62.8	756.27	<0.001 *
II	81	58.7	34	24.6	21	15.2	2	1.4	138	12.5		
III	37	30.1	0	0.0	85	69.1	1	0.8	123	11.1		
Asymmetrical	52	34.7	1	0.7	17	11.3	80	53.3	150	13.6		
Over-jet												
Normal 1-3mm	296	68.4	7	1.6	90	20.8	40	9.2	433	39.2	118.91	<0.001 *
Increased >3mm	109	58.3	23	12.3	32	17.1	23	12.3	187	16.9		
Ant. Cross-bite	7	25.9	0	0.0	18	66.7	2	7.4	27	2.4		
Decreased <1mm	205	56.6	9	2.5	123	34.0	25	6.9	362	32.7		
Edge-to-edge	47	48.5	0	0.0	46	47.4	4	4.1	97	8.8		
Over-bite												
Ideal 1-50%	448	62.8	14	2.0	195	27.3	56	7.9	713	64.5	94.68	<0.001 **
Increase >50%	135	61.9	23	10.6	36	16.5	24	11.0	218	19.7		
Anterior open bite	29	54.7	2	3.8	14	26.4	8	15.1	53	4.8		
Edge to edge	45	47.4	0	0.0	46	48.4	4	4.2	95	8.6		
Reverse bite	7	25.9	0	0.0	18	66.7	2	7.4	27	2.4		
Decreased <1%	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0		

*Based on Pearson's chi-square test (χ^2). **Based on Fisher's Exact Test. Significant at p -value < 0.05.**Table 3: Illustrates the Canine relationship according to age, gender and type of school (n=1106).**

Variables	Canine relationships								χ^2	P-value*
	I		II		III		Asymmetrical			
	freq.	%	freq.	%	freq.	%	freq.	%		
Age (year)										
3 yrs. (n=109)	64	58.7	17	15.6	15	13.8	13	11.9	2.34	0.886
4 yrs. (n=308)	193	62.7	38	12.3	34	11.0	43	14.0		
5 yrs. (n= 689)	438	63.6	83	12.0	74	10.7	94	13.6		
Gender										
Boys (n= 589)	366	62.1	73	12.4	67	11.4	83	14.1	0.44	0.932
Girls (n= 517)	329	63.6	65	12.6	56	10.8	67	13.0		
Type of school										
Public School (n=370)	232	62.7	46	12.4	41	11.1	51	13.8	0.02	0.999
Private School (n= 736)	463	62.9	92	12.5	82	11.1	99	13.5		
Total	695	62.8	138	12.5	123	11.1	150	13.6		

*Based on Pearson's Chi-square test (χ^2). Significant at p -value < 0.05.**Table 4: Explains the Distribution Difference in the Over - jet Relationships According to Age, Gender, and Type of School (n=1106).**

Variables	Types of over-jets										χ^2	p -value*
	Normal 1-3mm		Increased >3mm		Reverse/ Ant. Cross-bite		Decreased <1mm		Edge-to-edge			
	freq.	%	freq.	%	freq.	%	freq.	%	freq.	%		
Age (year)												
3 yrs.	42	38.5	24	22.0	3	2.8	33	30.3	7	6.4	6.55	0.586
4 yrs.	127	41.2	56	18.2	7	2.3	96	31.2	22	7.1		
5 yrs.	264	38.3	107	15.5	17	2.5	233	33.8	68	9.9		
Gender												
Boys	228	38.7	107	18.2	10	1.7	193	32.8	51	8.7	4.11	0.391
Girls	205	39.7	80	15.5	17	3.3	169	32.7	46	8.9		
Type of school												
Public School	149	40.3	63	17.0	8	2.2	115	31.1	35	9.5	1.12	0.891
Private School	284	38.6	124	16.8	19	2.6	247	33.6	62	8.4		
Total	433	39.2	187	16.9	27	2.4	362	32.7	97	8.8		

*Based on Pearson's chi-square test (χ^2). Significant at p -value < 0.05.

But no significant association was found between the prevalence of different OJ relationships with the age, gender and school type of the pre-school study participants. Figure 4 shows that ideal OB of 1-50% was detected in 64.5% of the pre-schoolers. Followed by: increased OB of >50% (19.7%), edge-to-edge (8.6%), anterior open-bite (4.8%) and reverse-bite (2.4%). With no significant correlation found between the distribution difference of the different OB relationships with the age, gender and school type of the study participants (Table 5).

DISCUSSION

In the current study, Figure 1 shows that the majority of the pre-schoolers (60%) demonstrate a bilateral flush terminal molar relationship followed by the bilateral mesial step (27.9%). These results coincide with other epidemiological studies conducted in countries such as

Sudan²⁰, Iraq²¹, Nigeria²², Saudi Arabia^{2,23}, India²⁴, and Brazil²⁵. However, it disagrees with the results obtained by Zhou *et al.*,²⁶ who observed that the prevalence of flush terminal and mesial step was similar among their Chinese pre-schoolers.

As well as with Abu Alhaija and Qudeimat²⁷, Chebet²⁸ and Baral *et al.*,²⁹ who found out that mesial step was more commonly seen than the flush terminal molar relationship among their study participants. In the present study, a significant correlation was observed between the prevalence of different molar relationships and the age of the child as well as the type of their school. However, no significant association was observed between the occurrence of the molar relationship and gender (Table 1). These results were similar to what Yilmaz *et al.*, have observed among their Turkish study participants³⁰.

Table 5: Shows the distribution difference of the different types of over-bite relationships according to age, gender and type of school (n=1106).

Variables	Over-bite										χ^2	P-value*
	Ideal		Increase		Anterior		Edge to		Reverse-			
	1-50%		> 50%		Open bite		Edge		bite			
	freq.	%	freq.	%	freq.	%	freq.	%	freq.	%		
Age (year)												
3 yrs.	73	67.0	22	20.2	4	3.7	7	6.4	3	2.8	4.26	0.833
4 yrs.	201	65.3	59	19.2	19	6.2	22	7.1	7	2.3		
5 yrs.	439	63.7	137	19.9	30	4.4	66	9.6	17	2.5		
Gender												
Boys	388	65.9	115	19.5	27	4.6	49	8.3	10	1.7	3.48	0.48
Girls	325	62.9	103	19.9	26	5.0	46	8.9	17	3.3		
Type of School												
Public School	240	64.9	75	20.3	13	3.5	34	9.2	8	2.2	2.41	0.661
Private School	473	64.3	143	19.4	40	5.4	61	8.3	19	2.6		
Total	713	64.5	218	19.7	53	4.8	95	8.6	27	2.4		

*Based on Pearson's chi-square test (χ^2). Significant at p -value < 0.05

Figure 3: Bar Chart Illustrating the prevalence of the different over-jet relationships among the sample population (n=1106).

Table 2 shows that the flush terminal was significantly associated with class I canine relationship, where it was observed in 71.1%. These findings disagree with the Iranian study conducted by Sahebalam *et al.*, where class II canine occlusion seemed to have coincided with more than half of the flush terminal molar occlusions (62%)³¹. The asymmetrical molar

relationship (Figure 1) was the third common molar relationship, seen in 8.5%, which was greater than the results seen among the Kenyan, Indian and Sudanese pre-schoolers^{16,20,28}. But, lesser than the Jordanian, Nepalese and Chinese studies^{26,27,29}. The distal step (Figure 1) was the least common type of molar relationship (3.5%), which was similar to the results

seen among the Jordanian, and Saudi Arabian pre-schoolers^{23,27}. Furthermore, the distal step molar relationship observed in this study was most frequently associated with class II canine relationship (Table 2). While, the mesial step among the study participants was more commonly associated with class III canine relationship (Table 2). These results differ from those observed by Sahebalam *et al.*,³¹ who discovered that class I canine relationship was largely associated with mesial step molars. The Bilateral canine class I relationship was the most prevalent canine relationship in the current study, observed in 62.8% of the

participants (Figure 2). This result comes in agreement with the literature, where similar results were found among the Nigerian²², Jordanian²⁷, Libyan³⁴, Swedish³⁵ and Chinese²⁶ pre-schoolers retaining their primary teeth. However, the result was lower than studies conducted in India, Sudan, Iraq, Saudi Arabia, Turkey and Nepal, where the prevalence of class I canine relationship was in the 80–90 percentile^{2,16,20,21,29,30,36}. The asymmetrical canine relationship accounted for 13.6% (Figure 2) which was similar to the study done by Abu Alhaija and Qudeimat on the Jordanian 3 to 5 year olds²⁷.

Figure 4: Bar Chart illustrating the prevalence of the different over-bite relationship among the sample population (n=1106).

This was followed by: class II and class III canine relationships, which were observed in 12.5% and 11.1%, respectively. The class II relationship was found to be higher in prevalence among the Yemeni pre-schoolers in comparison to their Saudi² and Iraqi equivalents²¹. But, it was lower than the Jordanian²⁷ and Libyan³⁴ study participants. The prevalence rate of the canine class III in this study was close to the results obtained by Dimberg *et al.*, in Sweden³⁵, Zhou *et al.*, in China²⁶ and Bahadure *et al.*, in India³⁸. In Figure 3, a large proportion of the study participants (39.2%) had a regular OJ from 1 to 3 mm. However, the rate on pre-school children in Yemen was lower than the rates in Saudi Arabia, Libya, India, Brazil, and Nigeria, which ranged between 47.5 - 89.5%^{2,6,16,22,34,36}.

The prevalence of the decreased OJ (less than 1 mm) was 32.7%, which was similar to what Hegde *et al.*, has found among their Indian study participants. The edge-to-edge relationship was observed in 8.8% which was similar to the result obtained by Onyeaso and Sote²² in Nigeria. But, higher than the rates observed in India, Brazil, China and Libya^{6,16,26,34}. Ideal OB (of 1 to 50% vertical overlap) was detected in 64.5% of the current study subjects (Figure 4). This result was similar to results seen in Iraq and Nigeria (both 67.3%)^{21,22}. But, higher than the results detected in Saudi Arabia, Kenya, Jordan and Libya^{2,27,28,34}. As for the edge-to-edge OB relationship, it was found to be present in 8.6% of the study participants, which was similar to the prevalence of edge-to-edge relationship in Saudi Arabia and Nigeria^{2,22}.

No significant relationship was found between the distribution difference of the different OJ (Table 4) and OB relationships (Table 5) with the age, gender and

school type of this study participants, which was similar to the findings observed among the Libyan pre-schoolers. But regarding the lack of association between the different OB and gender, the results observed in this study comes in disagreement with the Libyan study, where the mean OB recorded in the Libyan boys was significantly greater than the girls³⁴. Conversely, among the Saudi children, Zakirulla found out that the severity of OB was significantly less in the five-year-olds in comparison to the 3-year-olds²³.

CONCLUSION

In conclusion the Bilateral flush terminal molar, class I canine relationships, normal overjet (OJ) of 1-3mm were the most commonly found sagittal occlusal traits in the current study. Ideal over-bite (OB) of 1-50% were identified in more than half of the children.

AUTHOR'S CONTRIBUTION

This research work is part of a Master's thesis. The candidate was the first author (LBY) has conduct clinical work and thesis. Corresponding author (HAA), second author (KAA) and third author (MAA) supervised the work, revised and edited the thesis draft and the manuscript.

ACKNOWLEDGEMENTS

The authors would like to acknowledge Sana'a University, Sana'a, Yemen which supported this work.

CONFLICT OF INTEREST

No conflict of interest associated with this work.

REFERENCES

- Infante PF. Malocclusion in the deciduous dentition in white, Black, and Apache Indian children. *Angle ortho* 1975; 45:2138. [https://doi.org/10.1043/00033219\(1975\)045<0213:MI TDDI>2.0.CO;2](https://doi.org/10.1043/00033219(1975)045<0213:MI TDDI>2.0.CO;2)
- Baidas L. Occlusion characteristics of primary dentition by age in a sample of Saudi preschool children. *Pakistan Oral Dent J* 2010; 30:425–31.
- Redzepagic Vrazalica L, Ilic Z, Laganin S, Dzemic V, Tiro A. An epidemiological study of malocclusion and occlusal traits related to different stages of dental development. *South Eur J Orthod Dentofac Res* 2017;4:9–13. <https://doi.org/10.5937/sejodr4-15205>
- Katz CR, Roseblatt A, Gondim PP. Nonnutritive sucking habits in Brazilian children: effects on deciduous dentition and relationship with facial morphology. *Am J Orthod Dentofac Orthop* 2004; 126:53–7. <https://doi.org/10.1016/j.ajodo.2003.06.011>
- Almeida ER, Narvai PC, Frazão P, Guedes-Pinto AC. Revised criteria for the assessment and interpretation of occlusal deviations in the deciduous dentition: a public health perspective. *Cad Saude Publica* 2008; 24:897–904. <https://doi.org/10.1590/S0102-311X2008000400021>
- Carvalho AC, Paiva SM, Scarpelli AC, Viegas CM, Ferreira FM, Pordeus IA. Prevalence of malocclusion in primary dentition in a population-based sample of Brazilian preschool children. *Eur J Paediatr Dent* 2011; 12:107–11.
- Yassin SM. Prevalence and distribution of selected dental anomalies among Saudi children in Abha, Saudi Arabia. *J Clin Exp Dent* 2016;8:485–90. <https://doi.org/10.4317/jced.52870>
- Al-Maqtari RA, Abdul Kadir R, Awang H, Zamzam NM. Assessment of Malocclusion among Yemeni adolescents using canine and incisor classifications. *J Adv Med Res* 2012; 2:153–9.
- Frazão P, Narvai PC, Latorre R, Castellanos RA. Malocclusion prevalence in the deciduous and permanent dentition of schoolchildren in the city of Sao Paulo, Brazil, 1996. *Cad Saude Publica* 2002; 18:1197–205. <https://doi.org/10.1590/s0102-311x2002000500012>
- Marques LS, Pordeus IA, Ramos-Jorge ML, Filogônio CA, Filogônio CB, Pereira LJ, Paiva SM. Factors associated with the desire for orthodontic treatment among Brazilian adolescents and their parents. *BMC Oral Heal* 2009; 9:34. <https://doi.org/10.1186/1472-6831-9-34>
- Foster TD, Hamilton MC. Occlusion in the primary dentition, study of children at 2 1/2 to 3 years of age. *Br Dent J* 1969; 126:76–9. PMID:5253447
- Chapman H. The normal dental arches and its changes from birth to adult. *Br Dent J* 1935; 58:201–29.
- Graber TM. *Orthodontics Principles and Practice*. 3rd ed. Philadelphia: W. B. Saunders Co., 1972.
- Mahmoodian J, Afshar H, Hadjhashem M. Determination of Primate Space on 4 to 5 Years Old Children of Tehran's Kindergarten in 2000. *J Dent Tehran Univ Med Sci* 2004; 1:21–6.
- Motayam KME, Elbardissy A. Occlusal characteristics of primary dentition in pre-school Egyptian children. *Cairo Dent J* 2007; 23:217–226.
- Vegesna M, Chandrasekhar R, Chandrappa V. Occlusal Characteristics and Spacing in Primary Dentition: A Gender Comparative Cross-Sectional Study. *Int Sch Res Not* 2014; 10:1–7. <https://doi.org/10.1155/2014/512680>
- World Health Organization (WHO). *Oral Health Surveys: Basic Methods*. 4th ed. Geneva, 1997.
- Anderson AA. Occlusal development in children of African American descent-types of terminal plane relationships in the primary dentition. *Angle Orthod* 2006;76:817–23.
- Maatouk F, Ayadi I, Masmoudi F, Chemli MA, Ghedira H. Oral health and occlusion among in Moknine preschool children (Aged 3-5), Tunisia. *Ped Dent Care* 2017; 02:1–5.
- Abuaffan AH, Abd-Alrahman RM. Occlusal Characteristics of Primary Dentition in Sudanese Children in Khartoum State. *Brazilian Dent Sci* 2014; 17:3–9. <https://doi.org/10.14295/bds.2014.v17i2.945>
- Jamal KM, Amash A, Ahmed I. Epidemiological study of features of primary dentition occlusion in Iraqi preschool kids sample. *Iraqi Dent J* 2017; 39:7–11.
- Onyeaso CO, Sote EO. A study of Malocclusion in the primary dentition in a population of Nigerian children. *Niger J Clin Pract* 2002; 5:52–6.
- Zakirulla M. Malocclusion in deciduous dentition of Saudi children: A cross-sectional study. *Bangladesh J Med Sci* 2012; 11:343–6.
- Lochib S, Indushekar KR, Saraf BG, Sheoran N, Sardana D. Occlusal characteristics and prevalence of associated dental anomalies in the primary dentition. *J Epidemiol Glob Health* 2015; 5:151–7. <https://doi.org/10.1016/j.jegh.2014.07.001>
- Bervian J, Feldens CA, Kramer PF, Pavinato LCB. Assessment of occlusal characteristics of the primary dentition: a cross-sectional study in Brazilian preschool children. *Rev da Fac Odontol - UPF* 2016;21:224–30.
- Zhou X, Zhang Y, Wang Y, Zhang H, Chen L, Liu Y. Prevalence of malocclusion in 3- to 5-year-old children in Shanghai, China. *Int J Environ Res Public Health* 2017; 14:1–10. <https://doi.org/10.3390/ijerph14030328>
- Abu Alhaija ESJ, Qudeimat MA. Occlusion and tooth/arch dimensions in the primary dentition of preschool Jordanian children. *Int J Paediatr Dent* 2003; 13:230–9. <https://doi.org/10.1046/j.1365-263x.2003.00466.x>
- Chebet D. Malocclusion and tooth/arch dimensions in the deciduous dentition of pre-school children in Nairobi. MsD Thesis, Univ Nairobi Libr 2011. <https://doi.org/10.1046/j.1365-263x.2003.00466.x>
- Baral P, Budathoki P, Bhujji KG, Koirala B. Prevalence of occlusal traits in the deciduous dentition of children of Kaski district, Nepal. *J Nepal Med Assoc* 2014; 52:862–5. PMID: 26982658.
- Yilmaz Y, Gürbüz T, Şimşek S, Dalmiş A. Primary canine and molar relationships in centric occlusion in three to six year-old Turkish children: A cross-sectional study. *J Contemp Dent Pract* 2006; 7:59–66. <https://doi.org/10.5005/jp-journals-10005-1622>
- Sahebalam R, Hajian S, Mokarami T. The evaluation of occlusal relationship between the primary canines and primary molars in 3 to 5-year-old Iranian children. *J Dent Mater Tech* 2017; 6:176–80.
- Davis SJ, Gray RJ, Mackie IC. Good occlusal practice in children's dentistry. *Br Dent J* 2001; 191:655–9. <https://doi.org/10.1038/sj.bdj.4801261a>
- Rakesh N, Nilima T, Rahul G. Occlusal traits of deciduous dentition of preschool children of Indian children. *Contemp Clin Dent* 2012; 3:443–7. <https://doi.org/10.4103/0976-237X.107437>
- Bugaighis I. Prevalence of malocclusion in urban Libyan preschool children. *J Orthod Sci* 2013; 2:50–4. <https://doi.org/10.4103/2278-0203.115085>
- Dimberg L, Lennartsson B, Söderfeldt B, Bondemark L. Malocclusions in children at 3 and 7 years of age: A longitudinal study. *Eur J Orthod* 2013; 35:131–7. <https://doi.org/10.1093/ejo/cjr110>
- Hegde S, Panwar S, Bolar DR, Sanghavi MB. Characteristics of Occlusion in primary dentition of preschool children of Udaipu, India. *Eur J Dent* 2012; 6:51–5. PMID: 22229007
- Fernandes S, Gordhanbhai Patel D, 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 Diagnostic Res* 2017; 11:92–6. <https://doi.org/10.7860/JCDR/2017/22515.9266>
- Bahadure R, Thosar N, Gaikwad R. Occlusal traits of deciduous dentition of preschool children of Indian children. *Contemp Clin Dent* 2013; 3:443. <https://doi.org/10.4103/0976-237X.107437>