SciForschen
Open HUB for Scientific Research

International Journal of Dentistry and Oral Health

ISSN 2378-7090 | Open Access

RESEARCH ARTICLE

Volume 7 - Issue 1

The Association between Malocclusion and Dental Caries among Yemeni School Children in Sana'a City

Tharwa Ali Mokred AL-Awadi[1], Fuad L Al-Motareb[1], Khaled A AL-Haddad[1], Ameen Abdullah Yahya Al-Akwa[1], Hassan Abdulwahab Al-Shamahy[2,*], Hussein Mohammad Shoga Al-deen[1], and Mohammed A Al-labani[1]

[1]Orthodontics, Pedodontics and Prevention Department, Faculty of Dentistry, Sana'a University, Yemen
[2]Department of Basic Sciences, Faculty of Dentistry, Sana'a University, Republic of Yemen

***Corresponding author:** Hassan Abdulwahab Al-Shamahy, Department of Basic Sciences, Faculty of Dentistry, Sana'a University, P.O. Box 775 Sana'a, Republic of Yemen, Tel: +967-1-239551; E-mail: shmahe@yemen.net.ye

Received: 01 Oct, 2020 | **Accepted:** 16 Oct, 2020 | **Published:** 23 Oct, 2020

Citation: AL-Awadi TAM, Al-Motareb FL, AL-Haddad KA, Al-Akwa AAY, Al-Shamahy HA, et al. (2020) The Association between Malocclusion and Dental Caries among Yemeni School Children in Sana'a City. Int J Dent Oral Health 7(1): dx.doi.org/10.16966/2378-7090.340

Abstract

Background: Even though few studies have documented malocclusion in different age groups in Yemen, the literature on the prevalence of malocclusion in mixed dentition is scarce or non-existent. Dental caries is another common condition that affects overall health. However, its link to malocclusion in mixed dentition is unknown in Yemen.

Objectives: The purpose of this study was to determine the prevalence of malocclusion and its association with the experience of caries in schoolchildren between the ages of 7 and 12 in Sana'a, Yemen.

Methods and subjects: A cross-sectional study was conducted on 1079 students (546 girls and 533 boys) between the ages of 7 and 12 years from government and private schools that were randomly selected in the city of Sana'a, Yemen. WHO criteria were used to assess the prevalence of dental caries (dmft) for deciduous teeth; and malocclusion was investigated by Angle's classification.

Results: This study showed that the overall prevalence of malocclusion among school children was 81.1%, in which Class I normal molar relationship was found only in 18.9% of school children, while Class I malocclusion involved the highest percentage of the sample 70.4%, followed by Class II relation 9.5%, and Class III involved only 1.1%. The prevalence of dental caries among school children in this study was very high, in which the proportions were 92.4% for primary teeth, and significantly increased with age. On the other hand, the study revealed positive association of malocclusion with dental caries (dmft) among school children, which was statistically significant ($P<0.05$).

Conclusion: The prevalence of malocclusion in our study was consistent with other studies reported worldwide, which ranged between 19.6% and 90%. Moreover, the association between malocclusion and dental caries in primary dentition was of great significance as children with malocclusion were presented to experience higher caries than children without malocclusion.

Keywords: Association; Dental caries; Malocclusion; Prevalence; School children; Yemen

Introduction

Researches and studies on dental health problems in Yemen are still modest and limited, despite the presence of studies that dealt with problems of tooth decay, gingivitis, causes of permanent tooth extraction and spread, formation of biofilms after introduction of fixed orthodontic devices and susceptibility to of Candida to antifungal drugs and the pattern of third molar impaction [1-9], but only one research deals with malocclusion [10] and this is the second study that deals with malocclusion and the first study that studies malocclusion and its relationship to dental caries. Malocclusion can be defined as an irregularity in the teeth or a malfunction of both arches outside of what is acceptable as normal. Malocclusion is thought to be a risk factor in the formation and progression of tooth decay [10,11]. Malocclusion is the most common oral problem, along with tooth decay, gum disease, and fluorosis [11]. According to international studies and the World Health Organization, major dental problems should be subjected to periodic epidemiological surveys; knowing the population's epidemiological situation is vital to planning and providing prevention and treatment services [10-15].

The causes of malocclusion can be genetic or environmental, and/or a combination of both factors, along with various local factors such as negative oral habits, dental abnormalities, the shape of the teeth and the location of their growth, can cause the malocclusion [10-15]. The prevalence of malocclusion varies from country to country and between different age groups and nationalities [10-15]. Globally, epidemiological studies of malocclusion show the prevalence to be

between 39% and 93% [15-17]. The prevalence of malocclusion in Yemen ranges from 19.6% to 90% [10]. The widespread prevalence of malocclusion indicates that public health efforts are required because such conditions negatively affect an individual's quality of life, especially in the case of children and adolescents who are sensitive to their appearance [10,15-17]. Primary dental caries and premature loss are predisposing factors to occlusion and void anisotropy in mixed and permanent teeth [10,16,17]. Dental caries is the most common oral disease in Yemen and around the world regardless of the fact that it can be prevented [6,8,18,19] because its etiology is complex and there are many unexplained interactions between confounding factors and unknown risk factors; it is the most prevalent oral health problem worldwide [6,10,18,19].

Even though one study has documented malocclusion in children groups in Yemen [10], the researches on the prevalence of malocclusion in mixed dentition is scarce or non-existent. Dental caries is another common condition that affects overall health. However, its link to malocclusion in mixed dentition is unknown in Yemen. The purpose of this study was to determine the prevalence of malocclusion and its association with the experience of caries in schoolchildren between the ages of 7 and 12 in Sana'a, Yemen.

Subjects and Methods

This descriptive cross-sectional study was conducted to measure the prevalence of malocclusion associated with dental caries among Yemeni school children in primary schools (government and private) in Sana'a, Yemen. A total of 1079 boys and girls aged 7-12 years from Sana'a schools were randomly selected and screened, and the schools are located in different areas of the city to avoid having children from the same area. The criteria for each assessment of malocclusion described by Angle, (1899) [20] divide the malocclusion into different categories based on the occlusal relationships of the first molar. Teeth affected by dental caries and their restoration/extraction as a result of dental caries were recorded using World Health Organization, (1997) [21]. Data were collected by one examiner who is the first researcher using the standard method [22]. The clinical examination for every child with a history and medical history was formed by a simple examination under sufficient light, sometimes if the natural light was insufficient, artificial light from a torch was used. All children were screened in a school room chosen by the school's principles. Children who were selected and refused to participate were replaced by new ones.

Before starting the study, ethical considerations were taken after the approval of the Faculty of Dentistry at Sana'a University, Yemen, for the study. The test was administered with permission from the relevant educational authorities. Permission was obtained from the District Education Office and the target school principals, after informed consent was obtained from the parents of the participating children.

Statistical Analysis

The data were analyzed by SPSS program (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Aromnk, NY: IBM Corp) and presented by using tables. Percentage (%) was used to describe the qualitative variables. Mean and standard deviation was used to describe the quantitative variables for the normally distributed data. Chi-square with Yate correction and Fisher tests were used to show the significance of the association between the outcomes at the level of significance less than 0.05 (P).

Results

The malocclusion rate was 81.1%, there was an association between malocclusion and the younger age group (7-9 years) of 84.2%, odds ratio=1.5 (CI=1.1-2), p=0.01. There was no significant association between malocclusion and sex or school type (Table 1). Class I malocclusion had the highest percentage of sample 70.4%, with 73.2% in age group 7-9 higher than age group 10-12 (67.8%) (P<0.05). Class II malocclusion was 9.5%, while Class III had the lowest incidence and was present in only 1.1% of the entire sample. According to age, there was a significant difference with Class II malocclusion (P<0.05). On the other hand, normal Class I occlusion was in 18.9% of the sample. It was found that 21.9% of the age group 10-12 years was greater than the age group 7-9 years (15.8%), and the age difference was significant (Table 2, Figure 1). The prevalence of caries in the deciduous teeth was present at 92.4% as shown in figure 2. There was a significant association between dmft (dental caries) and malocclusion with a rate of 82.1% positive caries in positive malocclusion with the associated odds ratio equal to 2.13 times, interval Confidence=1.30-3.48; P<0.05. There was also a significant association between missing primary teeth and malocclusion with a rate of 99.7% positive malocclusion with an associated odds ratio of 106.64 times, confidence interval=14.88-764.46; P<0.001 (Table 3, Figure 3).

Discussion

The current cross-sectional study was carried out to assess the prevalence of malocclusion and dental caries among 7-12 year-old children in Sana'a city, Yemen. Most studies [14-19] that evaluate the prevalence of malocclusions use samples that include various age groups. The present study covered an age group which orthodontic clinics are the most sought after due to the emergence of clinical situations that involve alterations in the arches and faces. This could be attributed to the normal sequence of eruption in 9-year olds as many deciduous teeth exfoliate at this age. Moreover, this is a

Table 1: The association between malocclusion with age, gender and school type.

Variable		Malocclusion		Normal		OR (95%CI)	p-value
		freq.	%	freq.	%		
Age (year)	7 - 9 yrs.	444	84	83	16	1.5 (1.1-2)	
	10 - 12 yrs.	431	78	121	22	Reference	0.010*
Gender	Boys	443	81	103	19	1.0 (0.7-1.3)	
	Girls	432	81	101	19	Reference	0.972
School type	Government	620	82	141	19	1.08 (0.7-1.5)	0.624
	Private	255	80	63	20	Reference	
Total (n=1079)		875	81	204	19		

*P<0.05 statistically significant

Table 2: Prevalence of Angle classification according to age, gender and school type.

Angle classification	Age (year)				Gender				School type					
	7-9yrs		10-12yrs		Boys		Girls		Government		Private		Total	
	freq.	%	freq.	%	freq.	%	freq.	%	freq.	%	freq.	%	freq.	%
Class I normal	83	16	121	22	103	19	101	19	141	19	63	20	204	18.9
Class I	386	73	374	68	384	70	376	71	540	71	220	69	760	70.4
Class II	52	9.9	51	9.2	53	9.7	50	9.4	70	9.2	33	10	103	9.5
Class III	6	1.1	6	1.1	6	1.1	6	1.1	10	1.3	2	0.6	12	1.1
P-value	0.085*				0.998				0.666					
X^2	6.24				0.035				1.57					

*P<0.05 statistically significant

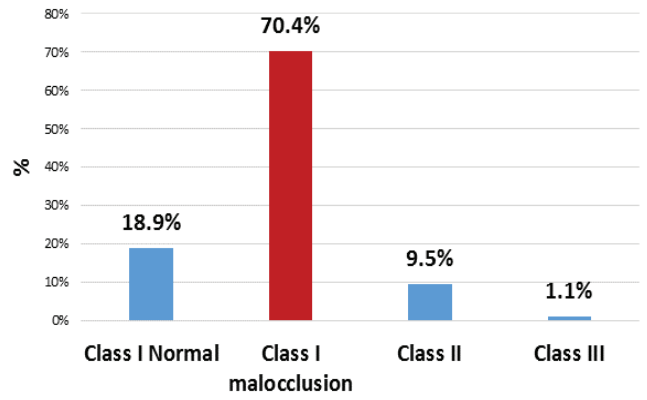

Figure 1: Bar chart showing the prevalence of Angles classification among school children in Sana'a City-2019.

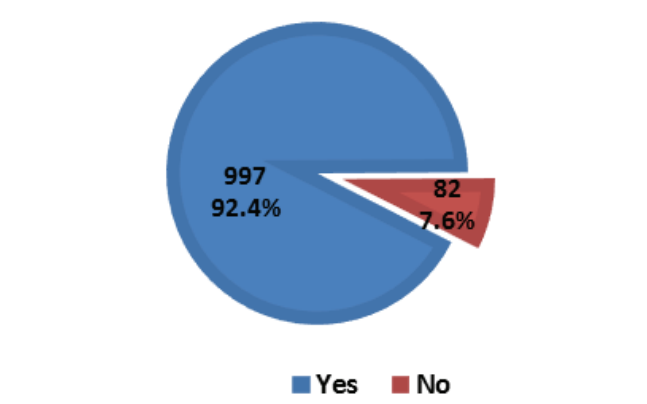

Figure 2: Bar chart showing the prevalence of dental caries by dmft index.

period of growth and development during which many professional interventions can be made, leading to numerous benefits for these individuals [10,14,15]. Malocclusion in this study was present in 81.1% of the school children (Table 1). The high rate of malocclusion in the current studies can be explained by the high prevalence of factors that lead to malocclusion among our tested children, including extra teeth, missing teeth, affected teeth, or abnormally shaped teeth. Ill-fitting dental fillings, crowns, appliances, fixings, or braces, as well as misalignment of jaw fractures after severe injury, are also known to cause malocclusion [10-15]. In addition to thumb sucking, tongue thrusting, pacifier use after the age of three, and prolonged use of the bottle [19]. Moreover, the lack of chewing stress during growth can cause overcrowding of the teeth. Children who chewed hard gum for two hours a day showed increased facial growth [21-23]. Animal experiments showed similar results. In an experiment with two groups of rock hyrax fed hard or soft copies of the same foods, animals fed more soft food had a narrower face and shorter jaw and thinner jaws than animals fed on solid food [24].

The rate of malocclusion in the current study (81.1%) is consistent with results from previous studies by Romano FL, et al., in Brazil (86.6%) [25], and Narayanan RK, et al., in India (83.3%) [26]. On the other hand, the current rate was higher compared to the rate reported by Reddy ER, et al. 52% [27] in Nalgonda, India, Morais CH, et al., (78.50%) [28] in Minas Gerais, Brazil, Disha P, et al. (40.9%) in South India region [29], Sultan S, et al. (78.31%) [30], and by Yu X, et al. in China (79.4%) [31]. Regarding sex, no statistically significant difference (P>0.05) was observed between boys and girls with regard to the prevalence of malocclusion (Table 2), in conjunction with Das UM, et al. [32]; De Souza RA, et al. [33]; Narayanan RK, et al. [26]. According to age groups, the prevalence of malocclusion was more pronounced for the 7-9 year age group than for the 10-12 year age group, with a statistically significant difference (P<0.05). This result is in agreement with Morais CH, et al. [28]. Class I malocclusion predominated in classes II and III in this study (Table 2) and this finding roughly corresponds to data reported in some other studies conducted by De Souza RA, et al. [33]; Brito DI, et al. [34]; Lux CJ, et al. [35]; Almeida MR, et al. [36]; Bourzgui F, et al. [37]; Morais CH, et al. [28]; Narayanan RK, et al. [26]; Disha P, et al. [29]; Sultan S, et al. [30]; and Alajlan SS, et al. [38].

The results obtained in the present study proved that the prevalence of dental caries is high in Sana'a City, and significantly increases with age, in which the percentages of dmft was 92.4%, (Table 3, Figure 2). This result comes in agreement with many studies reported a higher prevalence of dental caries by Gandeh MB, et al. [39]; Al-Haddad KA [40]; Wyne AH, et al. [41]; and Al Agili DE, et al. [42]. Increased tooth decay in developing countries is due to a combination of factors, including eating carcinogenic foods, exposure to fluoride, socioeconomic status, race, health, age, access to oral health services and other lifestyle factors [43,44]. The association between caries and malocclusion between the study subjects was statistically significant and that was present in primary teeth (dmft) 82.1% (Table 3, Figure 3). This finding is consistent with the findings of Gabris K, et al. [18];

Table 3: Dental caries prevalence and the association of four indices reflecting decay experience in deciduous (primary) teeth (dmft) with malocclusion.

Variable			Malocclusion					CI	
	freq	%	freq	%	χ^2	*p*-value	OR	Lower	Upper
Decayed deciduous teeth	983	91	808	82.2	9.14	0.002*	2.03	1.27	3.23
Missing deciduous teeth	302	28	301	99.7	94.56	<0.001**	106.64	14.88	764.46
Filled deciduous teeth	54	5	37	68.5	5.84	0.016*	0.49	0.27	0.88
dmft index	994	92	816	82.1	9.39	0.002*	2.13	1.3	3.48

χ^2: Chi-square test
**P<0.001 statistically significant
*P<0.05 statistically significant
OR: odd ratio
CI: Confidence Interval

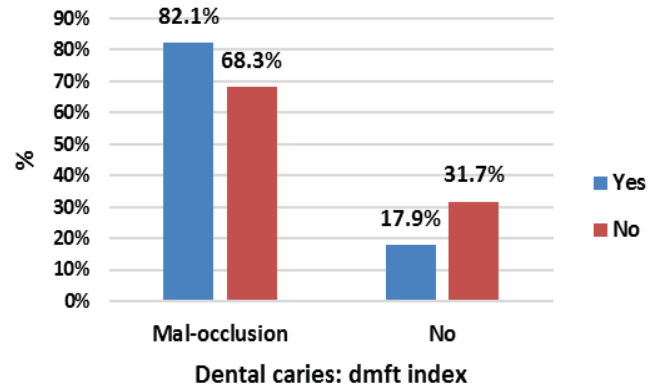

Figure 3: Bar chart showing the association of dental caries (dmft) index with malocclusion.

Mtaya M, et al. [14]; Shivakumar KM, et al. [15]; Singh A, et al. [19]; Buczkowska-Radlinska J, et al. [17]; and Baskaradoss KL, et al. [16] that demonstrated a positive association between caries prevalence and malocclusion. However, it differs with some other studies by Asahi K, et al. [45]; and Aamodt K, et al. [46], who did not report statistically significant association between caries and malocclusion.

Conclusion

The results of the current study showed that there is an increase in the prevalence of malocclusion among schoolchildren from 7 to 12 years old. The study showed that the prevalence of dental caries was very high in the deciduous teeth, and there was a significant association of the total dmft component with malocclusion (P<0.05). The results of this study provide the basic data for implementing preventive programs in schools in order to take immediate action and obtain more oral health awareness programs through early interception treatment to reduce factors that prevent the development of dental arch as well as structural jaw growth.

Acknowledgments

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

1. Alhasani AH, Al-Akwa AAY, Al-Shamahy HA, Al-deen HMS, Al-labani MA, et al. (2020) Biofilm formation and antifungal susceptibility of candida isolates from oral cavity after the introduction of fixed orthodontic appliances. Univ J Pharm Res 5: 21-27.
2. Shoga Al-deen HM, Obeyah AA, Al-Shamahy HA, Al-Shami IZ, AL-amri MAS, et al. (2020) Oral *Candida albicans* colonization rate in fixed orthodontics patients. UnivJ Pharm Res 5: 1-5.
3. Al-Kebsi AM, Othman MO, Abbas AKM, Madar EM, Al-Shamahy HA, et al. (2017) Oral *C. albicans* colonization and non-*candida albicans* candida colonization among university students, Yemen. Univ J Pharm 2: 5-11.
4. Al-Sanabani NF, Al-Kebsi AM, Al-Shamahy HA, Abbas AKMA (2018) Etiology and risk factors of stomatitis among Yemeni denture wearers. Univ J Pharm Res 3: 69-73.
5. Al-Dossary OAE, Al-Shamahy HA (2018) Oral *Candida albicans* colonization in dental prosthesis patients and individuals with natural Teeth, Sana'a City, Yemen. Biomed J Sci & Tech Res 11: 1-7.
6. Al-Shamahy HA, Abbas AKMA, Mahdie Mohammed AA, Alsameai AM (2018) Bacterial and Fungal Oral Infections among Patients Attending Dental Clinics in Sana'a City-Yemen. On J Dent Oral Health 1: 1-5.
7. Alhadi Y, Al-Shamahy HA, Aldilami A, Al-Hamzy M, Al-Haddad KA, et al. (2019) Prevalence and Pattern of Third Molar Impaction in Sample of Yemeni Adults. On J Dent Oral Health. 1: 1-5.
8. Al-Shami IZ, Al-Shamahy HA, Abdul Majeed ALA, Al-Ghaffari KM, Obeyah AA (2018) Association between the Salivary *Streptococcus Mutans* Levels and Dental Caries Experience in Adult Females. On J Dent Oral Health 1: 1-4.
9. Alhadi Y, Rassem AH, Al-Shamahy HA, Al-Ghaffari KM (2019) Causes for extraction of permanent teeth in general dental practices in Yemen. Univ J Pharm Res 4: 1-5.
10. AL-Awadi TAM, AL-Haddad KA, Al-labani MA, Al-Shamahy HA, Shaga-aldeen HM (2019) Prevalence of malocclusion among Yemeni children of primary schools. Univ J Pharm Res 5: 1-6.
11. Gomes MC, de Pinto-Sarmento TC, de Brito Costa EMM, Martins CC, Granville-Garcia AF, et al. (2014) Impact of oral health conditions on the quality of life of preschool children and their families: A cross-sectional study. Health Qual Life Outcomes 12: 55.
12. Tseveenjav B, Vehkalahti M, Murtomaa H (2003) Dental health of dentists' children in Mongolia. Int J Paediatr Dent 13: 240-245.
13. Ferreira SH, Beria JU, Kramer PF, Feldens EG, Feldens CA (2007) Dental caries in 0 to 5 years old Brazilian children: Prevalence,

severity, and associated factors. Int J Paediatr Dent 17: 289-296.

14. Mtaya M, Brudvik P, Astrom AN (2009) Prevalence of malocclusion and its relationship with sociodemographic factors, dental caries, and oral hygiene in 12 to 14 years old Tanzanian school children. Eur J Orthod 31: 467-476.

15. Shivakumar KM, Chandu GN, Subba RVV, Shafiulla MD (2009) Prevalence of malocclusion and orthodontic treatment needs among middle and high school children of Davangere city, India by using Dental Aesthetic Index. J Indian Soc Pedod Prev Dent 27: 211-218.

16. Baskaradoss JK, Geevarghese A, Roger C, Thaliath A (2013) Prevalence of malocclusion and its relationship with caries among school children aged 11-15 years in Southern India. Korean J Orthod 43: 35-41.

17. Buczkowska-Radlinska J, Szyszka-Sommerfeld L, Wozniak K (2012) Anterior tooth crowding and prevalence of dental caries in children in Szczecin, Poland. Community Dent Health 29: 168-172.

18. Gabris K, Marton S, Madlena M (2006) Prevalence of malocclusions in Hungarian adolescents. Eur J Orthod 28: 467-470.

19. Singh A, Purohit B, Sequeira P, Acharya S, Bhat M (2011) Malocclusion and orthodontic treatment need measured by the dental aesthetic index and its association with dental caries in Indian school children. Community Dent Health 28: 313-316.

20. Angle EH (1899) Classification of malocclusion. Dent Cosmos 41: 248-264.

21. WHO (1997) Oral health surveys. Basic Methods, 4th Edition, World Health Organization, Geneva.

22. Thilander B, Pena L, Infante C, Parada SS, de Mayorga C (2001) Prevalence of malocclusion and orthodontic treatment need in children and adolescents in Bogota, Colombia. An epidemiological study related to different stages of dental development. Eur J Orthod; 23: 153-167.

23. Lieberman D, Krovitz GE, Yates FW, Devlin M, St Claire M (2004) Effects of food processing on masticatory strain and craniofacial growth in a retrognathic face. J Hum Evol 46: 655-677.

24. Rosenberg J (2020) Malocclusion of teeth. Medline Plus.

25. Romano FL, Magnani MBBA, Ferreira JTL, Matos DS, Valerio RA, et al. (2012) Prevalence of malocclusions in school children with mixed dentition in the city of Piracicaba, Brazil. Rev Odontol Univ Cid Sao Paul 24: 96-104.

26. Narayanan RK, Jeseem MT, Kumar TVA (2016) Prevalence of malocclusion a mong 10-12 years old school children in Kozhikode District, Kerala: An epidemiological study. Int J Clin Pediatr Dent 9: 50-55.

27. Reddy ER, Manjula M, Sreelakshmi N, Rani ST, Aduri R, et al. (2013) Prevalence of Malocclusion among 6 to 10 Years old Nalgonda School Children. J Int Oral Health 5: 49-54.

28. Morais CH, Zanin L, Degani VV, Valdrighi HC, Venezian GC, et al. (2016) Malocclusion in schoolchildren aged 7-12 years old in Minas Gerais, Brazil. RGO, Rev Gauch Odontol, Porto Alegre 64: 164-170.

29. Disha P, Poornima P, Pai SM, Nagaveni NB, Roshan NM, et al. (2017). Malocclusion and dental caries experience among 8-9 years old children in a city of South Indian region: A cross-sectional survey. J Edu Health Promot 6: 98.

30. Sultan S, Ain TS (2018) Prevalence of malocclusion among 12 years old school children in Kashmir India. Sch J Dent Sci 5: 35-39.

31. Yu X, Zhang H, Sun L, Pan J, Liu Y, et al. (2019) Prevalence of malocclusion and occlusal traits in the early mixed dentition in Shanghai, China. PeerJ 7: e6630.

32. Das UM, Venkatsubramanian, Reddy D (2008) Prevalence of malocclusion among school children in Bangalore, India. Int J Clin Pediatr Dent 1: 10-12.

33. De Souza RA, de Araujo Magnani MBB, Nouer DF, Romano FL, Passos MR (2008) Prevalence of malocclusion in a Brazilian school children population and its relationship with early tooth loss. Braz J Oral Sci 7: 1566-1570.

34. Brito DI, Dias PF, Gleiser R (2009) Prevalence of malocclusion in children aged 9 to 12 years old in the city of Nova Friburgo, Rio de Janeiro State, Brazil. R Dental Press Ortodon Ortop Facial 14: 118-124.

35. Lux CJ, Ducker B, Pritsch M, Komposch G, Niekusch U (2009) Occlusal status and prevalence of occlusal malocclusion traits among 9 years old school children. Eur J Orthod 31: 294-299.

36. Almeida MR, Pereira ALP, Almeida RR, Almeida-Pedrin RR, Silva Filho OG (2011) Prevalence of malocclusion in children aged 7 to 12 years. R Dental Press J Orthod 16: 123-131.

37. Bourzgui F, Sebbar M, Hamza M, Lazrak L, Abidine Z, et al. (2012) Prevalence of malocclusions and orthodontic treatment need in 8 to 12 years old schoolchildren in Casablanca, Morocco. Prog Orthod 13: 164-172.

38. Alajlan SS, Alsaleh MK, Alshammari AF, Alharbi SM, Alshammari AK, et al. (2019) The prevalence of malocclusion and orthodontic treatment need of school children in Northern Saudi Arabia. J Orthodont Sci 8: 1-5.

39. Gandeh MB, Milaat WA (2000) Dental caries among schoolchildren: Report of a health education campaign in Jeddah, Saudi Arabia. East Mediterr Health J 6: 396-401.

40. Al-Haddad KA (2002) Oral health status and treatment needs among 6-14 years old school children in Sana'a City, Yemen. Master Thesis, College of Dentistry, University of Baghdad, Iraq.

41. Wyne AH, Al-Ghannam N, Al-Shammery A, Amjad HW, Khan NB (2002) Caries in primary school children: Prevalence, severity and pattern in Al-Ahsa, Saudi Arabia. Saudi Med J 14: 135-139.

42. Al-Agili DE, Niazy HA, Pass MA (2012) Prevalence and socioeconomic determinants of dental sealant use among school children in Saudi Arabia. East Mediterr Health J 18: 1209 -1216.

43. WHO (1981) Oral Health Information Systems. World Health Organization, Geneva, Switzerland.

44. Miura H, Araki Y, Haraguchi K, Arai Y, Umenai T (1997) Socioeconomic factors and dental caries in developing countries: A cross-national study. Soc Sci Med 44: 269-272.

45. Asahi K, Yuki K (2003) Study on the relationship of malocclusion to dental caries on caries preventive program using fluoride. Journal of the Matsumoto Dental College Society 29: 18-21.

46. Aamodt K, Reyna-Blanco O, Sosa R, Hsieh R, Ramos MDG, et al. (2015) Prevalence of caries and malocclusion in an indigenous population in Chiapas, Mexico. Int Dent J 65: 249-255.