



# Prevalence of Malocclusion in Permanent Dentition of Iranian Population: A Review Article

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## Abstract

**Background:** The aim of this study was systematic review and meta-analysis of prevalence in current and relevant literature about this developmental disorder to present the profile of malocclusion in Iran.

**Methods:** This review study was carried out with systematically identified and critically assessed studies reporting malocclusion prevalence among Iranian population in permanent dentition. National and international databases were searched for articles about prevalence of malocclusion by Angle classification in different regions of Iran from 1994 to 2015. After applying inclusion and exclusion criteria, the quality of articles was checked by professional checklist. Data extraction and meta-analysis was performed. A random-effect model was employed. Publication bias was checked.

**Results:** Of 2768 articles, 21 cases were included. The pooled prevalence of malocclusion was about 87% (95% CI: 78.3–92.2) in Iranian population; however, the prevalence of malocclusion across individual studies varied considerably (ranging from 23.7% to 99.7%). Prevalence of normal occlusion, class I, II and III malocclusion were reported as 13.3% (CI 95%: 7.8–21.7), 50.7% (CI 95%: 42.9–58.4), 21% (CI 95%: 17.5–25.1), 5.5% (CI 95%: 3–10); respectively. Maximum prevalence of malocclusion was in the East of Iran.

**Conclusion:** The results showed a high prevalence of malocclusion in Iranian population. The baseline information could be appropriately utilized for the future planning to meet the orthodontic treatment need among the Iranian population.

**Keywords:** Dental malocclusion, Prevalence, Angle classification, Iran

## Introduction

Malocclusion is the most common developmental disorder that has significant negative impact on both children's and their families' quality of life (1-3). It is leading to psychosocial distress, speech and chewing problems (4), raising the possibility of injury in accidents (5, 6), periodontal problems (7), temporomandibular joint disease (8), bruxism (9), and headache (10). The prevalence and severity of malocclusion have increased over the last centuries. Therefore, needs for orthodontic treatment have been increased (11).

Determining the prevalence of malocclusion in a specific population group can help in developing health policies to prevent and treat (12). For evaluation the prevalence of malocclusion, we need to universal acceptable classification. Angle established a classification of occlusion based on the molar relationship still used today (13). A literature review showed different prevalence reports (23.7% to 99.7%) for dental malocclusion in various areas of Iran. About 78% of 1063 adolescence in Karaj had malocclusion (14). In 6151

children, 6 to 17 yr-old in Isfahan only 15% had normal occlusion and 85.2% were categorized into different types of malocclusions (15). In Shiraz, among 1338 people between 14 and 18 yr old, 23.7% had different types of malocclusions (16). In Tehran, 99.7% of 12 to 15 yr-old children had malocclusion (17).

The present study was aimed to investigate the pooled prevalence of malocclusion using all available national data.

## **Methods**

This meta-analysis study with regard prevalence of malocclusion was performed from 1994 to 2015 in Iran.

**Search strategy:** Electronic search was performed using international database including PubMed, Scopus, Google Scholar and national database including Iranian Scientific Information Database (SID), indexing article published in Iranian biomedical journals (Iran Medex), Iranian Research Institute of Information and Documentation (Iran Doc), Magiran and National Library and Archives from 1994 to 2015 in Iran. All thesis abstracts and original articles published up to Nov 2015 were put to work on. The search for articles was performed by two independent researchers using following search words: "malocclusion, Angle classification, class I malocclusion, class II malocclusion, class III malocclusion, prevalence, permanent dentition, dental malocclusion, cross-sectional studies and Iran". The Persian keywords were equivalent to their English word, and all probable combinations were considered.

Moreover, manual search of reference lists of previously selected studies was carefully performed to gather additional scientific reports, also submitted to full-text examination. A gray literature search was also performed using google Scholar, Iran Doc, National Library, and Archives of Islamic Republic of Iran, Searching for available thesis, dissertations, and unpublished articles.

### *Selection criteria*

Two investigators in a two-step approach performed the selection process independently. Af-

ter excluding duplicated articles, at first step, title and abstracts of all matched articles were reviewed for exclusion of unrelated articles. As inclusion criteria, descriptive studies that assessed prevalence of malocclusion in permanent dentition using Angle classification in Iranian population aged 11 to 35 yr were selected for review. Studies on syndromic or specific patients; assessment of other occlusal problems like cross bites, open bite and crowding and Studies were conducted on patients referred for orthodontic treatment to health centers were excluded. Disagreements were resolved by discussion.

### *Quality Assessment*

After selecting the articles, assessing risk of bias in studies was conducted by using a checklist based on STROBE protocol. This checklist contains 12 questions covered various aspects of the methodology such as sample size, study design, sampling method, population, data collection methods, and tools, examining samples method, statistical analysis and reporting findings based on objectives. Each items corresponded to "yes=1" or "no=0". Therefore, each study was allocated a score of 0 to 12. If a study achieved less than 8 points it was omitted from meta-analysis (18).

### *Data Extraction*

The evidence from the selected studies was recorded into an evidence table that included the name of the first author, year of publication, the region where the study conducted, the total number of samples, the number of samples by sex if it had been reported, the prevalence of normal occlusion and malocclusions and various subdivisions if it had been reported. The studies were categorized into five geographic regions in Iran. Region 1: Isfahan and Yazd cities were used as the sample of the center of Iran, region 2: Tehran, Karaj, Qazvin and Rezvanshahr cities as North, region 3: Shiraz and Ahvaz cities as South sample, region 4: Mashhad, Kerman, Neishabour and Zahedan cities as the East and region 5: Mehran, Khorram Abad, and Tabriz cities were the West sample.

### Statistical analysis

Comprehensive meta-analysis (V2.2, Biostat) was used to conduct the meta-analysis. The pooled prevalence of Malocclusion among children was calculated using a random-effect model in light of the observed heterogeneity (19). The statistical heterogeneity within studies was evaluated using a  $\chi^2$ -based Cochran's Q statistic (20), and was further quantified using  $I^2$  statistics ( $I^2 = 0\%$ -25%, no heterogeneity;  $I^2 = 25\%$ -50%, moderate heterogeneity;  $I^2 = 50\%$ -75%, large heterogeneity; and  $I^2 = 75\%$ -100%, extreme heterogeneity) (21). Sub-group analyses were conducted in accordance with the geographic areas (Center/ North /South/ East/ West), gender (male/ female), types of malocclusion (normal occlusion/ class I malocclusion/ class II malocclusion/ class III malocclusion), and their subdivisions. Publication bias was assessed by funnel plot, Egger's weighted regression, and Begg's rank correlation methods (22).

After exclusion, a sensitivity analysis was performed to evaluate the effect of sample size on the pooled prevalence. If the outcome was significantly changed after one study was removed, then the study was excluded from the included studies due to selection bias, and a new analysis was conducted (19).  $P < 0.05$  was considered statistically significant for all analyses.

### Results

The original search in national and international databases identified 2768 publications which completed by 4 article of hand searching, of which 2734 were excluded after removal of duplications and review of the title and abstract. Application of the inclusion and exclusion criteria reduced these to 22 cross-sectional studies from 1994 to 2015 evaluated their full text and qualified for the review analysis (Fig. 1).

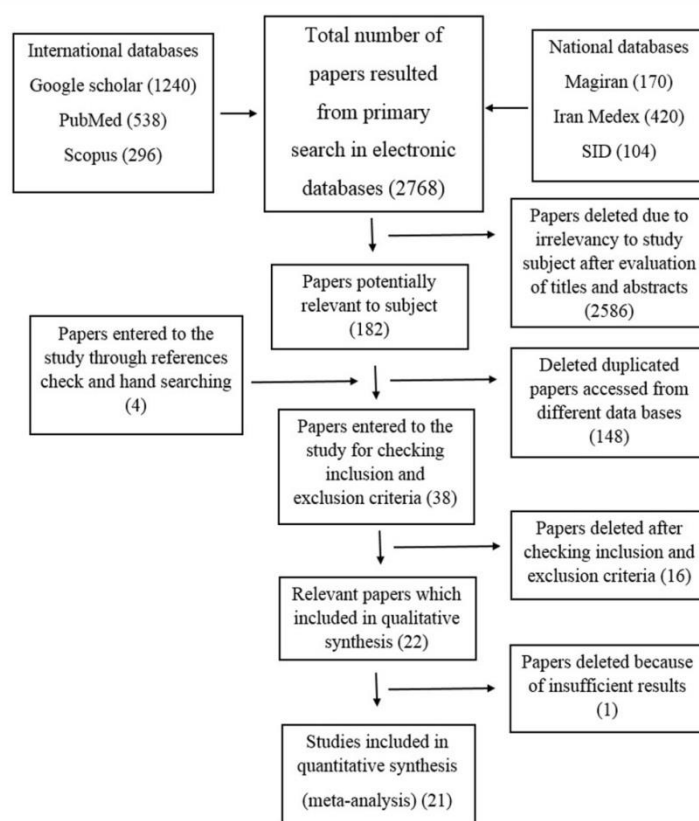


Fig. 1: Searching flowchart

**Table 1:** Key characteristics of included studies in the meta-analysis of malocclusion prevalence in Iranian population

<i>Author (et al.)</i>	<i>Region</i>	<i>Total number</i>	<i>Male</i>	<i>Female</i>	<i>Normal</i>	<i>Class 1</i>	<i>Class2 div1</i>	<i>Class2 div2</i>	<i>Total class2</i>	<i>True class3</i>	<i>Pseudo class3</i>	<i>Total class3</i>	<i>Total malocclusion</i>
Ordubazari(17)	2	2519	1278	1241	0.3	62.1	21.7	15	36.7	NR	NR	0.9	99.7
Akhundi(14)	2	1063	1063	0	22.2	68.2	7.7	1.3	9	NR	NR	0.6	77.8
Ramezanzade(56)**	4	1000	500	500	4.7	55.1	12.3	5.7	18	7.3	0.3	7.6	95.3
Nuri(57)	2	1800	900	900	10.9	44.1	16	4.2	32.1	NR	NR	12.9	89.1
Akhundi(24)**	5	562	285	277	17.62	56.94	8.72	6.04	14.76	NR	NR	10.68	82.38
Ravanmehr(58)**	2	500	250	250	16	48	15.6	5.2	20.8	12	3.2	15.2	84
Hedayati(59)**	3	632	367	265	6.7	61.16	18.04	3.26	21.3	NR	NR	4.46	93.3
Ghods(60)**	1	960	480	480	10.73	44.06	NR	NR	29.06	NR	NR	16.15	89.27
Khanemasjedi(61)	3	744	744	0	2.82	62.91	26.34	2.82	29.16	NR	NR	5.11	97.18
Ramezanzade(62)**	4	469	254	215	13.6	54	16.4	6.8	23.2	5.8	3.4	9.2	86.4
Taheri(63)	2	300	150	150	8.7	NR	NR	NR	NR	NR	NR	NR	91.3
Shahri(23)**	4	630	315	315	7.9	76.9	12.7	1.4	14.1	0.6	0.5	1.1	92.1
Basafa(8)	4	425	308	117	18.8	43	12	7	19	NR	NR	19.2	81.2
Ahangar(64)	5	398	398	0	4	57	17.6	4.3	21.9	NR	NR	17.1	96
Mirzaei(65)	3	1338	621	717	38	31	16	12	28	NR	NR	3	62
Jafari(66)	2	1484	743	741	79*	NR	NR	14.5	NR	NR	6.5	NR	
Kuchmeshgi(67)	2	600	314	286	58.5	NR	NR	NR	NR	NR	NR	NR	41.5
Aghili(25)	1	1980	1980	0	51*	NR	NR	22	NR	NR	27	NR	
Borzabadi(68)**	1	502	249	253	22.9	41.8	24.1	3.4	27.5	NR	NR	7.8	77.1
Arabiun(16)**	3	1338	621	717	76.31	12.78	4.78	5.16	9.94	NR	NR	0.97	23.69
Fallahinezhad(69)**	5	254	124	130	30.7	49.64	7.4	5.9	13.3	5.5	0.7	6.2	69.3

NR: Not reported,

\* Not used in meta-analysis of normal occlusion and class I malocclusion

\*\* Included studies in the meta-analysis that reports prevalence of malocclusions by sex

One study was excluded, mainly because the authors reported malocclusion in 6 to 17 aged population and were unable to provide exact data about prevalence of malocclusion in people with permanent dentition separately (18). Twenty-one eligible cross-sectional studies with a total number of 19498 participants met the inclusion criteria and were used for the meta-analysis (Table 1). Results of some studies were corrected using main data of research by making connection with correspondent author.

**Meta-analysis Findings**

Since the distribution of values in all of the meta-analyses exhibited significant heterogeneity, we used a random effect model for all meta-analyses. The prevalence of malocclusions in Iranian population was reported by all 21 included studies. Reported total malocclusion prevalence ranged from a low of 23.7% (7), to a high of 99.7% (17), and this range showed the extent of the variation in reported prevalence. The prevalence of class I malocclusion in articles varied from 12.7% (16), to 76.9% (23). The prevalence of class II maloc-

clusion in articles varied from 9% (24), to 36.7% (17), and about class III malocclusion it was varied from 0.6% (24), to 27% (25). The pooled prevalence of malocclusion was 86.7% (95% CI: 78.3 - 92.2%) (Fig. 2). The most prevalent type of malocclusion in this study was class I malocclusion with 50.7% (95% CI: 42.9 - 58.4%). The pooled prevalence of class II malocclusion was 21% (95% CI: 17.5 - 25.1%). The meta-analysis showed that the total class III prevalence was 5.5 % (95% CI: 3 - 10%) (Table 2). Ten studies had been reported malocclusions based on gender. Meta-analysis based on these studies showed the prevalence of malocclusion in boys and girls were 83% (95%CI: 66.2-92.4%), 79.9% (95% CI: 62-90.6%); respectively. Although 16 articles have been reported the prevalence of subdivisions of class II and only 5 articles have been reported subdivisions of class III malocclusion, based on pooled data of these studies Class II div 1 (13.9%) was more prevalent than div II; and pseudo class III was the least prevalent malocclusions (1.2%) (Table 2).

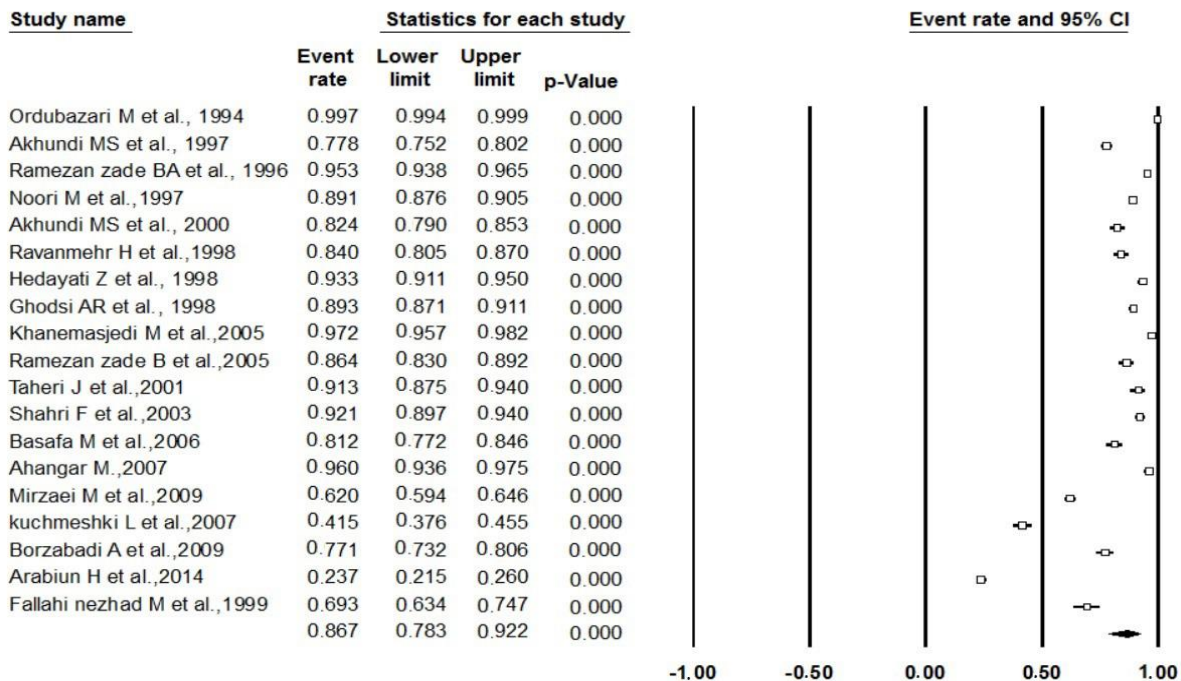


Fig. 2: Forest plot of total malocclusion

**Table 2:** Pooled prevalence of malocclusion according to Angle classification, subdivisions of malocclusion and sexual distribution of malocclusions

Variables	Total			Boys			Girls		
	Prevalence (95%CI)	Heterogeneity Q value	I2 (%)	Prevalence (95%CI)	Heterogeneity Q value	I2 (%)	Prevalence (95%CI)	Heterogeneity Q value	I2 (%)
Sample size (n)	19498			11945			7553		
CL I	50.7 (42.9, 58.4)	1340.32	98.80	50.3 (38.6, 61.9)	382.47	97.64	48.9 (36.1, 61.9)	452.96	98.013
Total CL II	21.0 (17.5, 25.1)	755.197	97.61	19.8 (15.9, 24.4)	86.25	89.56	18.0 (13.8, 23.0)	106.57	91.55
CL II,div1	13.9 (11.3, 17.0)	356.529	95.79	-	-	-	-	-	-
CL II,div2	4.8 (3.4, 6.8)	393.744	96.19	-	-	-	-	-	-
Total CL III	5.5 (3.0, 10.0)	1012.83	98.22	6.6 (4.3, 9.9)	94.69	90.49	6.3 (3.9, 10.1)	118.34	92.39
Pseudo CL III	1.2 (0.5, 2.9)	26.904	85.13	-	-	-	-	-	-
True CL III	5.3 (3.1, 9.0)	42.962	90.68	-	-	-	-	-	-
Normal	13.3 (7.8, 21.7)	2740.188	99.34	17.0 (7.6, 33.8)	787.82	98.85	20.1 (9.4, 38.0)	825.56	98.91
Total malocclusion	86.7 (78.3, 92.2)	2740.188	99.34	83.0 (66.2, 92.4)	787.823	98.85	79.9 (62.0, 90.6)	825.56	98.91

The study geographic region was coded to show dispersion of types of malocclusions in North/ South/ East/ West and central area of Iran. The results showed the most and least prevalence of malocclusion in East (89.9%) and South (79.6 %); respectively.

Maximum prevalence of class I malocclusion (58%) was in Eastern area of Iran. The most prevalence of class II (26%) and class III (15.6%)

malocclusion were in central region of Iran (Table 3). Significant publication bias was found in total malocclusion ( $P=0.007$  by Begg's rank correlation test;  $P=0.001$  by Egger's weighted regression analysis). In addition, class II and class III malocclusion were significantly heterogeneous ( $P<0.05$  in both Egger and Begg's analysis). Trim and fill procedure was applied to correct for publication bias.

**Table 3:** Pooled prevalence of malocclusion according to geographic regions

Variables	Region	Number of studies	Sample size (n)	Total		
				Prevalence (95%CI)	Heterogeneity Q value	I2 (%)
CL I	1	2	1462	43.3 (40.8, 45.8)	0.686	0
	2	4	5882	55.9 (44.2, 66.9)	214.761	98.60
	3	4	4052	39.3 (18.3, 65.1)	646.218	99.53
	4	4	2724	58.0 (44.2, 70.6)	130.972	97.70
	5	3	1214	55.0 (50.7, 59.2)	4.347	53.98
CL II	1	3	3442	26.0 (21.3, 31.2)	19.54	89.76
	2	5	7366	20.8 (12.7, 32.0)	410.874	99.02
	3	4	4052	20.9 (13.0, 31.7)	154.207	98.05
	4	4	2724	21.6 (14.3, 31.2)	77.603	96.13
	5	3	1214	16.5 (12.0, 22.3)	11.152	82.06
CL III	1	3	3442	15.6 (8.3, 27.5)	99.64	97.99
	2	5	7366	4.1 (1.7, 9.3)	243.918	98.36
	3	4	4052	3.0 (1.6, 5.3)	30.332	90.11
	4	4	2724	6.9 (3.2, 14.2)	80.583	96.27
	5	3	1214	10.9 (6.5, 17.7)	18.085	88.94
Normal occlusion	1	2	1462	15.9 (7.2, 31.4)	36.936	97.29
	2	6	6782	11.0 (4.4, 25.1)	692.832	99.27
	3	4	4052	20.4 (5.0, 55.6)	932.36	99.67
	4	4	2724	10.1 (5.4, 17.9)	72.63	95.87
	5	3	1214	14.0 (5.6, 30.9)	68.178	97.06
Total malocclusion	1	2	1462	84.1 (68.6, 92.8)	36.93	97.29
	2	6	6782	89.0 (74.9, 95.6)	692.83	99.27
	3	4	4052	79.6 (44.4, 95.0)	932.36	99.67
	4	4	2724	89.9 (82.1, 94.6)	72.63	95.87
	5	3	1214	86.0 (69.1, 94.4)	68.178	97.06

Region 1: Center, Region 2: north, Region3: south, Region 4: east, Region 5: west

## Discussion

In this study, the results of original articles were selected by critical appraisal and combined with random effect model. Based on the results, 87% of Iranian population in permanent dentition suffer from at least one type of malocclusions. The high prevalence of malocclusion was also reported in other countries, for example in Pakistan (73.6%), (26) Turkey (96.5%), (27) India (85.5%), (28) Nigeria (88.2%), (29) and Sudan (98.6%), (30) and that are approximately similar to the result of this meta-analysis in Iran.

The prevalence of Class I malocclusion was in the range of range of 40.4%, (31) to 84.3%, (30) in Europe and Africa, respectively. The prevalence of class I malocclusion in Iran was similar to other Asian countries (26-28), and Americans (32). Thirty percent of American children and youths have normal occlusion based on Angle classification and Class I malocclusion (50% to 55%) is by far the largest single group in this population (32), which is close to the result of this study. In comparison with Danish (33), Africans (29, 30, 34), and Latinos (35), Iranian children had fewer Class I malocclusions.

The prevalence of a Class I malocclusion in males (50.35%) in this study was higher than that of females (48.9%). Similar trends were found (33). Contrary to the present result Goose et al (36), and Wood et al (37), showed female predominance in Class I malocclusions.

The prevalence of class II malocclusion was 21% (13.9% division 1 and 4.8% division 2) which was comparable with Caucasians (38). Although this prevalence was higher than in white Americans (39), and was more comparable with western Europeans (33, 36, 40, 41). In addition, Class II malocclusion was the most prevalent in whites of northern European descent (32). The pooled prevalence of Class II in this study was similar to the findings of the studies conducted in Asian countries such as Pakistan (26), Turkey (27), and India (28). We can point to racial, ethnic, cultural and nutritional similarities. Class II malocclusions are less prevalent (5%-10%) in isolated populations such as American Indians (42), Eskimos

(37), and native Australians (43). Iranian children also showed a higher prevalence of Class II malocclusions compared with Egyptians (44), Lebanese (45), and blacks and black Africans (29, 30, 46-48).

Class III problem was the least prevalent malocclusion (5.5%) in Iranian populations which some of them were pseudo class III but this was more prevalent than the Caucasians and less than Eastern Asian populations (38, 49). It was comparable with Latinos (35), and black Americans (50). This is probably due to the racial differences. Previous studies in Lebanon (45), and Egypt (44), also yielded a higher prevalence of Class III malocclusions compared with white Americans or Caucasians. Class III problems were reported in Americans less than 1% that represents a very small proportion of the total malocclusions (32). On the other hand, studies in Chinese (15.7%) and Malaysian (16.6%) groups showed a much higher mean prevalence rate than other racial groups (51-55).

According to analysis, minimum and maximum prevalence of malocclusion are in the South and East of Iran, respectively. Although variation of number and sample sizes in the studies, cause to impossibility of a subtle argumentation on geographical distribution.

One of limitations of the study was incomplete report of data in some articles. Reporting of sexual distribution of malocclusions and prevalence of subdivisions of Class II and class III malocclusions are the examples of incomplete data. Another limitation was the lack of enough study about prevalence of malocclusion in central and western regions of Iran.

## Conclusion

The pooled prevalence of malocclusion is about 87% of Iranian population. Class I, II, and III malocclusions were reported 50.7%, 21%, and 5.5%, respectively.

## Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or fal-

sification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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## Conflicts of interest

The authors declare that there is no conflict of interest.

## References

1. Graber L, Vanarsdall R, Vig K (2011). *Orthodontics Current Principles and Techniques*. 5th ed. Louis: Mosby.
2. Johal A, Cheung M, Marcenes W (2007). The impact of two different malocclusion traits on quality of life. *Br Dent J*, 202(2):E2.
3. Shaw W, Meek S, Jones D (1980). Nicknames, teasing, harassment and the salience of dental features among school children. *Br J Orthod*, 7(2):75-80.
4. Proffit W, Fields H (2000). *Contemporary orthodontics*. 3rd ed. Philadelphia: Mosby. 15 p.
5. Grimm S, Frazão P, Antunes JL, et al(2004). Dental injury among Brazilian schoolchildren in the state of São Paulo. *Dent Traumatol*, 20(3):134-8.
6. Petti S, Tarsitani G (1996). Traumatic injuries to anterior teeth in Italian schoolchildren: prevalence and risk factors. *Dent Traumatol*, 12(6):294-7.
7. Geiger AM (2001). Malocclusion as an etiologic factor in periodontal disease: a retrospective essay. *Am J Orthod Dentofacial Orthop*, 120(2):112-5.
8. Basafa M, Shahabi M (2006). Prevalence of TMJ disorders among students and its relation to malocclusion. *Iran J Otorhinolaryngol*, 18(45):53-9.
9. Ghafournia M, Tehrani MH (2012). The Relationship Between Bruxism and malocclusion among preschool childrens in Isfahan. *J Dent Res Dent Clin Dent Prospects*, 6(4):138-42.
10. Komazaki Y, Fujiwara T, Ogawa T, et al (2014). Association between malocclusion and headache among 12-to 15-year-old adolescents: a population-based study. *Community Dent Oral Epidemiol*, 42(6):572-80.
11. Brin I, Zwilling-Sellam O, Harari D, et al (1998). Does a secular trend exist in the distribution of occlusal patterns? *Angle Orthod*, 68(1):81-4.
12. Frazão P, Narvai PC (2006). Socio-environmental factors associated with dental occlusion in adolescents. *Am J Orthod Dentofacial Orthop*, 129(6):809-16.
13. Angle E (1907). *Malocclusion of the teeth*. 7th ed. Philadelphia: Whith Manufacturing Co.
14. Akhondi M (1997). The prevalence of malocclusions in the male students of elementary schools of Karaj. *J Dent Med Tehran Univ Med Sci* 1:9-19.
15. Azarbajejani S, Mirsafaei R, Maghsoudi S, et al (2015). Relationship between different types of malocclusion and sex and age in students in Isfahan. *J Isfahan Dent Sch* 11(2):143-52.
16. Arabiun H, Mirzaye M, Dehghani-Nazhvani A, et al (2014). The prevalence of malocclusion among 14-18 years old students in Shiraz. *J Oral Health Oral Epidemiol*, 3(1):8-11.
17. Ordoobazari M et al. Prevalence of dento-alveolar malocclusion and facial deformity in 12-15 years old children in Tehran: Shahid Beheshti University of Medical Sciences; 1994.
18. Moosazadeh M, Nekoei-moghadam M, Emrani Z, et al(2014). Prevalence of unwanted pregnancy in Iran: a systematic review and meta-analysis. *Int J Health Plann Manage*, 29(3):e277-90.
19. Higgins JP (2008). Commentary: Heterogeneity in meta-analysis should be expected and appropriately quantified. *Int J Epidemiol*, 37(5):1158-60.
20. Wang P, Liu H, Jiang T, et al(2015). Cigarette Smoking and the Risk of Adult Myeloid Disease: A Meta-Analysis. *PLoS One*, 10(9):e0137300
21. Higgins JP, Thompson SG, Deeks JJ, et al(2003). Measuring inconsistency in meta-analyses. *BMJ*, 327:557.
22. Begg CB, Mazumdar M (1994). Operating characteristics of a rank correlation test for publication bias. *Biometrics*, 50(4):1088-101.



23. Shahri F, Khosrawi Khosrovshahi A (2003). Prevalence of ideal occlusion and dental malocclusion in 12-13 years old students in Zahedan. *Zahedan J Res Med Sci* 5(3):165-70.
24. Akhundi M (2000). Assessment of prevalence of occlusal relation in 11-13 year-old students in Mehran in 1997. *J Dent Shahid Beheshti Univ*, 12(4):91-101.
25. Aghili H, Tude M, Hedayati Far A, et al (2007). *Assesment of prevalence of malocclusion in 12-15 year old urban students of Yazd*. Yazd University of Medical Sciences-, Yazd, Iran.
26. Nazir R, Hussain A, Kaleem M (2012). Oral health status and malocclusion in flood affected and internally displaced children in Pakistan. *Pak Oral Dent J*, 32:110-4.
27. Celikoglu M, Akpinar S, Yavuz I (2010). The pattern of malocclusion in a sample of orthodontic patients from Turkey. *Med Oral Patol Oral Cir Bucal*, 15(5):e791-6.
28. Singh VP, Sharma A (2014). Epidemiology of Malocclusion and Assessment of Orthodontic Treatment Need for Nepalese Children. *Int Sch Res Notices*, 2014:768357.
29. Aikins E, Onyeaso C (2014). Prevalence of malocclusion and occlusal traits among adolescents and young adults in Rivers State, Nigeria. *Odontostomatol Trop*, 37(145):5-12.
30. Gamer A. Prevalence of Malocclusion in University of Khartoum Students. Graduate College: Univ Khartoum 2015.
31. Laganà G, Masucci C, Fabi F, et al(2013). Prevalence of malocclusions, oral habits and orthodontic treatment need in a 7-to 15-year-old schoolchildren population in Tirana. *Prog Orthod*, 14:12.
32. Proffit W, Fields H, Sarver D, et al(2012). *Contemporary orthodontics*. 5rd ed: Mosby.P:8.
33. Helm S (1968). Malocclusion in Danish children with adolescent dentition: an epidemiologic study. *Am J Orthod*, 54(5):352-66.
34. Bugaighis I (2013). Prevalence of malocclusion in urban libyan preschool children. *J Orthod Sci*, 2(2):50-4.
35. Silva RG, Kang DS (2001). Prevalence of malocclusion among Latino adolescents. *Am J Orthod Dentofacial Orthop*, 119(3):313-5.
36. Goose DH, Thompson DG, Winter FC (1957). Malocclusion in school children of the West Midlands. *Br Dent J*, 102:174-8.
37. Wood BF (1971). Malocclusion in the modern Alaskan Eskimo. *Am J Orthod*, 60(4):344-54.
38. Thilander B, Pena L, Infante C, et al (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(2):153-67.
39. Proffit WR, Fields HW Jr, Moray LJ (1998). Prevalence of malocclusion and orthodontic treatment need in the United States: estimates from the NHANES III survey. *Int J Adult Orthodon Orthognath Surg*, 13(2):97-106.
40. SCLARE R (1945). Orthodontics and the school child: a survey of 680 children. *Br Dent J*, 79:278-80.
41. Thilander B, N M (1973). The prevalence of malocclusion in Swedish schoolchildren. *Scand J Dent Res*, 81(1):12-21.
42. Grewe JM, Cervenka J, Shapiro BL, et al(1968). Prevalence of malocclusion in Chippewa Indian children. *J Dent Res*, 47(2):302-5.
43. Homan B, Davies G (1973). An oral health survey of Aborigines and Torres Strait Islanders in far North Queensland. *Aust Dent J*, 18(2):75-87.
44. El-Mangoury NH, Mostafa YA (1990). Epidemiologic panorama of dental occlusion. *Angle Orthod*, 60(3):207-14.
45. Saleh F (1999). Prevalence of malocclusion in a sample of Lebanese schoolchildren: an epidemiological study. *East Mediterr Health J Dent Med*, 5:337-43.
46. Diagne F, Ba I, Ba-Diop K, et al(1993). Prevalence of malocclusion in Senegal. *Community Dent Oral Epidemiol*, 21(5):325-6.
47. Isiekwe MC (1983). Malocclusion in Lagos, Nigeria. *Community Dent Oral Epidemiol*, 11(1):59-62.
48. Ng'ang'a PM, Ohito F, Øgaard B, et al(1996). The prevalence of malocclusion in 13-to 15-year-old children in Nairobi, Kenya. *Acta Odontol Scand*, 54(2):126-30.
49. Hardy DK, Cubas YP, Orellana MF (2012). Prevalence of angle class III malocclusion: a systematic review and meta-analysis. *Open J Epidemiol* 2:75-82.
50. Garner L, Butt M (1985). Malocclusion in black Americans and Nyeri Kenyans: an epidemiologic study. *Angle Orthod*, 55(2):139-46.

51. Soh J, Sandham A, Chan YH (2005). Occlusal status in Asian male adults: prevalence and ethnic variation. *Angle Orthod*, 75(5):814-20.
52. Tang E (1994). Occlusal features of Chinese adults in Hong Kong. *Aust Orthod J*, 13(3):159-63.
53. Woon K, Thong Y, Abdul KR (1989). Permanent dentition occlusion in Chinese, Indian and Malay groups in Malaysia. *Aust Orthod J*, 11(1):45-8.
54. Lew K, Foong W, Loh E (1993). Malocclusion prevalence in an ethnic Chinese population. *Aust Dent J*, 38(6):442-9.
55. Tang E (1994). The prevalence of malocclusion amongst Hong Kong male dental students. *Br J Orthod*, 21(1):57-63.
56. Ramazanzadeh BA, Keyhaninejad M, Nikian Y (1996). Evaluation of prevalence of dental malocclusion in junior high schools in Kerman city during 1995-96. *J Kerman Univ Med Sci*, 3(4):185-90.
57. Bashirinejad M, Alizadeshani H, et al (1997). Prevalence of dento-alveolar malocclusion in 12-17 years old children in Qazvin. *J Qazvin Univ Med Sci*, 1(2):29-38.
58. Ravanmehr H, Rashidi Birgani M (1998). A Study on prevalence of dentofacial anomalies in 12 to 14 years old students in Tehran. *J Dent Med*, 11(3):38-45.
59. Hedayati Z, Taherizade H, Mohammadi S (1998). Evaluation and Prevalence of malocclusion in 13-15 years old students of Shiraz. *J Mashhad Dent Sch*, 22:85-97.
60. Ghodsi A, Fayegh M. Clinical assessment of prevalence of malocclusion in 14-17 year-old students of number 3 provincial educational region in Isfahan: Isfahan University of Medical Sciences; 1998.
61. Khanehmasjedi M, Basir L (2004). A study on prevalence of dentofacial anomalies according to Angle Classification in 11-14 year old boy students in ahvaz 2002. *Jundishapur Sci Med J*, 42(2):20-5.
62. Ramezanzadeh B, Hosseini S (2005). Evaluation of prevalence of dental malocclusion in students of junior high school students in the city of neishabour in year 2002-2003. *J Mashhad Dent Sch*, 29(1-2):57-66.
63. Taheri J, Baharvand M, Gholami Kuhestani M (2003). Assesment of oral health in students of 13-15 year-old in Rezvanshahr in 2001. *Dent J Shabid Beheshti Univ*, 15(3):59-67.(In Persian)
64. Ahangar Atashi M (2007). Prevalence of malocclusion in 13-15 year-old adolescents in Tabriz. *J Dent Res Dent Clin Dent Prospects*, 1(1):13-8.
65. Mirzaye M, Arabiun H. Prevalence of malocclusion among 14-18 years old students in Shiraz. The preliminary program for IADR 2nd African and Middle East Regional Conference 2009.
66. Jafari A, Kowsari A, Mahmoodian J, et al (2008). The prevalence of occlusion classification of permanent dentition in Tehran's students age 12 to 13 years. *Acta Med Iran*, 46(5):423-8.
67. Koochmeshgi L, Hosseinzadeh Nik T, Kharrazi FM (2007). Assesment of prevalence of dentofacial deformity and orthodontic treatment need in 12 year old students of Karaj. *Iran J Epidemiol*, 3(4):29-34.
68. Borzabadi-Farahani A, Borzabadi-Farahani A, Eslamipour F (2009). Malocclusion and occlusal traits in an urban Iranian population. An epidemiological study of 11-to 14-year-old children. *Eur J Orthod*, 31(5):477-84.
69. Fallahi Nezhad Ghajari M, Rashidi Fard H (1999). Assessment of Epidemiology of malocclusion in 9 and 12 year old students of Khorram abad. *Dent J Shabid Beheshti Univ*, 11(1):35-45.