

Review Article

Prevalence of malocclusion among Iranian children: A systematic review and meta-analysis

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ABSTRACT

Background: The high prevalence of malocclusion is a public health problem in the world and the third priority in oral care. Numerous primary studies have presented reports on the prevalence of malocclusion among Iranian children. In combination, the results of these studies using meta-analysis are highly valuable for health policy-making. Similarly, this study aimed at determining the prevalence of different types of malocclusion among Iranian children.

Materials and Methods: Using relevant keywords, national and international databases were explored. After narrowing down the search strategy and leaving out the duplicates, the remaining articles were screened based on titles and abstracts. To increase search sensitivity, reference lists of the papers were examined. To identify unpublished articles and documentations, a set of negotiations were done with the people involved and research centers. Finally, the heterogeneity index between the studies was determined using Cochran (Q) and I^2 tests. According to the results of heterogeneity, the random effects model was used to estimate the prevalence of malocclusion in Iran.

Results: In total, 25 articles were included in the meta-analysis process. The prevalence of dental malocclusion was estimated in 28,693 Iranian children aged 3–18 years. The total prevalence of Class I, II, and III malocclusion was 54.6% (46.5-62.7), 24.7% (20.8-28.7), and 6.01% (4-7.1), respectively. The prevalence of Class I, II, and III malocclusion was 44.6% (32.9-56.2), 21.5% (18.01-25.1), and 4.5% (3.2-5.9) in boys and 48.8% (36.8-60.8), 21.5% (16.9-25.1), and 5.5% (3.9-7.1) in girls, respectively.

Conclusion: This study showed a high prevalence of malocclusion among Iranian children. Also, the results indicated that the prevalence is higher in girls.

Key Words: Children, malocclusion, meta-analysis as topic, review

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INTRODUCTION

The high prevalence of malocclusion has made it a public health problem in the world; it is now considered as the third highest oral health priority.^[1,2] “A malocclusion is defined as an irregularity of the teeth or a malrelationship between the dental arches

beyond the range of what is accepted as normal.”^[3] Malocclusion is one of the most common dental problems as well as dental caries, periodontal disease, and dental fluorosis.^[4] In addition, maloccluded dentition can cause disturbances in oral function

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and psychosocial problems due to impaired dentofacial esthetics.^[5,6] The etiology of malocclusion is multifactorial and can be a combination of hereditary factors including some stimulus during the formation and development of orofacial structures and environmental factors such as oral habits, social characteristics, and diet.^[7-9]

The prevalence of malocclusion has been reported in a range from 20% to 80% in the majority of studies. This wide range is because of the differences in ethnic groups, age groups, and registration procedures.^[10,11] In the study conducted by Proffit *et al.*, in the USA, almost 30% of people have normal occlusion and prevalence of Class I malocclusion was between 50–55%. The prevalence of Class II and Class III malocclusion is about 15% and <1%, respectively.^[12] Another study in Denmark has reported the prevalence of normal malocclusion as 14%, Class I malocclusion 58%, Class II malocclusion 24%, and Class III malocclusion 4%.^[13] Among the Chinese living in Australia, the prevalence of normal malocclusion was reported to be 7.1%, Class I malocclusion 58.8%, Class II malocclusion 21.5%, and Class III malocclusion 12.6%.^[14]

In Iran, like other countries, several studies have reported the distribution of malocclusion in different locations. In the study conducted by Borzabadi-Farahani *et al.*, in Isfahan (2008) on 502 students aged 11–14, the prevalence of normal malocclusion was 22.9%, Class I malocclusion 41.8%, Class II malocclusion 27.5%, and Class III malocclusion 7.8%.^[15] In another study conducted by Arabiun *et al.* in Shiraz, the prevalence of normal malocclusion was 76.3%, Class I malocclusion 12.78%, Class II malocclusion 9.94%, and Class III malocclusion 0.97%.^[16] Electronic search and document review showed that the prevalence of malocclusion in different areas of Iran has a considerable diversity that brings about some limitations for applying the results. A systematic review of all documents and combining the results of the initial studies using meta-analysis describe the magnitude of this problem in Iranian society.^[17,18]

Regarding the fact that no meta-analysis has been done on the prevalence of malocclusion yet, this study aimed to estimate the prevalence of malocclusion in Iranian children using meta-analysis. These results will be given to health policymakers and they will use these results to plan for a better prevention and treatment. Therefore, health policymakers could be

aware of the gravity of the problem and adopt a more detailed and accurate plan for the prevention and treatment of this problem.

MATERIALS AND METHODS

Search strategy

The National and International Journals were used to find published articles until May 31, 2015. The National databases including Scientific Information Database (www.sid.ir), Iranmedex (www.iranmedex.com), Magiran (www.magiran.com), and Irandoc (www.irandoc.ac.ir) and international databases including PubMed, Google Scholar, Scopus, and Science Direct were searched using keywords. A literature search strategy was primarily applied using the key words: “Prevalence,” “frequency,” “epidemiological,” “dental malocclusion,” “Class I,” “Class II,” “Class III,” “primary school,” “preschool children,” “child,” “Iran,” and their Farsi equivalents. Two independent researchers carried out the search during June 1–20, 2015. Moreover, the reference list of published studies was examined to increase search sensitivity and to select a greater number of studies. Search evaluation was randomly performed by one of the researchers which indicated that no study had been eliminated. The paper source for access to unpublished papers was searched electronically. Research institutes and experts in the field were negotiated to identify unpublished studies.

Inclusion criteria

All studies with publication language of Persian and English selected that obtaining the required scores and reported prevalence of Class I, II, III, and normal malocclusion by overall, boys and girls under the age of 18 years.

Exclusion criteria

Studies that not reported the prevalence of dental malocclusion, studies without a specified sample size, abstracts submitted to conferences and seminars, case-control studies and clinical trials not providing an accurate estimation of the prevalence, case report studies and studies that did not obtain a minimum score of quality assessment and studies with a population of over 18 years of age.

Selection of studies

Full text or abstracts of all papers, documents, and reports were obtained through advanced search. After leaving out the repetitive and irrelevant materials, full texts or abstracts of the papers were selected

based on titles. It should be noted that to prevent bias caused by republishing (publication transverse and longitudinal biases), the researchers examined the findings of primary studies to identify and remove repetitive materials.

Quality assessment

After determining the relevant studies in terms of titles and contents, the checklist of previous studies was used to assess the quality of documentation.^[19] The checklist examined the content of Strengthening the Reporting of Observational Studies in Epidemiology checklist and consisted of questions (12 questions) that covered various aspects of the methodology such as determining appropriate sample size, study design, sampling, population, data collection methods, definition of variables and method of examining the samples, data collection tools, statistical analysis, purpose of the study, appropriate way of reporting findings, and reporting findings based on objectives.^[20] A score was allocated to each question and studies with minimum 8 points entered the meta-analysis.^[19]

Data extraction

Data for each study were extracted based on title of the article, first author's name, year of the study, sample size, study design, sampling, sample size, total sample size, sample size in terms of gender, language of the article, age range of the studied population, overall prevalence of Class I, II, III, and normal malocclusion, and the prevalence of Class I, II, III, and normal malocclusion in boys and girls. The data were entered into an Excel spreadsheet.

Analysis

Data analysis was done by STATA version 11 software, METAN package (STATA Corporation, College Station, TX, USA). The standard error of the overall prevalence of normal, Class I, II, and III malocclusion and the prevalence of Class I, II, III, and normal malocclusion in boys and girls in each study was calculated using binominal distribution formula. Finally, the index of heterogeneity between the studies was determined using Cochran (Q) and I^2 tests. According to the results of heterogeneity, random or fixed effects model was used to estimate the overall prevalence of Class I, II, III and normal malocclusion, the prevalence of Class I, II, III, and normal malocclusion in boys and girls. To minimize random dispersion between point estimates of the studies, the findings of all studies were adjusted using

Bayesian analysis. In addition, sensitivity analysis was applied to determine the studies affecting heterogeneity. The suspected factors of heterogeneity were examined using meta-regression. The point estimation of the prevalence of malocclusion in Iran with confidence interval of 95% was calculated in a forest plot. In this plot, square size represents the weight of each study and side lines show the confidence interval of 95%.

RESULTS

In the initial search, 2181 papers were found on national and international databases. After narrowing down the search strategy and crossing out repetitive materials due to overlapping databases, a number of 679 documents remained. By screening based on titles and abstracts, 542 irrelevant cases were identified. As a result, 137 remaining full-text papers were examined and 111 cases were irrelevant. Two articles were included to check the references. After assessing the quality of articles and considering the exclusion and inclusion criteria, 3 documents were omitted and 25 papers entered the meta-analysis [Figure 1].^[15,16,21-43]

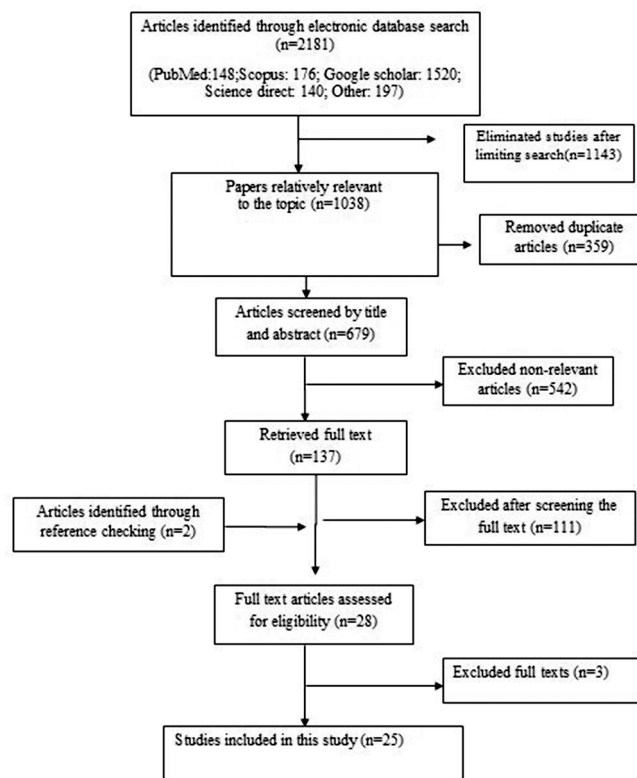


Figure 1: Literature search and review flowchart for selection of primary studies.

Year of publication of the papers varied from 1978 to 2015. The papers which entered the meta-analysis were cross-sectional studies. The study population aged from 3 to 18 years. The prevalence of Class I malocclusion in children varied from 8.1% in the study done by Navidi with a sample size of 486 patients aged 14–13 years to 87.5% in the study conducted by Basir with a sample size of 359 patients in the age group of 3–5 years. After adjusted with Bayesian analysis, the prevalence range of Class I malocclusion in children in primary studies was limited to 8.3–87.3%. The prevalence of Class II malocclusion in children varied from 3.3% in the study done by Basir with a sample size of 359 participants aged 3–5 years to 67.3% and in the study conducted by Ghandhari with a sample size of 104 participants in the age group of 8–10 years. After Bayesian analysis and modifying the inter-study effects, this value reduced to 3.5–59.6%. The prevalence of Class III malocclusion in children varied from 0.6% in the study done by Akhondi with a sample size of 1063 participants aged 11–13 years to 17% in the study conducted by Atashi with a sample size of 398 participants in the age group of 13–15 years. After Bayesian analysis, the value reduced to 0.6–12.9% [Table 1].

In this meta-analysis, the prevalence of dental malocclusion estimated in 28693 Iranian children aged 3–18 (7582 girls and 7996 boys selected using random effects model) was estimated. The total prevalence of Class I, II, and III malocclusion was 54.6% (46.5–62.7), 24.7% (20.8–28.7), and 6.01% (4–7.1), respectively. The prevalence of Class I, II, and III malocclusion was 44.6% (32.9–56.2), 21.5% (18.01–25.1), and 4.5% (3.2–5.9) in boys and 48.8% (36.8–60.8), 21.5% (16.9–25.1), and 5.5% (3.9–7.1) in girls, respectively. The more details are presented in Table 2 and Figures 2–4. Sensitivity analysis was performed to examine the studies affecting heterogeneity. The total prevalence of Class I, II, and III malocclusion was 50.8% (42.5–58.9), 26.6% (22.6–30.6), and 6.1% (5.1–7.2) in age group of more than 5 years and 84.6% (80.5–88.8), 10.1% (1.2–18.9), and 4.9% (–0.5–10.3) in age group of 3–5 years, respectively. In previous studies on the prevalence of Class I malocclusion, the research by Arabiun and Navidi on the prevalence of Class II malocclusion and the research by Ordubazari were identified to be influential on heterogeneity. Disregarding these two studies, it results in substantially reducing the heterogeneity. Moreover, sensitivity analysis did not

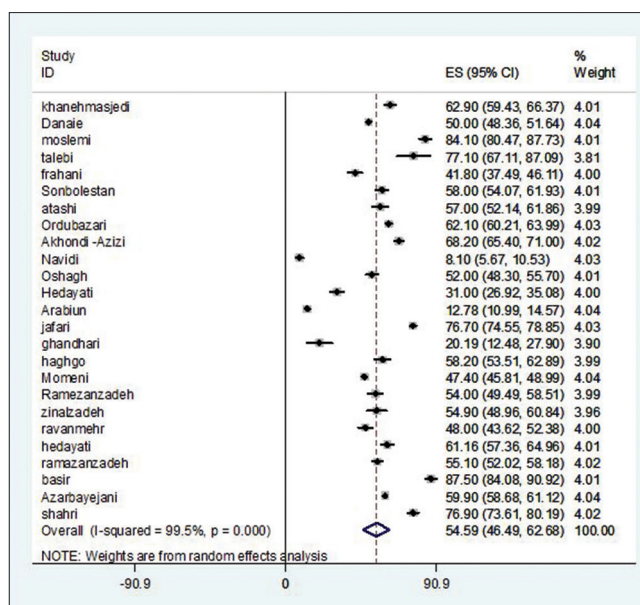


Figure 2: Prevalence of Class I malocclusion among Iranian children.

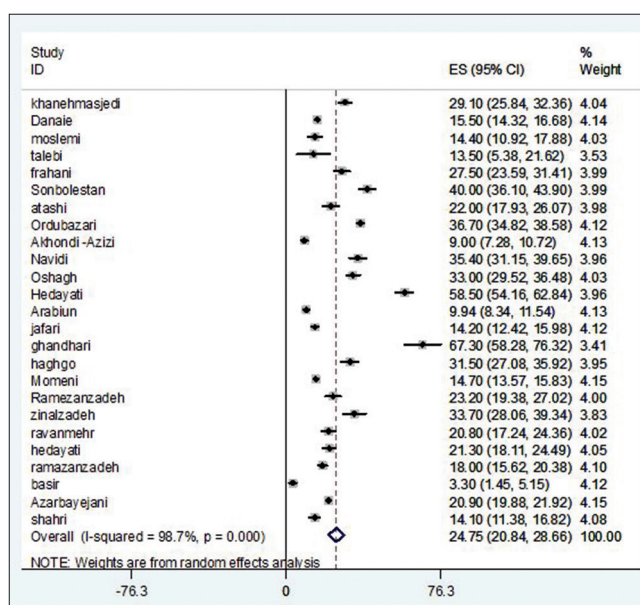


Figure 3: Prevalence of Class II malocclusion among Iranian children.

reveal the influence of heterogeneity between studies on the prevalence of Class III malocclusion. According to analysis meta-regression, the overall prevalence of malocclusion in terms of year of the publication did not have a significant effect ($\beta = 0.124$, $P = 0.813$).

DISCUSSION

This study juxtaposed the results of initial studies with structured criteria and combined them using

Table 1: Distribution and characteristics of primary studies included in the meta-analysis

ID	First author	Publication year	Local study	Range of age	Total			Boys			Girls								
					Sample size	Class I	Class II	Class III	Sample size	Class I	Class II	Class III	Sample size	Class I	Class II	Class III			
1	Khanehmasjedi ^[21]	2005	Khuzestan	11-14	744	62.9	29.1	5.1	2.8	-	-	-	-	-	-	-	-	-	
2	Danale ^[22]	2006	Shiraz	7-9	3584	50	15.5	2.2	32.3	1775	47.3	19.7	2	30.8	1809	52.5	11.4	2.4	33.6
3	Moslemi ^[23]	2015	Yazd	3-5	390	84.1	14.4	1.5	-	195	28.6	15.3	0.5	-	195	85.6	13.3	1.1	-
4	Talebi ^[24]	2013	Mashhad	3-5	68	77.1	13.5	4.2	5.2	-	-	-	-	-	-	-	-	-	-
5	Borzabadi-Farahani ^[15]	2008	Isfahan	11-14	502	41.8	27.5	7.8	22.9	249	45	28.1	6.8	20.1	253	38.7	26.9	8.7	25.7
6	Sonbolestani ^[25]	2005	Isfahan	9-12	607	58	40	2	-	277	50	45	5	-	330	63	35	2	-
7	Ahangar Atashi ^[26]	2007	Tabriz	13-15	398	57	22	17	4	-	-	-	-	-	-	-	-	-	-
8	Ordubazar ^[27]	1995	Tehran	12-15	2519	62.1	36.7	0.9	0.3	-	-	-	-	-	-	-	-	-	-
9	Akhond ^[28]	1997	Karaj	11-13	1063	68.2	9	0.6	22.2	-	-	-	-	-	-	-	-	-	-
10	Navidi ^[29]	2003	Tabriz	13-15	486	8.1	35.4	13.2	33.3	-	-	-	-	-	-	-	-	-	-
11	Oshagh ^[30]	2010	Shiraz	6-14	700	52	33	15.4	-	309	47.6	34	18.4	-	391	55.5	31.5	13	-
12	Hedayati ^[31]	2013	Shiraz	10-18	494	31	58.5	10.5	-	162	9.92	18.62	4	-	332	21.25	39.68	6.48	-
13	Arabian ^[16]	2014	Shiraz	14-18	1338	12.78	9.94	0.97	76.3	621	12.56	10.95	1.77	74.71	717	12.97	9.1	0.27	77.68
14	Jafari ^[32]	2007	Tehran	12-13	1484	76.7	14.2	6.3	-	743	77.4	13.9	5.4	-	741	76	14.4	7.3	-
15	Ghandhari ^[33]	2001	Tehran	8-10	104	20.19	67.3	12.5	-	51	11.54	35.5	1.9	-	53	8.65	31.6	10.58	-
16	Haghighi ^[34]	2004	Tehran	6-12	425	58.2	31.5	3.3	7	-	-	-	-	-	-	-	-	-	-
17	Momeni ^[35]	2003	Shiraz	7-9	3776	47.4	14.7	2.1	30.5	1881	44.7	18.7	1.9	29.1	1895	50.2	10.8	2.3	32.1
18	Ramezanzadeh ^[36]	2005	Neishabour	12-15	469	54	23.2	9.2	13.7	254	56.7	20.5	11	11.8	215	50.7	26.5	7	15.8
19	Zade ^[37]	1978	Mashhad	6-18	270	54.9	33.7	12.7	4.7	-	-	-	-	-	-	-	-	-	-
20	Ravanmehr ^[38]	1998	Tehran	12-14	500	48	20.8	15.2	16	250	58	18.8	6.4	14.8	250	38	22.8	23	17.2
21	Hedayati ^[39]	1998	Shiraz	13-15	632	61.16	21.3	4.46	6.7	-	-	-	-	-	-	-	-	-	-
22	Ramazan-zadeh ^[40]	1996	Kerman	12-16	1000	55.1	18	7.6	4.7	500	58.2	18.6	7.8	3.4	500	52	17.4	7.4	6
23	Basir ^[41]	2013	Ahvaz	3-5	359	87.5	3.3	9.2	-	-	-	-	-	-	-	-	-	-	-
24	Azarbayeji ^[42]	2015	Isfahan	6-17	6151	59.9	20.9	4.4	14.8	-	-	-	-	-	-	-	-	-	-
25	Shahri ^[43]	2003	Zahedan	12-13	630	76.9	14.1	1.1	7.9	315	76.2	15.2	0.9	7.6	315	77.4	13.1	1.2	8.3

meta-analysis based on random effects model. It showed that almost 85% of Iranian children were suffering from at least one type of malocclusion. Meanwhile, the prevalence of Class III malocclusion was estimated to be 6.10% in Iranian children. Also, the prevalence of Class I, II, and III malocclusion were 44.6%, 21.5%, and 4.5% in boys and 48.8%, 21.5%, and 5.5% in girls, respectively.

The prevalence of Class I malocclusion was reported to be a wide range of 10.3–84.3% in Europe and Africa, respectively [Table 3].^[44-53] In this study, the estimated prevalence of Class I malocclusion in Iran compared to other continents was the average value of 54.7%. However, compared to the neighboring countries such as Pakistan and Turkey, the prevalence is approximately similar.^[44-53] It can be understood that in most cases, with the growth and development of communities, the prevalence of Class I malocclusion is reduced. In other words, in addition

to genetic factors, we have to seriously consider the environmental factors such as excessive use of sugars that cause caries and early loss of deciduous teeth, as well as the lack of health care and hygiene that affect the prevalence of Class I malocclusion.

The results of the studies for the prevalence of Class II malocclusion in Iran are similar to the findings of the studies conducted in Asian countries such as Pakistan, Turkey, Syria, and India [Table 3].^[44-53] To explain these findings, we can point to racial, ethnic, cultural, nutritional, and climatic similarities. Also, a review of literature demonstrates the highest and lowest prevalence of Class II malocclusion belong to Asian and African communities, respectively.^[54] To justify the difference in the prevalence of Class II malocclusion, it is crucially important to attend to the potential role of social and economic factors.

The low prevalence rate of Class III malocclusion among Iranian children is also reported in other countries. It is noteworthy that the prevalence of such abnormalities in Asian populations is higher than other communities. However, even in these countries, the prevalence of Class III malocclusion is different which is due to genetic, ethnic, and racial difference.^[44-53]

On the basis of gender, the prevalence of malocclusions Class I and III were 1.09 and 1.23 times higher in girls than boys, respectively. In Class II malocclusion, the ratio was, however, almost equal in both sexes. In general, it can be concluded that the prevalence of different types of dental malocclusion is higher in Iranian girls than boys. To explain the findings, we can attribute the difference to a series of behavioral differences between boys and girls such as thumb-sucking, early baby teeth fall, and skeletal differences, girls' higher sensitivity to pain as well as the possibility of their referral rates for treatment of temporomandibular disorders, mental stress, and puberty.

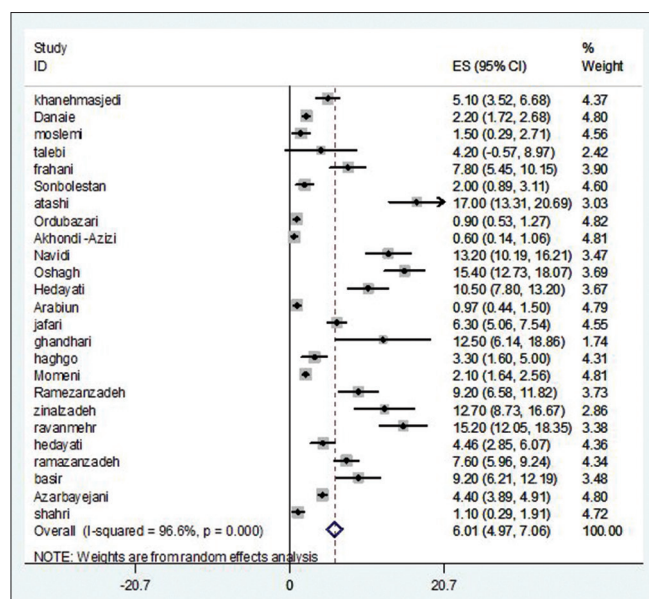


Figure 4: Prevalence of Class III malocclusion among Iranian children.

Table 2: Pooled estimate of the prevalence of malocclusion among Iranian children based on random effects model

Variables	Total			Boys			Girls		
	Prevalence (%)	Heterogeneity		Prevalence (%)	Heterogeneity		Prevalence (%)	Heterogeneity	
		Q (P)	I ² (%)		Q (P)	I ² (%)		Q (P)	I ² (%)
Sample size (n)	28,693	-	-	7582	-	-	7996	-	-
Class I	54.6 (46.5-62.7)	5279.5 (<0.001)	99.5	44.6 (32.9-56.2)	1589.1 (<0.001)	99.2	48.8 (36.8-60.8)	1805.8 (<0.001)	99.3
Class II	24.7 (20.8-28.7)	1791.5 (<0.001)	98.7	21.5 (18.01-25.1)	185.4 (<0.001)	93	21.05 (16.9-25.1)	325.7 (<0.001)	96
Class III	6.01 (4.9-7.1)	715.9 (<0.001)	96.6	4.5 (3.2-5.9)	151.5 (<0.001)	91.4	5.5 (3.9-7.1)	270.3 (<0.001)	95.2
Normal	16.9 (9.7-24.1)	8717.5 (<0.001)	99.8	24.04 (9.3-38.7)	1666.2 (<0.001)	99.6	27.1 (11.1-43.05)	1693.01 (<0.001)	99.6

Table 3: Prevalence of malocclusion among countries: Distribution and characteristics

ID	First author	Publication year	Local study	Range of age	Total			Boys			Girls								
					Sample size	Class			Sample size	Class			Sample size	Class					
						I	II	III		I	II	III		I	II	III			
1	Aikins ^[41]	2014	Nigeria	13-20	620	80.3	6.3	1.6	11.8	297	80.13	7	1.3	10.6	323	80.5	5.57	1.85	12
2	Ahmed ^[45]	2015	Sudan	18-22	2550	84.3	10.5	3.8	1.4	1305	83.8	10.3	4.3	1.6	1245	84.7	10.6	3.4	1.3
3	Bugaighis ^[46]	2013	Libya	12-17	343	66.5	25.4	3.7	4.4	169	30.6	14.4	2.4	2.1	174	35.6	11.3	1.1	2.6
4	Laganà ^[47]	2013	Albania	7-15	2617	40.4	29.2	3.24	27.16	1257	40.4	27.6	3.6	28.4	1360	40.4	30.7	2.9	26
5	Kasparaviciene ^[48]	2014	Lithuanian	5-7	503	10.3	10.7	0.8	78.1	260	11.5	9.2	0.8	78.5	243	9.1	12.3	0.8	77.8
6	Singh ^[49]	2014	India	12-15	2010	48.5	32.68	4.32	14.5	1121	49.68	33.71	2.76	13.85	889	47	31.49	6.3	15.21
7	Siddegowda ^[50]	2014	Indian	10-16	9505	79.2	17.2	0.1	3.5	4966	78.4	17.8	0.1	3.7	4539	80.2	16.6	0	3.2
8	Alatrach ^[51]	2014	Syrian	8-13	200	30	19.5	12	38.5	100	27	20	13	40	100	33	19	11	37
9	Nazir ^[52]	2012	Pakistan	12-16	424	48.6	23.6	1.4	26.4	198	52	22.2	2	23.8	226	45.6	24.8	0.9	28.7
10	Cellikoglu ^[53]	2010	Turkey	12-25	1507	41.5	38.3	16.7	3.5	623	42.2	38.7	15.2	3.9	884	41.1	38	17.8	3.1

However, these studies have not reported any particular trend in the prevalence of malocclusions on the basis of gender. It can be mainly traced in comparison with the results of different studies. In other words, differences in statistical methods, sample size, different criteria for a diagnosis are major factors that can reduce the validity of comparison between studies and may lead to a wrong conclusion. With regard to the aforementioned factored, this is the first study in Iran that has succeeded in providing a more accurate and comprehensive picture of the prevalence of malocclusion using structured review and meta-analysis methods.

This study had some limitations. One of the limitations was the considerable heterogeneity between primary studies. Unfortunately, it was impossible to identify the sources of heterogeneity. However, to resolve this problem, the results were estimated using random effects model. Moreover, it is likely that a number of studies have not been included in the search strategy despite applying structured search criteria. It is worth mentioned since the present study was a descriptive meta-analysis, formal tests such as Egger or Begg or Funnel plot do not show the level of publication bias. The variation in the quantity and quality of primary studies was another limitation which probably affected the result of other studies. Also, another limitation of the present study was lack of report of the prevalence of malocclusion in primary studies included in the meta-analysis by primary dentition, mixed dentition, and permanent dentition. The estimation of prevalence of malocclusion was not provided according to these three categories.

CONCLUSION

This study provided the combined estimation of prevalence of malocclusion in Iranian children using meta-analysis. The results revealed that the prevalence of malocclusion is high in Iranian children and it is higher in girls. In addition, it has provided substantiated and sufficient sample evidence for better policy-making for oral hygiene in Iran Ministry of Health.

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Conflicts of interest

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or non-financial in this article.

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