

## Review Article

# Prevalence of orthodontic treatment need in permanent dentition of Iranian population: A systematic review and meta-analysis of observational studies

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## ABSTRACT

**Background:** Malocclusion is a common oral health problem and can affect the psychosocial well-being in the long term. Therefore, in the recent decades, demand for orthodontic treatment to correct malocclusion has greatly increased worldwide. This systematic review and meta-analysis was undertaken to assess existing evidence on the prevalence of orthodontic treatment need in Iran.

**Materials and Methods:** National and international databases were searched for articles on the prevalence of orthodontic treatment need using index of orthodontic treatment need (IOTN) and dental aesthetic index (DAI). The required data were completed by hand-searching. After applying the inclusion and exclusion criteria, the quality of articles was checked by a professional checklist. Data extraction and meta-analysis were performed. A random effects model was employed, and publication bias was checked.

**Results:** From a total of 443 articles that reported orthodontic treatment need in Iran, 24 articles were included in the meta-analysis process. Meta-analysis was performed on components of IOTN and DAI. The pooled prevalence of orthodontic treatment need based on Dental Health Component and Aesthetic Component of IOTN and DAI was 23.8% (19.5%–28.7%), 4.8% (3.3%–7%), and 16.1% (12.3%–20.8%). The results were found to be heterogeneous ( $P < 0.05$ ).

**Conclusion:** The results of this study revealed that orthodontic treatment need was not high in the Iranian population. Considering the differing prevalence of orthodontic treatment need based on normative index and self-perceived index, it is essential to improve the people's awareness of malocclusion and its side effects on their oral and general health.

**Key Words:** Dental aesthetic, index of orthodontic treatment need, Iran, meta-analysis

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## INTRODUCTION

Malocclusion is a common health problem and can affect the psychosocial well-being in the long term.<sup>[1]</sup> Prevention and treatment of this developmental disorder need a rational planning

of oral health aiming at orthodontic cares,<sup>[2,3]</sup> and comprehensive data about malocclusion such as prevalence are necessary in this regard. Assessment of malocclusion in a community can show only the

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prevalence of different degrees of deviation from normal occlusion,<sup>[4]</sup> some of which have no need for any treatment. However, when changes in normal occlusion affect the function and aesthetics, the need for orthodontic treatment becomes more evident.<sup>[5]</sup> Therefore, evaluation of orthodontic treatment need by indices seems to be necessary. Among several indices developed for this purpose,<sup>[2,6]</sup> the index of orthodontic treatment need (IOTN)<sup>[7]</sup> and dental aesthetic index (DAI)<sup>[2]</sup> are universally acceptable and have been more frequently used in epidemiological studies. The IOTN ranks malocclusion in terms of the significance of various occlusal traits for an individual's dental health and perceived aesthetic impairment, aiming at identifying those individuals who will most likely benefit from an orthodontic treatment. The index has two components: aesthetic and dental health. The aesthetic component of IOTN is a self-perceived index of dental attractiveness which can help us to evaluate changes of attractiveness by malocclusions.<sup>[8]</sup> The DAI links the clinical and aesthetic components mathematically to produce a single score that combines the physical and aesthetic aspects of occlusion, which reflects malocclusion severity and orthodontic treatment need.<sup>[2]</sup>

In Iran, in particular, many epidemiological studies have been carried out on this subject. A literature review of national documents showed orthodontic treatment need varied from 1.58% to 48.2% in different cities of Iran. In Tehran, Safavi *et al.* reported 20% definite orthodontic treatment need by IOTN in 5200 adolescents aged 14–16 years.<sup>[9]</sup> Borzabadi-Farahani *et al.* showed 36% of adolescents in Isfahan needed orthodontic treatment.<sup>[10]</sup> Another study conducted by Oshagh *et al.* in Shiraz using DAI showed that 20.4% of 1818 adolescents had high orthodontic treatment need.<sup>[11]</sup> Furthermore, Eslamipour *et al.* reported 20% orthodontic treatment need among 728 adolescents in Isfahan using DAI.<sup>[12]</sup>

Yet, there is no comprehensive report about this subject. A meta-analysis can provide valuable data on the prevalence of orthodontic treatment need as a component of oral health status of Iranian population, which seems to be useful for policy making and program planning in oral public health system. Thus, the present study was aimed to undertake a meta-analysis to systematically review existing evidence on the prevalence of orthodontic treatment need in Iran.

## MATERIALS AND METHODS

### Search strategy

Literature search methods included scouring original articles in the following electronic databases: PubMed, Scopus, Google scholar, and national database including Iranian Scientific Information Database, indexing article published in Iranian biomedical journals (Iran Medex), Magiran which index thesis abstracts and articles up to November 2015. Searching for articles was performed by two independent researchers according to search strategy shown in Table 1. Search terms included “orthodontic treatment need, index of orthodontic treatment need, prevalence, permanent dentition, Iran, and cross-sectional studies.”

In addition, the references of the included studies were searched for further relevant studies. Handsearching was also performed using Iran doc and National Library and Archives of Islamic Republic of Iran, for available theses, dissertations, and unpublished articles.

### Selection of studies

The selection process was performed by two investigators (F.E and Z.A) in a two-step approach independently. After excluding duplicated articles, at first step, abstracts of all matched articles were reviewed for exclusion of those clearly not related to our purpose. The second phase consisted of detailed full-text analysis of the screened eligible studies. Descriptive studies which assessed treatment need using IOTN or DAI in Iranian population aged 11–35 years old are included in full-text analysis and exclusion criteria's are epidemiological studies on orthodontic treatment needs in primary or mixed dentition, studies which samples were chosen among syndromic or specific patients, studies conducted on population referred for orthodontic treatment to oral health centers, and studies which conducted on other nationality who lives in Iran.

### Quality assessment

After selecting the articles, assessing the risk of bias of studies was conducted using Modified STROBE checklist. This checklist contains 12 questions which are listed in Table 2 which 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, aim of the study, way of reporting

**Table 1: Keywords and search strategy**

#1: Orthodontic treatment need (MeSH)
#2: Prevalence (MeSH)
#3: Epidemiology
#4: Permanent dentition
#5: IOTN (MeSH)
#6: Iran
#7: Cross-sectional studies (MeSH)
#8: #2 or #3
#9: #1 or #5
#10: #8 and #9 and #4 and #6 and #7
IOTN: Index of orthodontic treatment need

**Table 2: Criteria for the assessment of study quality**

Questions	Score	
	Yes=1	No=0
Are the research questions clearly stated?		
Is the approach appropriate for the research question?		
Is the study context clearly described?		
Is the role of the researcher clearly described?		
Is the sampling method clearly described?		
Is the sampling strategy appropriate for the research question?		
Is the method of data collection clearly described?		
Is the data collection method appropriate to the research question?		
Is the method of analysis clearly described?		
Are the main characteristics of the population well described?		
Is the analysis appropriate for the research question?		
Are the claims made supported by sufficient evidence?		

findings, and reporting findings based on objectives. Each study was awarded a score of 0 to 12. If a study achieved less than 8 point, it is omitted from meta-analysis.<sup>[13]</sup> All retrieved full-length articles were evaluated for inclusion in the evidence base against a list of inclusion criteria independently by two trained reviewers. A third reviewer facilitated article reassessment and discussion to resolve conflicts.

**Data extraction**

Data extraction from the included articles was performed by one of the reviewers. The following information was extracted from every included original article: the first author, year of publication, the city where the study conducted, the total number of samples, the number of samples by sex if reported, and the prevalence of each component of indices of IOTN or DAI. Both components of IOTN categorized orthodontic treatment need in 3 groups: no need, borderline need, and severe need. DAI divided treatment need into 4 groups: no need, borderline need, definite need, and severe need.

**Analysis**

A comprehensive meta-analysis (V2.2, Biostat) was used to conduct the meta-analysis. A stratified analysis was conducted in accordance with 3 groups of DHC and AC components of IOTN and 4 groups of DAI. Fixed effects or random effects models were selected based on the heterogeneity shown by the Chi-square based Q test and *I*<sup>2</sup> statistic. Since the distribution of values in all of the meta-analyses exhibited significant heterogeneity, we used a random effects model for all meta-analyses. Publication bias was assessed by funnel plot, Egger’s weighted regression, and Begg’s rank correlation methods.<sup>[14]</sup> 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.<sup>[15]</sup> *P* < 0.05 was considered statistically significant for all analyses.

**RESULTS**

**Study characteristics**

The result of search in national and international databases was 443 articles which completed by 2 articles of handsearching. After excluding irrelevant and duplicated articles, evaluating the relevancy of titles and abstracts was done and finally 27 articles selected. After applying inclusion and exclusion criteria, 24 articles remained [Figure 1]. Five articles measured only DAI, 17 articles used IOTN, and 2 of them used both DAI and aesthetic component of IOTN for measuring orthodontic treatment need [Tables 3 and 4].

All of these 24 articles after evaluation and qualification by the checklist were included in meta-analysis. A total number of participants in articles using DAI were 5914 and about IOTN were 17,977. Some of studies did not report data in detail. Access to main data in these researches was done by making connection with correspondent authors.

**Findings from meta-analysis**

The meta-analysis showed that the prevalence of mandatory need to orthodontic treatment according to DHC of IOTN (grade 4 and 5) was 23.8% (95% confidence interval [CI]: 19.5%–28.7%) and patients who had no need and borderline need for orthodontic treatment were 44.5% (95% CI: 38.4%–50.7%) and 25.3% (95% CI: 23.1%–27.6%),

**Table 3: Included studies in meta-analysis that recorded orthodontic treatment need based on index of orthodontic treatment need**

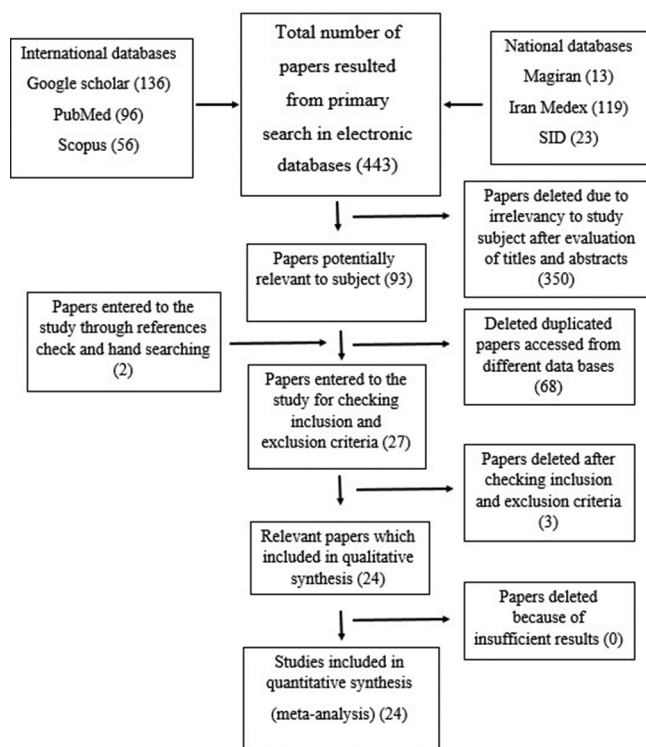
Author	Publication year	Age	Region	Total (n)	Male	Female	DHC1,2 (no need)	DHC3 (borderline need)	DHC4,5 (definite need)	AC 1-4 (no need)	AC5-7 (borderline need)	AC8-10 (definite need)	Modified STROBE score
Biria et al. <sup>[16]</sup>	2005	12-13	2	793	396	397	66.71	16.89	16.4	71.9	20.9	7.2	11
Fayaz montared and Hamze <sup>[17]</sup>	2007	Guidance school children	4	748	329	419	67.11	18.72	14.17	NR	NR	NR	12
Hedayati et al. <sup>[18]</sup>	2007	11-14	3	1965	1190	775	55.78	25.8	18.42	91.95	3.92	4.13	12
Fezbakhsh et al. <sup>[19]</sup>	2011	14-18	1	370	0	370	51.8	23.88	24.32	98.9	1.1	0	12
Fezbakhsh et al. <sup>[20]</sup>	2013	14-18	1	408	408	0	56.9	22.5	20.6	76.47	15.2	8.33	11
Omid khoda et al. <sup>[21]</sup>	2009	14-18	3	1818	965	853	59.96	28.38	11.66	96.5	1.8	1.7	12
Safavi et al. <sup>[9]</sup>	2009	14-16	2	4888	NR	NR	56.71	22.85	20.44	NR	NR	NR	12
Asgari et al. <sup>[22]</sup>	2012	13-18	1	568	NR	NR	53.5	29.8	16.7	90.04	7.83	2.13	12
Hosseinzadeh Nik et al. <sup>[23]</sup>	2011	12	3	417	NR	NR	22.3	29.5	48.2	77.9	14.4	7.7	12
Nik et al. <sup>[24]</sup>	2007	17	3	427	211	216	18.7	35.6	45.7	79.8	16.9	3.3	12
Oshagh et al. <sup>[25]</sup>	2011	18-22	3	240	NR	NR	46.2	27.5	26.3	93.1	5.6	1.3	11
Eslamipour et al. <sup>[26]</sup>	2011	14-17	1	963	262	701	36.66	28.87	34.47	60.1	29.8	10.1	12
Shahr <sup>[27]</sup>	2011	11-14	4	395	198	197	46.5	17	36.5	77.2	16.2	6.6	12
Markazi Moghadam et al. <sup>[28]</sup>	2011	11-14	5	721	361	360	48.7	25.1	26.2	88.1	7.7	4.2	12
Jamilian et al. <sup>[29]</sup>	2010	14-17	2	350	0	350	52	35.4	12.6	NR	NR	NR	12
Borzabadi-Farahani et al. <sup>[30]</sup>	2012	11-20	1	728	388	340	NR	NR	NR	59.75	29.4	10.85	12
Borzabadi-Farahani et al. <sup>[10]</sup>	2009	11-14	1	496	244	252	43.75	20.16	36.09	46	36.1	17.9	12
Eslamipour et al. <sup>[9]</sup>	2011	12-19	1	508	288	220	NR	NR	NR	91.73	6.69	1.58	12
Eslamipour et al. <sup>[32]</sup>	2014	11-18	1	1174	566	608	52.4	27.7	19.9	NR	NR	NR	12

NR: Not reported; DHC: Dental health component; AC: Aesthetic component

**Table 4: Included studies in meta-analysis that recorded orthodontic treatment need based on dental aesthetic index**

Author	Year	Age	Region	Total (n)	Male	Female	DAI 13-25 (no need)	DAI 26-30 (borderline need)	DAI 31-35 (definite need)	DAI >36 (severe need)	Modified STROBE score
Danaei <i>et al.</i> <sup>[33]</sup>	2007	12-15	3	900	450	450	70.1	17.8	7.9	4.2	12
Khanehmasjedi <i>et al.</i> <sup>[34]</sup>	2007	11-14	3	900	450	450	70.8	19.2	7.8	2.2	11
Koochmeshgi <i>et al.</i> <sup>[35]</sup>	2007	12	2	600	314	286	66.4	18.3	8.3	7	12
Oshagh <i>et al.</i> <sup>[11]</sup>	2008	14-18	3	1818	965	853	48.3	31.3	12.3	8.1	11
Borzabadi-Farahani <i>et al.</i> <sup>[30]</sup>	2012	11-20	1	728	388	340	54.5	23.6	11	10.9	12
Danaee <i>et al.</i> <sup>[36]</sup>	2015	11-14	3	240	NR	NR	73.7	15.2	4.4	6.7	12
Eslamipour <i>et al.</i> <sup>[31]</sup>	2011	12-19	1	728	382	346	54.5	19.5	15.1	10.9	12

DAI: Dental aesthetic index; NR: Not reported



**Figure 1:** Flowchart of study selection.

respectively [Figures 2 and 3]. The results of AC of IOTN showed that only 5.2% (95% CI: 3.4%–7.8) of children perceived orthodontic treatment need and 82% of them satisfied from their dental attractiveness [Table 5 and Figures 4,5].

According to DAI, 16.1% (CI 95%: 12.3%–20.8%) of children had definite need to orthodontic treatment (DAI > 31) [Table 6 and Figures 6,7]. The maximum prevalence is related to no need in each index.

Significant publication bias was found in DHC (no need), AC (no need and borderline need), and DAI (definite need) ( $P < 0.05$  in both Egger’s and Begg’s analysis). The results were reported after trim

and fill procedure was applied to correct publication bias.

## DISCUSSION

Management of malocclusion is carried out by a number of disciplines in dentistry, particularly orthodontics, and its priority can be measured by IOTN and DAI, which is related to treatment need rather than its complexity.

In epidemiological surveys of malocclusion, it is important to gather accurate and reliable data about orthodontic treatment need. These data can then be used for policy making of health-care systems and resource planning purposes or for evaluating the effectiveness of orthodontic care services. Indices of orthodontic treatment need have the potential for both acquiring descriptive data on the distribution of treatment need in populations (epidemiological use) and establishing priorities for treatment (administrative use). This systematic review and meta-analysis was undertaken to assess existing evidence on the prevalence of orthodontic treatment need in Iran.

Based on the results of this study, orthodontic treatment need was found to have a prevalence of 16.1% according to DAI. Studies conducted in Asia reported 12.8% and 24.1% orthodontic treatment need in India<sup>[37]</sup> and Malaysia<sup>[38]</sup> according to DAI, respectively, which was relatively close to the results obtained in Iran. But in African countries, the prevalence was up to 44.7%.<sup>[39]</sup> In American countries, studies reported a prevalence of 53.2%<sup>[40]</sup> and 32.8% in Brazil,<sup>[40,41]</sup> which is higher than the prevalence rate in Iran. According to the results of DHC-IOTN, the prevalence of Iranian orthodontic treatment need was similar to that of European countries such as Italy (27.3%),<sup>[42]</sup> Serbia (27.4%),<sup>[43]</sup> and

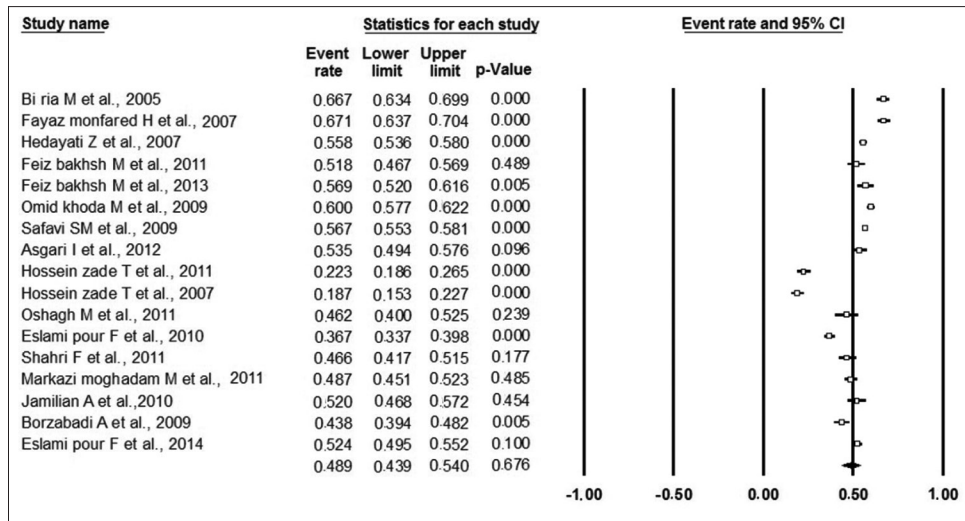


Figure 2: Forest plot of no need to orthodontic treatment based on DHC (Grade 1, 2).

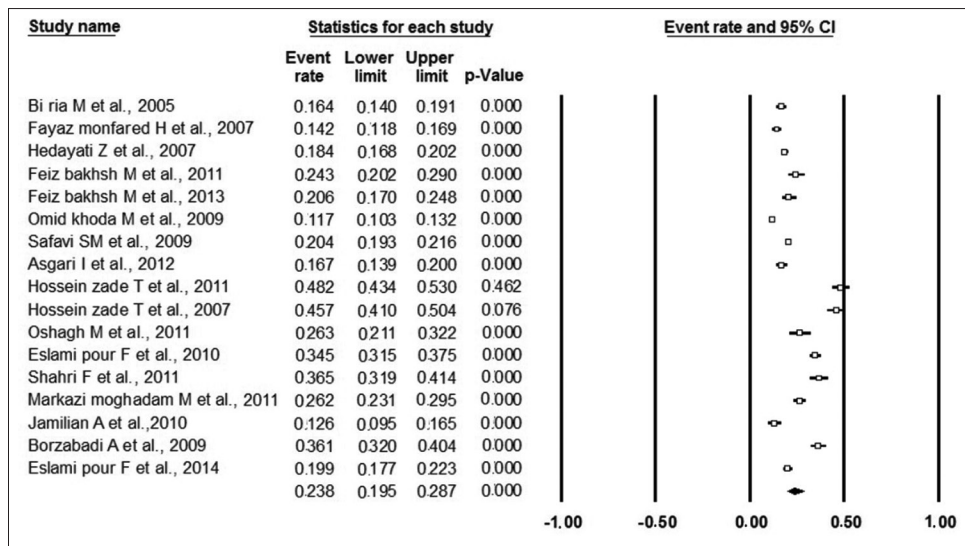


Figure 3: Forest plot of great orthodontic treatment need based on DHC (Grade 4, 5).

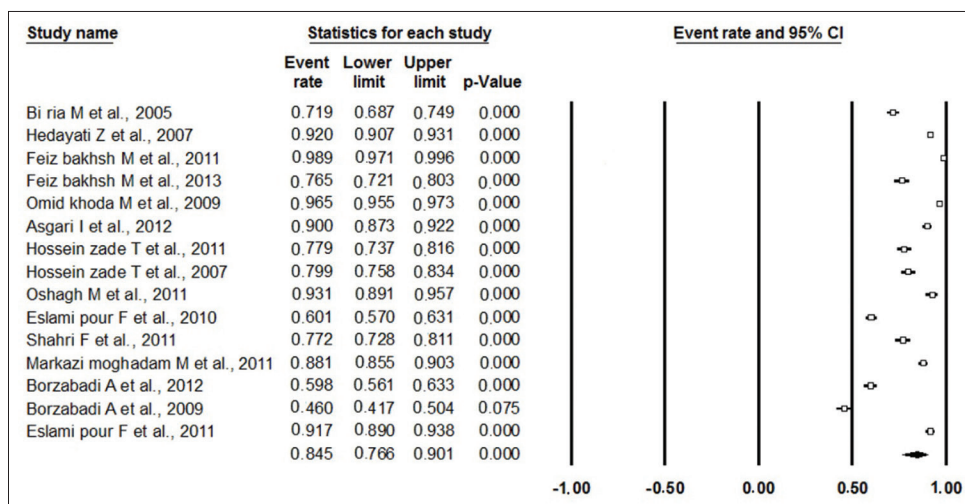


Figure 4: Forest plot of no need to orthodontic treatment based on AC (Grade 1-4).

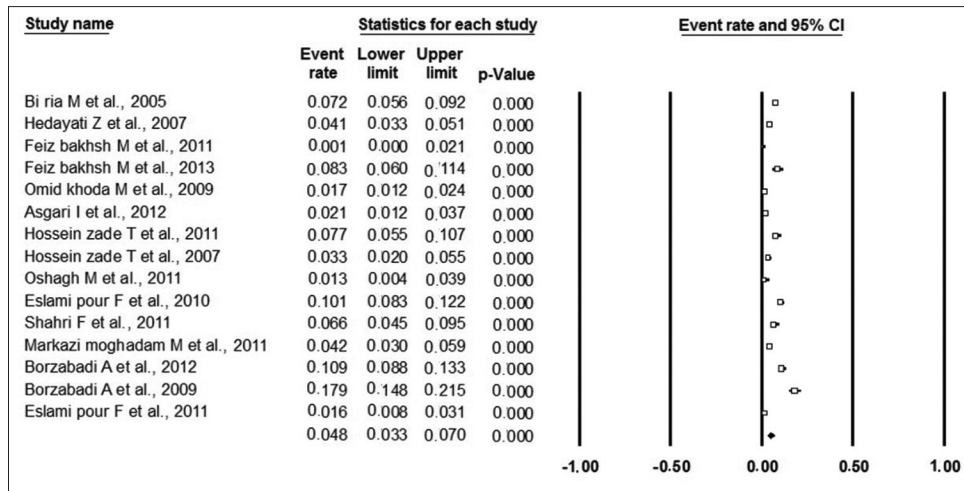


Figure 5: Forest plot of great orthodontic treatment need based on AC (Grade 8-10).

Table 5: Pooled prevalence of orthodontic treatment need according to index of orthodontic treatment need

Variables	Total		
	Prevalence (95% CI)	Heterogeneity	
		Q	I <sup>2</sup> (%)
Sample size (n)	17,977		
DHC 1, 2	44.5 (38.4-50.7)	617.318	97.40
DHC 3	25.3 (23.1-27.6)	156.466	89.77
DHC 4, 5	23.8 (19.5-28.7)	666.885	97.60
AC 1-4	84.5 (76.6-90.1)	1226.052	98.85
AC 5-7	10.7 (6.9-16.3)	851.452	98.35
AC 8-10	4.8 (3.3-7.0)	275.685	94.92

CI: Confidence interval; DHC: Dental health component; AC: Aesthetic component

Table 6: Pooled prevalence of orthodontic treatment need according to dental aesthetic index

Variables	Total		
	Prevalence (95% CI)	Heterogeneity	
		Q	I <sup>2</sup> (%)
Sample size (n)	5914		
DAI 13-25	62.9 (54.8-70.4)	226.86	97.35
DAI 26-30	20.5 (16.4-25.4)	110.42	94.56
DAI 31-35	9.5 (7.5-11.9)	47.466	87.35
DAI >36	6.6 (4.7-9.2)	70.022	91.43
DAI >31	16.1 (12.3-20.8)	114.19	94.74

CI: Confidence interval; DAI: Dental aesthetic index

Spain (21.8%).<sup>[44]</sup> Studies conducted on the prevalence of orthodontic treatment need according to AC-IOTN showed self-perceived need of 2% in London,<sup>[45]</sup> 7.1% in Brazil<sup>[40]</sup> and 4.4% in Spain,<sup>[44]</sup> which were similar to the prevalence rate in Iran (4.8%). However, the prevalence rates of Eastern Asian countries such as Malaysia (22.8%)<sup>[38]</sup> and Africa (more than 10%)<sup>[46,47]</sup> were higher than that of Iran [Table 7].

According to the obtained results, people’s self-assessment of their dental appearance is different from a professional assessment. It is because professional measures (DHC-IOTN and DAI) evaluate all dental aspects, including missing, diastema, crowding, crossbite, overjet, and open bite. Meanwhile, the self-assessment measure (AC-IOTN) only focuses on the attractiveness of anterior dental appearance at smile. Hence, these indices show different aspects of orthodontic treatment need, all of which can be used to complement each other in epidemiologic surveys and diagnostic procedures.

Previous studies have shown a high correlation and diagnostic agreement between AC (IOTN) and DAI.<sup>[50,51]</sup> In their study in Iran, Borzabadi-Farahani *et al.*<sup>[30]</sup> reported a statistically significant association between DAI and AC scores ( $\rho = 0.795$ ). This result was expected since both indices are heavily based on the aesthetic aspects of occlusion.

One of the limitations of this meta-analysis was lack of studies in different geographic regions of Iran; hence, more epidemiologic studies about orthodontic treatment need are suggested to be carried out in different regions of Iran.

Another limitation was a few studies on orthodontic treatment need according to DAI in Iran.

## CONCLUSION

The majority of Iranian population were categorized in no-need group with regard to orthodontic treatment need. According to DHC, nearly one-fourth of the population would have a mandatory need for orthodontic treatment. Using DAI, less than

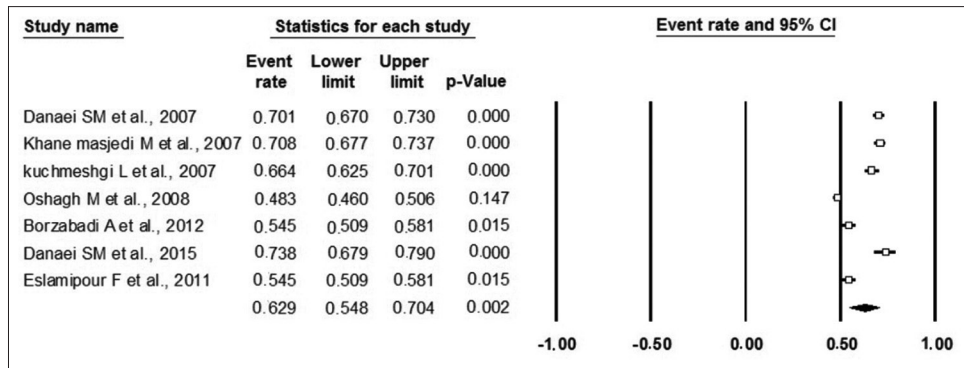


Figure 6: Forest plot of no need to orthodontic treatment based on DAI (Score 13-25).

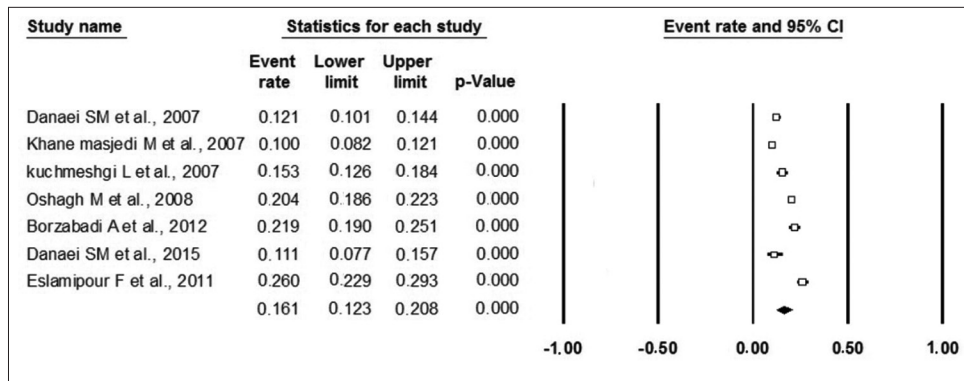


Figure 7: Forest plot of definite orthodontic need based on DAI (Score >31).

Table 7: Distribution of orthodontic treatment need in different ethnic groups

Area	First author	Publication year	Study's location	Range of age	Sample size	Orthodontic treatment need		
						DHC-IOTN	AC-IOTN	DAI
African	Utomi and Onyeano <sup>[39]</sup>	2015	Nigeria	-	150	-	-	44.7
	Mugonzibwa <i>et al.</i> <sup>[46]</sup>	2004	Tanzania	9-18	386	22	11	-
	van Wyk and Drummond <sup>[48]</sup>	2005	South Africa	12	5744	-	-	30.9
	Puertes-Fernández <i>et al.</i> <sup>[47]</sup>	2011	Western Sahara	12	248	18.1	13.7	13.2
European	Perillo <i>et al.</i> <sup>[42]</sup>	2010	Italy	12	703	27.3	-	-
	Janošević <i>et al.</i> <sup>[43]</sup>	2015	Serbia	11-14	301	27.4	15.3	-
	Josefsson <i>et al.</i> <sup>[49]</sup>	2007	Sweden	12-13	476	37	-	-
	Manzanera <i>et al.</i> <sup>[44]</sup>	2009	Spain	12	363	21.8	4.4	-
	Alkhatib <i>et al.</i> <sup>[45]</sup>	2005	London	12-14	2788	15	2	-
Asian	Jha <i>et al.</i> <sup>[37]</sup>	2014	Lucknow	12-15	697	-	-	12.8
	Abdullah and Rock <sup>[38]</sup>	2001	Malaysia	12-13	5112	47.9	22.8	24.1
American	Freitas <i>et al.</i> <sup>[41]</sup>	2015	Brazil	15-19	16,833	-	-	53.2
	de Almeida and Leite <sup>[40]</sup>	2013	Brazil	12	7993	-	7.1	32.8

DHC: Dental health component; AC: Aesthetic component; DAI: Dental aesthetic index; IOTN: Index of orthodontic treatment need

one-fourth (16%) of samples had an increasing need for orthodontic treatment. If the AC scores were used as a self-perceived index, the treatment need would decrease to 5% among the samples. To sum up, Iranian population had more orthodontic treatment need than they perceived, and the majority of them were satisfied with their dental appearance. On the other hand, the majority of them perceived themselves as attractive with regard to their dental appearance.

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**Conflicts of interest**

The authors of this manuscript declared that they have no conflicts of interest, real or perceived, financial or nonfinancial in this article.

**REFERENCES**

- Borzabadi-Farahani A. A review of the oral health-related evidence that supports the orthodontic treatment need indices. *Prog Orthod* 2012;13:314-25.
- Jenny J, Cons NC. Comparing and contrasting two orthodontic indices, the index of orthodontic treatment need and the dental aesthetic index. *Am J Orthod Dentofacial Orthop* 1996;110:410-6.
- Väkiparta MK, Kerosuo HM, Nyström ME, Heikinheimo KA. Orthodontic treatment need from eight to 12 years of age in an early treatment oriented public health care system: A prospective study. *Angle Orthod* 2005;75:344-9.
- Sandhu S, Bansal N, Sandhu N. Incidence of malocclusions in India: A review. *J Oral Health Community Dent* 2012;6:21-4.
- Traebert ES, Peres MA. Do malocclusions affect the individual's oral health-related quality of life? *Oral Health Prev Dent* 2007;5:3-12.
- Shaw WC, Richmond S, O'Brien KD. The use of occlusal indices: A European perspective. *Am J Orthod Dentofacial Orthop* 1995;107:1-10.
- Brook PH, Shaw WC. The development of an index of orthodontic treatment priority. *Eur J Orthod* 1989;11:309-20.
- Hunt O, Hepper P, Johnston C, Stevenson M, Burden D. The aesthetic component of the index of orthodontic treatment need validated against lay opinion. *Eur J Orthod* 2002;24:53-9.
- Safavi SM, Sefidroodi A, Nouri M, Eslamian L, Kheirieh S, Bagheban AA, *et al.* Orthodontic treatment need in 14-16 year-old tehran high school students. *Aust Orthod J* 2009;25:8-11.
- Borzabadi-Farahani A, Borzabadi-Farahani A, Eslamipour F. The relationship between the ICON index and the dental and aesthetic components of the IOTN index. *World J Orthod* 2010;11:43-8.
- Oshagh M, Moumeni Danaei S, Omid Khoda M, Borhan Haghighi Z, Karami Far A, Kerdegari Y. Evaluation of orthodontic treatment need according to dental aesthetic index in 14-18 year old students in the city of Shiraz in 2007. *J Mashhad Univ Med Sci* 2008;32:143-50.
- Eslamipour F, Borzabadi-Farahani A, Asgari I. Assessment of orthodontic treatment need in 11- to 20-year-old urban Iranian children using the dental aesthetic index (DAI). *World J Orthod* 2010;11:e125-32.
- Moosazadeh M, Nekoei-Moghadam M, Emrani Z, Amiresmaili M. Prevalence of unwanted pregnancy in iran: A systematic review and meta-analysis. *Int J Health Plann Manage* 2014;29:e277-90.
- Begg CB, Mazumdar M. Operating characteristics of a rank correlation test for publication bias. *Biometrics* 1994;50:1088-101.
- Higgins JP. Commentary: Heterogeneity in meta-analysis should be expected and appropriately quantified. *Int J Epidemiol* 2008;37:1158-60.
- Biria M, Eslami Amirabadi G, Nazari R. The evaluation of orthodontic treatment need for 12-13 years students of Gorgan City with using IOTN index. *Shahid Beheshti Univ Dent J* 2005;23:225-33.
- Fayaz Monfared H, Hamze M. Assessment of prevalence of need and demand to orthodontic treatment in guidance school students of Kerman city in 2005-2006. *Rafsanjan Univ Med Sci* 2007;6:67-76.
- Hedayati Z, Fattahi HR, Jahromi SB. The use of index of orthodontic treatment need in an Iranian population. *J Indian Soc Pedod Prev Dent* 2007;25:10-4.
- Feizbakhsh M, Omrani A, Teimori F, Mirlolhi F. Orthodontic treatment needs of 14-18 year-old female students of Isfahan in 2009-2010 using IOTN index. *J Isfahan Dent Sch* 2011;7:47-52.
- Fezbakhsh M, Khadem P, Sarandi S, Teimouri F, Aslan F, Dadgar S. Orthodontic treatment needs of 14-18 year-old male students of Isfahan (Iran) in 2009-2010 using IOTN index. *J Mash Dent Sch* 2013;37:145-52.
- Omid Khoda M, Morteza O, Shahla M, Ladan Z. Orthodontic treatment need in 18-14 year old students in Shiraz. *Shiraz Univ Dent J* 2009;10:136-43.
- Asgari I, Ebn Ahmady A, Khoshnevisan MH, Eslamipour F. Evaluation of the patient-based indices for orthodontic need assessment in the 13 to 18 year-old adolescents in Isfahan. *J Dent Med* 2012;25:124-34.
- Hosseinzadeh Nik T, Shahsavari N, Gholami D, Fattahi Meibodi A, Nourozi S. Evaluation the need and demand of orthodontic treatment in 12 years old school students in Abade, Iran. *Iran J Epidemiol* 2011;7:44-50.
- Nik TH, Nourozi S, Fard MK, Noroozi H. The relationship between patient, parent and orthodontic treatment need and demand in 17-year-old students residing in Abade/Iran. *J Dent Tehran Univ Med Sci* 2007;4:107-14.
- Oshagh M, Salehi P, Pakshir H, Bazayr L, Rakhshan V. Associations between normative and self-perceived orthodontic treatment needs in young-adult dental patients. *Korean J Orthod* 2011;41:440-6.
- Eslamipour F, Riahi Dehkordi A, Etemadi Shalamzari M. Comparative Survey of Self-Perceived Indices for Orthodontic Treatment Need Determination in Isfahan University Students Entered in 2010; 2011.
- Shahri F, Ansari Moghadam A, Eshaghi A. Assessment of Orthodontic Treatment Need Using IOTN Index in 11-14 Year-Old Student of Zahedan in 2010; 2011.
- Markazi Moghadam M, Moghimbeigi A, Jafari F. Evaluation of orthodontic treatment needs in a population of Iranian schoolchildren using the IOTN in 2010. *Avicenna J Dent Res* 2011;3:35-43.
- Jamilian A, Toliati M, Etezad S. Prevalence of malocclusion and index of orthodontic treatment need in children in tehran. *Oral Health Prev Dent* 2010;8:339-43.
- Borzabadi-Farahani A, Eslamipour F, Asgari I. A comparison of two orthodontic aesthetic indices. *Aust Orthod J* 2012;28:30-6.
- Eslamipour F, Asgari I, Farzaneh Khoo AR. Frequency of dental anomalies and the need for orthodontic treatment in

- 12-19 year-old adolescents in Isfahan. *J Isfahan Dent Sch* 2011;6:543-52.
32. Eslamipour F, Asgari I, Tabesh A. Orthodontic treatment need and oral health related quality of life in students in Isfahan. *Beheshti Univ Dent J* 2014;32:124-33.
  33. Danaei SM, Amirrad F, Salehi P. Orthodontic treatment needs of 12-15-year-old students in Shiraz, Islamic Republic of Iran. *East Mediterr Health J* 2007;13:326-34.
  34. KhanehMasjedi M, Bassir L, Haghhighizadeh M. Evaluation of relationship between orthodontic treatment need according dental aesthetic index (DAI) and student's perception in 11-14 year old students in the city of Ahwaz in 2005. *J Mashhad Dent Sch Mashhad Univ Med Sci* 2007;31:37-46.
  35. Koochmeshgi L, Hosseinzadeh Nik T, Kharrazi Fard M. Assessment of prevalence of dentofacial deformity and orthodontic treatment need in 12 year old students of Karaj. *Iran J Epidemiol* 2007;3:29-34.
  36. Danaee SM, Fijan S, Mohammadi N, Zadeh RS. Evaluation of relationship between orthodontic treatment need according dental aesthetic index (DAI) and student's perception in 11-14 year old students in the city of Shiraz in 2012. *Int J Res Med Sci* 2015;3:1056-60.
  37. Jha K, Saha S, Gv J, Narang R, Biswas G, Sood P, *et al.* Prevalence of malocclusion and its psycho-social impact among 12 to 15-year-old school children in Lucknow city. *J Clin Diagn Res* 2014;8:ZC36-9.
  38. Abdullah MS, Rock WP. Assessment of orthodontic treatment need in 5,112 malaysian children using the IOTN and DAI indices. *Community Dent Health* 2001;18:242-8.
  39. Utomi IL, Onyeano CO. Malocclusion and orthodontic treatment need of patients attending the lagos university teaching hospital, Lagos, Nigeria. *Odontostomatol Trop* 2015;38:23-30.
  40. de Almeida AB, Leite IC. Orthodontic treatment need for Brazilian schoolchildren: A study using the dental aesthetic index. *Dental Press J Orthod* 2013;18:103-9.
  41. Freitas CV, Souza JG, Mendes DC, Pordeus IA, Jones KM, Martins AM, *et al.* Need for orthodontic treatment among Brazilian adolescents: Evaluation based on public health. *Rev Paul Pediatr* 2015;33:204-10.
  42. Perillo L, Masucci C, Ferro F, Apicella D, Baccetti T. Prevalence of orthodontic treatment need in Southern Italian schoolchildren. *Eur J Orthod* 2010;32:49-53.
  43. Janošević P, Stošić M, Janošević M, Radojičić J, Filipović G, Čutović T, *et al.* Index of orthodontic treatment need in children from the Niš region. *Vojnosanit Pregl* 2015;72:12-5.
  44. Manzanera D, Montiel-Company JM, Almerich-Silla JM, Gandía JL. Orthodontic treatment need in Spanish schoolchildren: An epidemiological study using the index of orthodontic treatment need. *Eur J Orthod* 2009;31:180-3.
  45. Alkhatib MN, Bedi R, Foster C, Jopanputra P, Allan S. Ethnic variations in orthodontic treatment need in London schoolchildren. *BMC Oral Health* 2005;5:8.
  46. Mugonzibwa EA, Kuijpers-Jagtman AM, Van 't Hof MA, Kikwilu EN. Perceptions of dental attractiveness and orthodontic treatment need among Tanzanian children. *Am J Orthod Dentofacial Orthop* 2004;125:426-33.
  47. Puertes-Fernández N, Montiel-Company JM, Almerich-Silla JM, Manzanera D. Orthodontic treatment need in a 12-year-old population in the Western Sahara. *Eur J Orthod* 2011;33:377-80.
  48. van Wyk PJ, Drummond RJ. Orthodontic status and treatment need of 12-year-old children in South Africa using the dental aesthetic index. *SADJ* 2005;60:334-6, 338.
  49. Josefsson E, Bjerklin K, Lindsten R. Malocclusion frequency in swedish and immigrant adolescents – Influence of origin on orthodontic treatment need. *Eur J Orthod* 2007;29:79-87.
  50. Otuayemi OD, Noar JH. A comparison between DAI and SCAN in estimating orthodontic treatment need. *Int Dent J* 1996;46:35-40.
  51. Shue-Te Yeh M, Koochek AR, Vlaskalic V, Boyd R, Richmond S. The relationship of 2 professional occlusal indexes with patients' perceptions of aesthetics, function, speech, and orthodontic treatment need. *Am J Orthod Dentofacial Orthop* 2000;118:421-8.