PROFESSIONAL TREATMENT 

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

INTRODUCTION

Malocclusion is a common health problem and can affect the psychosocial well-being in the long term.[1] Prevention and treatment of this developmental disorder need a rational planning of oral health aiming at orthodontic cares,[2,3] and comprehensive data about malocclusion such as prevalence are necessary in this regard. Assessment of malocclusion in a community can show only the...
prevalence of different degrees of deviation from normal occlusion, 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. Therefore, evaluation of orthodontic treatment need by indices seems to be necessary. Among several indices developed for this purpose, the index of orthodontic treatment need (IOTN) and dental aesthetic index (DAI) 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. 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.

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. Borzabadi-Farahani et al. showed 36% of adolescents in Isfahan needed orthodontic treatment. Another study conducted by Oshagh et al. in Shiraz using DAI showed that 20.4% of 1818 adolescents had high orthodontic treatment need. Furthermore, Eslamipour et al. reported 20% orthodontic treatment need among 728 adolescents in Isfahan using DAI.

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
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.\cite{13} 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 $I^2$ 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.\cite{14} 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.\cite{15} $P < 0.05$ 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 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                                      |
| 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? |

Score: Yes=1  No=0
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 | DHC 1, 2 (no need) | DHC 3 (borderline need) | DHC 4, 5 (definite need) | AC 1-4 (no need) | AC 5-7 (borderline need) | AC 8-10 (definite need) | Modified STROBE score |
|-------------------------------|------------------|------|-----------------------------|-----------|------|--------|--------------------|--------------------------|--------------------------|-----------------|------------------------|------------------------|----------------------|
| Biria et al.[16]              | 2005             | 12-13| 2                           | 793       | 396  | 397    | 66.71             | 16.89                    | 16.4                     | 71.9           | 20.9                   | 7.2                    | 11                   |
| Fayaz monfared and Hamze[17]  | 2007             | Guidance school children   | 4          | 748       | 329  | 419    | 67.11             | 18.72                    | 14.17                    | NR             | NR                     | NR                     | 12                   |
| Hedayat et al.[18]            | 2007             | 11-14| 3                           | 1965      | 1190 | 775    | 55.78             | 25.8                     | 18.42                    | 91.95          | 3.92                   | 4.13                   | 12                   |
| Feizbakhsh et al.[19]         | 2011             | 14-18| 1                           | 370       | 0    | 370    | 51.8              | 23.88                    | 24.32                    | 98.9           | 1.1                    | 0                      | 12                   |
| Feyzabakhsh et al.[20]        | 2013             | 14-18| 1                           | 408       | 408  | 0      | 56.9              | 22.5                     | 20.6                     | 76.47          | 15.2                   | 8.33                   | 11                   |
| Omid khod et al.[21]          | 2009             | 14-18| 3                           | 1818      | 965  | 853    | 59.96             | 28.38                    | 11.66                    | 98.5           | 1.8                    | 1.7                    | 12                   |
| Safavi et al.[22]             | 2009             | 14-16| 2                           | 4888      | NR   | NR     | 56.71             | 22.85                    | 20.44                    | NR             | NR                     | NR                     | 12                   |
| Asgari et al.[23]             | 2012             | 13-18| 1                           | 568       | NR   | NR     | 53.5              | 29.8                     | 16.7                     | 90.04          | 7.83                   | 2.13                   | 12                   |
| Hossein Nik et al.[24]        | 2011             | 12   | 3                           | 417       | NR   | NR     | 22.3              | 29.5                     | 48.2                     | 77.9           | 14.4                   | 7.7                    | 12                   |
| Nik et al.[25]                | 2007             | 17   | 3                           | 427       | 211  | 216    | 18.7              | 35.6                     | 45.7                     | 79.8           | 16.9                   | 3.3                    | 12                   |
| Oshag et al.[26]              | 2011             | 18-22| 3                           | 240       | NR   | NR     | 46.2              | 27.5                     | 26.3                     | 93.1           | 5.6                    | 1.3                    | 11                   |
| Eslampour et al.[27]          | 2011             | 14-17| 1                           | 963       | 262  | 701    | 36.66             | 28.87                    | 34.47                    | 60.1           | 29.8                   | 10.1                   | 12                   |
| Shahri[28]                    | 2011             | 11-14| 4                           | 395       | 198  | 197    | 46.5              | 17                       | 36.5                     | 77.2           | 16.2                   | 6.6                    | 12                   |
| Marzai Moghadam et al.[29]    | 2011             | 11-14| 5                           | 721       | 361  | 360    | 48.7              | 25.1                     | 26.2                     | 88.1           | 7.7                    | 4.2                    | 12                   |
| Jamil et al.[30]              | 2010             | 14-18| 2                           | 350       | 0    | 350    | 52                | 35.4                     | 12.6                     | NR             | NR                     | NR                     | 12                   |
| Borzabadi-Farahani et al.[31] | 2012             | 11-20| 1                           | 728       | 388  | 340    | NR                | NR                       | NR                       | NR             | NR                     | 29.4                   | 10.85                |
| Borzabadi-Farahani et al.[32] | 2010             | 11-14| 1                           | 496       | 244  | 252    | 43.75             | 20.16                    | 36.09                    | 46             | 36.1                   | 17.9                   | 12                   |
| Eslampour et al.[33]          | 2011             | 12-19| 1                           | 508       | 288  | 220    | NR                | NR                       | NR                       | NR             | 91.73                  | 6.69                   | 1.58                 |
| Eslampour et al.[34]          | 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
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Figure 1: Flowchart of study selection.

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 et al.[23]     | 2007 | 12-15             | 3      | 900       | 450  | 450    | 70.1                | 17.8                        | 7.9                      | 4.2                  | 12                   |
| Khanehmasjedi et al.[24] | 2007 | 11-14             | 3      | 900       | 450  | 450    | 70.8                | 19.2                        | 7.8                      | 2.2                  | 11                   |
| Koochmesghi et al.[25] | 2007 | 12                | 2      | 600       | 314  | 286    | 66.4                | 18.3                        | 8.3                      | 7                    | 12                   |
| Oshagh et al.[27]     | 2008 | 14-18             | 3      | 1818      | 965  | 853    | 48.3                | 31.3                        | 12.3                    | 8.1                  | 11                   |
| Borzabadi-Farahani et al.[28] | 2012 | 11-20             | 1      | 728       | 388  | 340    | 54.5                | 23.6                        | 11                      | 10.9                 | 12                   |
| Danaei et al.[29]     | 2015 | 11-14             | 3      | 240       | NR   | NR     | 73.7                | 15.2                        | 4.4                      | 6.7                  | 12                   |
| Eslamipour et al.[31] | 2011 | 12-19             | 1      | 728       | 382  | 346    | 54.5                | 19.5                        | 15.1                    | 10.9                 | 12                   |

DAI: Dental aesthetic index; NR: Not reported

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 analyses). 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[37] and Malaysia[38] 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%[39] in Brazil,[40,41] 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%)[42] Serbia (27.4%)[43] 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).
Spain (21.8%). Studies conducted on the prevalence of orthodontic treatment need according to AC-IOTN showed self-perceived need of 2% in London, 7.1% in Brazil and 4.4% in Spain, which were similar to the prevalence rate in Iran (4.8%). However, the prevalence rates of Eastern Asian countries such as Malaysia (22.8%) and Africa (more than 10%) 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.[50,51] In their study in Iran, Borzabadi-Farahani et al.[30] 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

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

| Variables | Total Prevalence (95% CI) | Heterogeneity |
|-----------|---------------------------|---------------|
|           |                           | Q  | I (%) |
| 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 (%) |
| 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

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