

## Comparing orthodontic treatment need indexes

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### Abstract

**Background:** Orthodontic Treatment Need Indexes are investigated to evaluate their validity criteria and their formulation on a scientific basis.

**Methods:** A bibliographic research was performed on Medline Database to find articles about orthodontic treatment need indexes published from 1960 to 2007. English language papers about criteria to establish indexes, their validity and reproducibility, and comparing two or more indexes were chosen.

**Results:** The study shows that orthodontic treatment need indexes are not based on evidence but are all based on the opinion of experts, although widely shared by the orthodontic community since the use of these indexes in clinical practice. The validity is assessed in terms of objectivity of the measurements needed to evaluate the clinical severity of the case under consideration. In this case, the quantitative methods seem to be more reliable and objective than the qualitative.

**Conclusions:** Currently in the orthodontic field the theory that orthodontic therapy is useful to prevent any disease in the patients is not supported by evidence based medicine. The recommendations about orthodontic treatment need should come from scientific debates, in order to support consensus based decisions.

**Key words:** orthodontic treatment need index, risk of malocclusion, occlusal index, validity

### Introduction

The use of orthodontic treatment need indexes is currently universally accepted and wide spread in Europe and in USA.

They are used for screening and epidemiological studies, in order to identify treatments that need to be prioritised in health structures where the number of requests are high, in particular in countries where costs of therapies are totally or partially covered by the Health Care System or by Private Insurance Companies [1].

Since the 60's several organizations, governmental or non-governmental, have promoted and financed projects for the elaboration of methods to evaluate the need for orthodontic treatment.

As a matter of fact, in order to face the increasing demand, it was important to correctly allocate funds for the health services system for the organization of health care services, this highlighted the problem of third party financing (States or Insurances).

The refund of therapies is justified if it's established that treatment of the malocclusion prevents subsequent development of physical or psychological problems.

Several indexes have been realized - Handicapping Labolinguial Deviation Index (HLDI), Treatment Priority Index (TPI), Handicapping Malocclusion Assessment Record (HMAR), Occlusal Index (OI) and the Dental Aesthetic Index (DAI) - to measure how much the occlusion has deviated from normality, because if deviation is higher, the risk of a subsequent damage is higher too. Furthermore, the Grade Index Scale for Assessment Treatment Need (GISATN) and Index of Orthodontic Treatment Need (IOTN) have a grading based on type and severity of the malocclusion.

However, these indexes don't describe the specific risks that can occur for each type of occlusion.

Only the Danish Index from 1990 describes possible damages and problems coming from

untreated malocclusion thus allowing for the identification of subjects needing treatment. It is a descriptive index that is more valid from a biological point of view, because the stomatognathic system is dynamic and evolving, a classification with scores could therefore be highly restrictive [2]. For the economic use of these indexes, attention is focused on the orthodontic problems of teenagers who have a permanent dentition. This is because in order to obtain the refund from the US Medicaid or other insurance companies, recipients must be under legal age. There is also a limit of the duration of insurance coverage, which is often used during the most expensive phase undertaken in late adolescence when fixed appliances are used. Rarely do insurance companies provide reimbursement for longer treatments, such as two phases treatments. Probably this is the reason why when using the indexes the number of patients needing orthodontic treatment is almost halved [3, 4].

US authors also define the limits of this system, because there is agreement regarding the fact that therapies performed in younger age can prevent conditions from becoming worse as they get older and can simplify the phase of the final therapy, even if the validity of the therapy in two phases is not verified.

In Italy public orthodontic care doesn't exist, not even for the most severe disease, such as gross malformations, and private insurance companies use arbitrary parameters to quantify refunds. So it is necessary to evaluate the most effective therapeutic tier for the patient to optimize care in public structures and to propose evaluation parameters for insurance transactions. It was for this reason that the Risk of Malocclusion Assessment (ROMA) index was created. It can be applied to children in mixed dentition phases and furthermore it is useful to evaluate the need for interventions and the risk of malocclusions worsening if they remain untreated [5].

The aim of the study was to evaluate the validity criteria (internal and external) and the conditions of orthodontic treatment need indexes, using a bibliographic literature search (1960-2007).

## Methods

A bibliographic search was performed on Medline and Scopus Databases in order to locate articles about orthodontic treatment need indexes published from 1960 to 2007. English language papers concerning the criteria used to establish the indexes, their validity and reproducibility, as well as the comparison of two or more indexes were chosen (comparative studies,

consensus development conferences, research support, reviews and validation studies).

The following keywords were used: "occlusal index", "treatment need", "malocclusion" e "orthodontics", and were combined using the following algorithm:

"occlusal index"[All Fields] OR index[all fields] OR "treatment need"[All Fields] AND ("malocclusion"[MeSH Terms] OR malocclusion[Text Word]) AND ("orthodontics"[MeSH Terms] OR orthodontics[Text Word] OR orthodont\*).

669 articles were located from this string using Medline, from which 57 articles were chosen after reading the title and 25 by reading the abstract. Using Scopus we found 230 articles and among these we chose 19, already included in the results of Medline. 150 articles were obtained using the Embase database. One article was chosen after reading the title, but it was not selected after reading the abstract.

There were no articles from Randomized Clinical Trial or a Metanalyses. The bibliography of each article was also considered.

## Results

### Evaluation of the indexes

The requirements of an index are outlined by the World Health Organization [6] (table 1). It's important that the index is reproducible. It also has to measure what it is meant to measure (internal validity) and taking into consideration the development of the dental occlusion, so that it can be applied in childhood and adolescence.

Since 1960, *different treatment need indexes* have been developed. They can be classified into qualitative and quantitative indexes, depending on the type of description used (table 2).

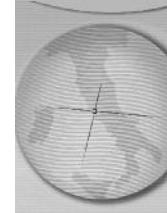
Indexes based on qualitative methods use descriptions to define the scale of treatment need (for example: extreme, marked, extensive, and so on) and as such they can be used in an arbitrary way, which may bring a high risk of bias (methodological mistake).

The correct application of these indexes depends on the capability and the experience of the operator.

Indexes based on quantitative methods allow for the measurement of some established occlusal features and for the assignment of a score or a grade of intervention need that is realized by adding the scores and/or the most severe characteristics.

The result, in this case, doesn't depend on the ability of the operator, in particular if the operator who recollects data has been "calibrated".

Regardless, in many cases, the clinical signs of malocclusion have been chosen arbitrarily, on the strength of indication of expert orthodontists or epidemiological data available.



In this work validity and scientific postulates of the orthodontic treatment need indexes are assessed.

### Validity

In order to evaluate an index it is important to consider its reproducibility, that is the capability to have the same result if one or more operators use it for the same clinical case in the same or in different moments [7].

It must be valid, to measure what it really has to measure and it must be valid over time, to take into account the development of dental occlusion during childhood and adolescence. Above all it must be close to the truth, avoiding the introduction of bias and distortion of the

measurements. Therefore, the index even though it may be reproducible, could still introduce bias [8].

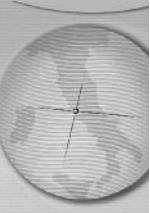
As already demonstrated, indexes based on qualitative methods have a high risk of bias, because they use descriptive terms to define the scale of treatment need. The right use depends on the ability and experience of the operator. So quantitative methods are more reliable, even if the clinical signs are chosen arbitrarily. In these cases the influence of the operator is high too [9]. Using DAI, for example, the decision to intervene in patients with borderline scores depends only on the subjective clinical opinion of the orthodontist. HLDI identifies only the most severe cases, instead for the others the subjective clinical opinion of the

**Table 1. Requirements of an ideal index (WHO).**

1	Classification is expressed by a finite scale with definite upper and lower limits; running by progressive gradation from zero (absence of disease), to the ultimate point (disease in its terminal stage).
2	The index should be equally sensitive throughout the scale.
3	The score should correspond closely with the clinical importance of the disease stage it represents.
4	Index value should be amendable to statistical analysis.
5	The classification must be reproducible.
6	The index should also be simple, accurate and yield itself to modification for the collection of data.
7	The examination procedure should require a minimum of judgement.
8	The index should be simple enough to permit the study of a large population without undue cost in time or energy
9	The examination required should be performed quickly, to evidence a group variation.
10	The index should be valid during time.

**Table 2. Orthodontic treatment need indexes.**

INDEX	AUTHOR	YEAR	METHOD
Handicapping Labiolingual Deviation Index (HLDI)	Draker HL	1960	quantitative
Grade Index Scale For Assessment of Treatment Need (GISATN)	Salonen L, Mohlin B, Gotzlinger B	1966	qualitative
Dental Aesthetic Index (DAI)	Cons NC, Jenny J	1966	quantitative
Treatment Priority Index (TPI)	Grainger RM	1967	quantitative
Handicapping Malocclusion Assessment Record (HMAR)	Salzmann JA	1968	quantitative
Occlusal index (OI)	Summers CJ	1971	quantitative
Eismann index	Eismann D.	1974	quantitative
Index of Orthodontic Treatment Need (IOTN)	Brook PH, Shaw WC	1989	quantitative
Risk of Malocclusion Assessment Index (ROMA index)	Grippoaldo C, Russo E, Marchionni P, Deli R,	1998	quantitative
Memorandum of Orthodontic Screening and Indications for Orthodontic Treatment	Danish National Board of Health	1990	qualitative
Need for Orthodontic Treatment Index (NOTI)	Espeland LV, Ivarson K, Stenvik	1992	quantitative



orthodontist [10] is considered very important, so the treatment need determination closely depends on the constitutive criteria of each index [11].

Several studies compare HMAR, OI and TPI and it arose that OI have less bias than the others [12] and it's validity across time [13], even if they are all reproducible. For Tang and Wei, both TPI and OI indexes need the subjective opinion of the operator to quantify the dental rotation and the molar relationship.

OI is less reliable to determine treatment need in case of deciduous dentition, it's difficult to use and not very quick to obtain data and compute the final score than HMAR [14].

Moreover, minimal mistakes and millimetric failings in the survey of the measurement could compromise reliability and the truth of the final score. DAI, compared with HMAR and OI, is easy and simple to apply [15].

However, for Tang and Wei, it's better to use the OI index, because it includes measurements that relate more to clinical practice in order to incorporate less bias, and it's adaptable to the several situations that come out during the development of the occlusion. Comparative studies with HLD, DAI and IONT have demonstrated there is no concordance between indexes cut-off and the specialist's opinion, because the first are too rigid [16] and don't reflect the difference of the severity of malocclusion in the different clinical situations [17]; moreover, even if when using IONT and DAI the same results are obtained, applied to the same sample, about subjects needing treatment [18]; DAI, unlike Brook and Shaw index, allows for underclassification by severity in the same levels of treatment need [19].

Nonetheless, it seems that this index undervalues treatment need in cases with overbite or overcrowding and overvalue it in cases with excessive overjet [20].

For the most recent indexes the items have been chosen more accurately and in a systematic way, to avoid possible bias. Among these, one of the most used is IONT, with its two components: the Dental Health Component (DHC) and the Aesthetic Component (AC). DHC is highly reproducible, more so than the largely used Angle classification [21], it is valid, allows for quick application and easy use, as So and Tang could verify it comparing it with the OI index [22].

However Richmond and Daniels objected that it could be considered to be an invalid index in other countries because it was validated only by a panel of UK experts. This is the reason why the Index of Complexity Outcome and Need (ICON) was

assessed by experts from different European and North American States and so it was considered to be a valid index when determining *orthodontic treatment need* [23].

Fox and coll. observed that ICON can substitute IONT both Peer Assessment Rating (PAR) indexes, it's used to evaluate results after treatment, and it is more rigorous than the others for the evaluation of therapy results [24].

For Savastano this is a valid index used to determine the complexity of the case and their outcome [25]. For Onyeaso DAI e ICON can be highly related [26].

Several indexes have a common issue: they have been realized to evaluate permanent dentition. Only the OI index has different scores for deciduous, mixed and permanent dentition but it doesn't describe items related to skeletal and functional issues.

ICON instead is used only for delayed mixed and permanent dentition.

To evaluate the treatment need in children with precocious or deciduous mixed dentition the ROMA index was proposed. This index is used to individuate not only *orthodontic treatment need* for children in growth age but also intervention time and treatment costs in the strength of the severity of the score.

To verify the validity it was tested on a sample of Italian children using cross sectional and longitudinal epidemiological studies [27, 28]. Cross sectional studies analyze descriptive qualities of the attribution of the orthodontic risk, instead of longitudinal studies that evaluate ability to evidence the right timing for orthodontic intervention.

### **Scientific Assumptions**

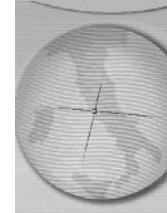
Evidence based searches to support the assumptions about the possible damage caused by malocclusion are lacking in all the indexes.

Brook and Shaw wanted to make more objective criteria to establish *orthodontic treatment need*.

An efficacious way to identify subjects taking advantage of the therapy is to individuate occlusion disease that have negative effects on oral health and also aesthetic features causing psychosocial problems.

Three consecutive studies evaluate the cost/benefit ratio of orthodontic treatment [29], in which all the factors influencing treatment request of the patient are considered [30] and propose IONT describing validation criteria basing on international standards [31].

Among orthodontic treatment benefits there is



the possibility to reduce risk of periodontal or carious diseases and incidence of dental injuries caused by increased overjet, but there is not evidence to support this [32, 33].

Among the risks there is the possibility of damage during the therapy, increased predisposition to dental diseases during the treatment, failure of the therapy and relapse. This is also not supported by evidence.

Common opinion is that orthodontic treatment can improve psychosocial wellness if craniofacial and dental diseases have caused any aesthetic handicap.

In fact in the majority of the cases therapy is used to improve the social impact about aesthetics and to increase self-esteem. However, evidence based medicine doesn't support this thesis.

## Discussion

*Orthodontic treatment need* indexes have been introduced to individualize risk subjects, that are subjects needing therapy more than others, on the strength of the determination of the possible damage that malocclusion could give to the patient. These indexes are largely used even if evidence demonstrating cause-effect relationship between malocclusion and damage of stomatognathic system are missing and also for craniofacial growth and conservative dentistry, periodontology or pathology of temporomandibular joints.

Considering this point of view, *orthodontic treatment need* indexes could appear to be arbitrary, based on largely diffused opinion but not yet verified.

The most recent indexes, like the ICON, are based on the concurring opinion of a panel of experts and they are considered clinically valid and used for screenings, epidemiological studies, to organize work into structures with high requests for intervention particularly when it is possible to obtain partial or total refund of treatment costs.

In terms of diffusion, the latest indexes, such as IOTN or ICON, are the most used, as several publications show.

Indexes realized to evaluate problems in early age are less used. The reason could be that cares for permanent dentition are the most expensive and the insurances prefer to value *orthodontic treatment need* in teenagers. So in the Countries where orthodontic treatments are refunded by insurance companies, it is necessary to use an appropriate index for market demand.

In Italy there is a very high degree of treatment

requests for children of primary school age, therefore the ROMA index is the most appropriate.

It is possible to use it to regulate the waiting lists of the public healthcare institutions and as a guide for economic evaluations of orthodontic treatment by Italian welfare institutions.

Moreover, orthodontic treatments are considered valid and necessary even if evidence is lacking in orthodontics, but remembering that this is still a rather young discipline.

Often the opinion of the experts can anticipate evidence based medicine when in clinical research ethical issues arise, because the treatment requirement of the patient must be always satisfied, although therapies are based on not very objective scientific evidence [34].

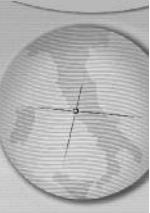
If evidence is lacking, research about *orthodontic treatment need* must be continued considering population demand, satisfaction, technological update of the corrective instruments and experience.

## Conclusions

Currently in the field of orthodontics theories that consider orthodontic therapy useful to prevent any disease in the patients is not supported by evidence based medicine. The recommendations about *orthodontic treatment need* should come from discussions held within the scientific community, in order to find consensus while waiting for evidence.

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