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Prevalence and factors related to malocclusion and orthodontic treatment need in children and adolescents in Italy

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Background: The purpose of this study was to determine prevalence of malocclusions, normative and perceived orthodontic treatment need and related risk factors in schoolchildren in Italy. **Design**: A random sample of 1000 11–15 years old children was selected from randomly selected schools in Catanzaro (Italy). Parents completed a questionnaire on sociodemographic, orthodontic history and perception of their child orthodontic treatment need. Children were interviewed on utilization of dental services, perception of orthodontic treatment need and use of orthodontic devices. The Decayed, Missing, Filled Teeth (DMFT) index and the Dental Health Component (DHC) of the Index of Orthodontic Treatment Need (IOTN) were assessed. The Aesthetic Component (AC) of IOTN was assessed by parents, children and dentist. **Results**: A total of 546 children participated in the study. Three hundred and twenty-five subjects (59.5%) were assigned a 4 or 5 IOTN score, thus requiring orthodontic treatment. Definite treatment need (AC score 8–10) was reported for 8.6% of subjects by the orthodontist, 5.4% by parents and 3.2% by children. Higher DMFT significantly predicted orthodontic treatment need according to IOTN. Perceived orthodontic treatment need was significantly predicted by orthodontic treatment need for crowding/spacing and overjet. **Conclusion**: A high proportion of children needs normative orthodontic treatment and perceptions of orthodontic treatment do not overlap with normative need.

Keywords: adolescents, IOTN, Italy, malocclusion, orthodontic treatment

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Introduction

In recent years, much attention has been focused on measuring the severity and prevalence of malocclusion and orthodontic treatment need worldwide. In particular, the aetiological importance of genetic factors has been reduced, considering that many malocclusions recognize a post-natal origin, related to non-nutritive or nutritive sucking habits at early stages of life and traumas.[1–5] Moreover, the expanded opportunities in orthodontic treatment demand more careful individual evaluation of treatment needs and standardized criteria for their assessment. Indeed, it has been reported that a significant number of children are inappropriately referred for orthodontic treatment, underlying the necessity of objective or normative assessment of orthodontic treatment by the use of an index.[6]

In Italy, in the last decades, several studies have been undertaken to document the oral health status in children and adolescents[7,8] and in special groups.[9–12] Very few studies have been conducted to assess prevalence of malocclusion and orthodontic treatment need and a prevalence of malocclusion of 32.2%, using the Angle classification, in 5–8 years old children has been reported,[13] whereas in a more recent study a value of 93% was reported in 11–14 years old children, using the NHANES III criteria.[14] Studies on orthodontic treatment needs carried out in several countries on subjects of different ages, reported extremely heterogeneous values, ranging from

15% in 12–14 years old in England[15] to 71% in 15 years old in Jordan[16] (table 1).

Interest to orthodontic treatment has increased in recent years, as a consequence of patients' expectations as regards to oral impact on quality of life and treatment opportunities. Moreover, the importance of oral health related quality of life is particularly relevant for children and adolescents, since younger subjects are more sensitive to a variety of impacts, such as appearance, that may affect their current quality of life and psychological development and ultimately result in influencing their social skills and education. Chen and Hunter[17] found that psychological impacts of oral health, such as avoiding laughing and being teased about teeth, were more prevalent in children than in adults and elderly.

Therefore, the purposes of this study were to determine the prevalence of normative [i.e. assessed by Index of Orthodontic Treatment Need (IOTN)] and perceived orthodontic treatment need and to analyse whether factors related to normative orthodontic treatment need were similar to those related to perception in a population of schoolchildren in Italy.

Material and methods

The study took place from April to November 2003. A two-stage cluster sample was selected. Seven schools were randomly selected among all junior-high schools in Catanzaro (Italy) and a random sample of 1000 children aged 11–15 years old attending these schools was selected. Parents of sampled children were notified about purposes of the study and invited to participate. All parents who provided informed written consent completed a questionnaire related to sociodemographic details (sex, age, employment status, education level) and on the following factors: dental and orthodontic history, as well as factors related to malocclusions [occurrence and duration of breastfeeding, non-nutritive sucking habits (fingers and pacifiers), experience of caries and/or extractions for any reason of deciduous teeth], and perception of orthodontic

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Table 1 Prevalence of malocclusions and orthodontic treatment need in various countries

Author	Country	No. of subjects	Age	Index/Classification	Prevalence of malocclusions (%)	Orthodontic treatment need (%)
Triassi et al.[13]	Italy	500	5–8	Angle	32.2	–
Ûgur et al.[22]	Turkey	571	6–10	TPI		37.8
Tickle et al.[23]	England	6067	14	IOTN		26.2
Abdullah and Rock[24]	Malaysia	5112	12–13	IOTN		47.9
Shyama et al.[3]	Kuwait	818	3–20	WHO methods	60	–
Linder-Aronson et al.[25]	Sweden	1281	8–16	TPIm		23.8–28.9
Abu Alhaija et al.[26]	Jordan	1002	12–14	IOTN		34
Hamdan[16]	Jordan	103	15.3 (mean)	IOTN		71
Mugonzibwa et al.[27]	Tanzania	386	9–18	IOTN		22
Tausche et al.[28]	Germany	1975	6–8	IOTN		26.2
Alkhatib et al.[15]	England	3500	12–14	IOTN		15
Ciuffolo et al.[14]	Italy	810	11–14	NHANES III criteria	93	–

IOTN: Index of Orthodontic Treatment Need; TPI: Treatment Priority Index; TPIm: Treatment Priority Index (modified).

treatment need for their children. Parents also assessed the Aesthetic Component (AC) of the IOTN of their children.[18] Parents were sent 10 photographs in the AC range and detailed written instruction were given to identify the dental appearance that mostly resembled that of their child.

Before the dental examination, trained and standardized personnel interviewed all children on utilization of dental services and perception of orthodontic treatment need. The questions on the use of dental services included whether the child had ever had a dental visit and time since last visit. Information on use of orthodontic devices and perception of orthodontic treatment need was asked, and the AC of IOTN index was also administered to children, as described for parents. Since our study was aimed at estimating prevalence of malocclusions and related treatment needs, children wearing orthodontic devices were included in the descriptive analysis.

The examinations were conducted at school, by one trained and calibrated dentist with the subject seated on a chair using portable equipment, using mirror, probe and ruler; no radiographs were taken. The Decayed, Missing, Filled Teeth (DMFT) index was used to record caries experience.[19] Also calculated were the Dental Health Component (DHC) and the AC of IOTN,[18] and the Angle classification of malocclusions.[20] The DHC of the IOTN has five categories classifying progressively increasing severity of malocclusions and indicating the relative need of orthodontic treatment (Grade 1: no treatment required, Grade 2: little need, Grade 3: borderline need, Grade 4: treatment required, Grade 5: great need of treatment). Within each category the different malocclusions are included (overjet, overbite, crossbite, open bite, displacement, etc.) according to their severity. The most severe occlusal trait is identified by the examiner for any particular patient and the patient is then categorized according to this most severe trait, with a score ranging therefore from 1 to 5.[18]

Validation of the questionnaire to reveal major difficulties and weaknesses was performed through a pilot study, surveying a convenience sample of children and parents.

Statistical analysis

The data were analysed using the Stata software program.[21]

Examiner reliability was checked in the pilot study through intra-examiner replicate examinations for 50 subjects at a time interval of 20 days and evaluated by the kappa score. Reproducibility of the AC score was recorded also for the evaluation of a group of 20 children and 20 parents through the kappa score.

Three models were developed using stepwise multiple logistic regression analyses to identify, in children who did not use orthodontic appliances and, therefore, those who already wore orthodontic devices were not included, the variables that affect the following outcomes: overall orthodontic treatment need according to IOTN (IOTN 4–5) (Model 1), orthodontic treatment need perceived by parents (Model 2) and by children (Model 3). The following variables were included in all models: age (continuous); gender (0 = male; 1 = female); highest education level of father (0 = none; 1 = elementary school; 2 = junior high school; 3 = high school; 4 = university); breastfeeding (0 = no; 1 = <6 months; 2 = 6–12 months; 3 = >12 months); non-nutritive sucking habits (0 = never; 1 = 1–12 months; 2 = 13–24 months; 3 = 25–36 months; 4 = 37–48 months; 5 = >48 months); reported caries in deciduous teeth (0 = no; 1 = yes); reported extractions of deciduous teeth (0 = no; 1 = yes), and DMFT index (continuous). In models 2 and 3 the following variables were also included: orthodontic treatment need for overjet (0 = no; 1 = yes); crowding/spacing (0 = no; 1 = yes), and crossbite (0 = no; 1 = yes). Adjusted odds ratio (OR) and 95% confidence intervals (CI) were calculated.

Results

A total of 546 subjects participated in the study, with a response rate of 54.6%. The main sociodemographics and dental characteristics of the study population are reported in table 2. About one third and 15%, respectively, had at least one dental caries and one extraction in the deciduous teeth, 22.7% were caries free in the permanent dentition, 60.6% had visited a dentist in the previous year, and 15.9% already used orthodontic devices.

Table 3 presents the distribution of IOTN in the study population. Only 18.9% had no need of treatment, and more than half (59.5%) were assigned a 4 or 5 IOTN DHC score, thus requiring orthodontic treatment. The normative orthodontic treatment need, disaggregated according to age, was 56.2% in 11 years, 60.1% in 12–13 years and 56.5% in 14–15 years old children. If we exclude those who already wore orthodontic devices (15.9%), at least 43.6% of children had unmet dental health care need. This proportion was almost evenly spread across ages, ranging from 40.3% in preadolescents to 41.2% in adolescents and 44.4% in early adolescents. Orthodontic treatment need as perceived by parents attained to only 37.7% of those with a high IOTN score (4 or 5) and to 16% of those with a value lower than 4, whereas the need perceived by children was 40.3% and 22%, respectively.

Scores for the AC of IOTN as perceived by the dentist, child and parent are shown in table 4. Definite treatment need (AC score 8–10) was reported for 8.6% of subjects by the dentist, 5.4% by parents and 3.2% by children, whereas most of the subjects were considered to have no need of orthodontic treatment (AC score 1–4) and particularly 77.8% by dentist, 89% by parents and 91.5% by children.

Dental health status was significantly related to orthodontic treatment need, since children with a higher DMFT were

Table 2 Selected characteristics of the study population

Variables	N*	%	Mean ± SD
Sex			
Male	273	50.3	
Female	270	49.7	
Age			12.3 ± 1.1
Breastfeeding			
No	96	17.9	
Yes	469	82.1	
Non-nutritive sucking habits			
No	238	55.1	
Yes	194	44.9	
Caries in deciduous teeth			
No	345	65.1	
Yes	185	34.9	
Extractions of deciduous teeth			
No	447	84.7	
Yes	81	15.3	
Orthodontic devices need according to parents			
No	292	60.2	
Yes	116	23.9	
Using	77	15.9	
Orthodontic devices need according to children			
No	307	57.4	
Yes	151	28.2	
Using	77	14.4	

*The numbers that do not add to 546 are due to missing values.

Table 3 Distribution of IOTN DHC grades in the study population

	N	%	Treatment need	%
DHC				
IOTN = 5			123	22.5
IOTN = 4			202	37
IOTN = 3	118	21.6		
IOTN = 1–2	103	18.9		

Table 4 Assessment of IOTN AC grades by dentist, child and parent

AC Grade	Dentist		Child		Parent		Need for Treatment
	n	%	n	%	n	%	
1–4	400	77.8	491	91.5	364	89	No need
5–7	70	13.6	29	5.4	23	5.6	Borderline
8–10	44	8.6	17	3.2	22	5.4	Definite
Total	514	100	537	100	409	100	

significantly more likely to need orthodontic treatment according to the IOTN DHC (OR = 1.16; 95% CI = 1.04–1.29) (Model 1 in table 5). Orthodontic treatment need as perceived by parents and by children was significantly predicted by treatment need for crowding/spacing (OR = 3.37; 95% CI = 1.98–5.73; OR = 1.9; 95% CI = 1.16–3.12) and overjet (OR = 2.24; 95% CI = 1.28–3.91; OR = 2.51; 95% CI = 1.53–4.13) as measured by IOTN (Models 2 and 3 in table 5).

High kappa scores (>0.7) showed satisfactory reliability for the dentist (DHC and AC scores), the parents and the children (AC score).

Discussion

The primary goal of this survey was to detect prevalence of malocclusions needing orthodontic treatment in the population of children and adolescents in Southern Italy and the orthodontic treatment need as perceived by parents and children.

Several studies have already been published to describe the prevalence and types of malocclusions in different populations.[3,13–16,22–28] Comparisons of these findings must be done cautiously, because different methods and indices were used in varying age of populations. Several of these indices have been developed for the assessment of orthodontic treatment need and contain both orthodontic and aesthetic components. One of the most widely used is the IOTN, which categorizes patients' malocclusions in grades according to severity, with Grade 3 or below meaning borderline or no need of orthodontic treatment, whereas a Grade 4 or 5 indicates need for treatment.[18] However, to the best of our knowledge, this is the first study applying the IOTN to assess orthodontic treatment need in Italy. We found a high prevalence of malocclusions (59.5%) which requires orthodontic treatment, and since only 15.9% of subjects were already wearing orthodontic device, that means that at least 43.6% of children had unmet dental health care need. We also found that this proportion was almost evenly spread across ages, and this represent a public health concern because although the 11 year olds may not yet be ready for treatment, this is not the case of the 14–15 years old. It should be pointed out, however, that the lack of close correlation between chronological age, dental development and skeletal maturation makes assessments of unmet orthodontic need difficult.

A number of studies conducted on the same target population and using the IOTN index yielded varying results, most of which reported lower prevalence of orthodontic treatment need compared with ours. Indeed, our prevalence (59.5%) was higher than that in 6067 14 years old children in England, ranging from 26.2% to 36.6% in deprived children,[23] that of 34% revealed by a study conducted on 1002 12–14 years old Jordanian schoolchildren,[26] and of 15% in a study conducted in England on a sample of 3500 subjects 12–14 years old.[15] A value similar to ours was found in 5112 Malaysian 12–13 years old children (47.9%),[24] whereas it was lower than the 71% in Jordanian subjects with a mean age of 15 years.[16]

The results of the multivariate analysis showed that the only determinant of overall orthodontic treatment need was high DMFT score. This finding is in accordance with Tickle et al.[23] that observed higher orthodontic treatment need in deprived children associated with a higher DMFT, resulting in the early loss of deciduous teeth and subsequent drifting and crowding of teeth.

The most worrisome finding is that normative (DHC of IOTN) and perceived orthodontic treatment need did not overlap, since the simple measure of IOTN does not allow an assessment of perceived need and does not predict the demand of orthodontic care. Indeed, we found that sensitivity of perception of orthodontic treatment need was only 37.7% for parents and 40.3% for children, so if these children have no contact with dental health care services, there will be no opportunity for orthodontic treatment.

Assessment of the AC of IOTN by the dentist revealed definite orthodontic treatment need only for 8.6% of subjects and concordance between the two components of IOTN showed that 88.7% of children assigned an AC score of 8–10 by the dentist had a DHC score of 4 or 5, whereas only 12.9% of those who had a DHC score of 4 or 5 were assigned an AC score of 8–10. Discrepancies among these indices have already been reported[29] and the reliability of AC score as a measure of patient's perspective has been questioned.[30,31] Moreover, it has been argued that the assessment of the IOTN-AC score may be difficult for parents to understand, and there are not many other experiences in the literature, although it has already been used by Abdullah and Rock[29] in a study conducted to explore perceptions of orthodontists as compared with that of children

Table 5 Results of the logistic regression models

Variable	OR	SE	95% CI	*P*-value
Model 1: Orthodontic treatment need according to IOTN (IOTN 4–5)				
Log-likelihood = −233.64, chi-square = 9.54, *P* = 0.023				
DMFT	1.16	0.06	1.04–1.29	0.007
Breastfeeding	0.85	0.11	0.65–1.09	0.2
Gender	0.78	0.17	0.5–1.2	0.25
Model 2: Orthodontic treatment need perceived by parents				
Log-likelihood = −170.39, chi-square = 42.5, *P* < 0.001				
Treatment need for crowding/spacing	3.37	0.91	1.98–5.73	<0.001
Treatment need for overjet	2.24	0.64	1.28–3.91	0.004
Age	0.8	0.1	0.62–1.03	0.088
Gender	1.45	0.39	0.86–2.45	0.17
Level of education of the father	0.81	0.13	0.58–1.12	0.2
Model 3: Orthodontic treatment need perceived by children				
Log-likelihood = −207.03, chi-square = 36.78, *P* < 0.001				
Treatment need for overjet	2.51	0.64	1.53–4.13	<0.001
Treatment need for crowding/spacing	1.9	0.48	1.16–3.12	0.011
Level of education of the father	0.75	0.11	0.55–1.01	0.056
Prolonged non-nutritive sucking habits	1.17	0.11	0.97–1.4	0.096
Age	0.87	0.1	0.69–1.08	0.21
DMFT	1.06	0.06	0.95–1.19	0.28
Gender	1.29	0.31	0.8–2.06	0.29

and parents and in another study with a similar scope carried out in Jordan.[16] We agree that the assessment of IOTN-AC requires considerable effort to understand by parents but we are confident that the detailed instructions provided and the reliability estimates we performed in the pilot study gave evidence for considering our measure valid and reliable. More subjects were assigned scores by the dentist than the parents and the children in the AC 8–10 Grade, which indicates a more critical approach to dental attractiveness by the dentist and this accord with previous studies.[25,29]

Subjective perception of orthodontic treatment need was significantly associated by both parents and children to treatment need for overjet and crowding/spacing and this is not surprising since these are the most 'visible' types of malocclusions. This finding emphasizes the need to educate the population to recognise other kinds of malocclusions.

One of our aims was to identify determinants of normative and perceived orthodontic treatment need, and we found that the only determinant of normative need was dmft, whereas it was not associated to perceived orthodontic treatment. However, our findings suggest that malocclusions as assessed by IOTN are also perceived as a problem needing treatment by parents and children.

Limitations in this study must be taken into account when interpreting the results. Our participants were 11 or older and we could not calculate dmft, therefore, we recognize that the present study has a possible methodological limitation regarding the way of collecting information on the number of caries and extractions in deciduous teeth since such data were obtained from a self-administered questionnaire by the parents and may therefore be subject to recall bias. However, it is well-known that when respondents believe the assessment is being conducted for important reasons, this method is generally considered reliable for recording such information and respondents are more unlikely to erroneously report events concerning oral health of their children. Second, the study had a response rate of 54.6% and questions may arise as to non-participation bias. This may limit the validity and generalizability of the findings and this may mean that those who agreed to participate tended to be more interested to the problem of malocclusions and orthodontic treatment need, thus determining an overestimation in our sample of those with real or perceived orthodontic problems. However, we asked non-participants to provide at least some basic information on sociodemographic characteristics, since it is well-known that in many circumstances these factors may be used as proxies for assessing non-participation bias. We found no significant differences between participants and non-participants with regard to sociodemographic characteristics and we are confident that our sample is representative.

In Italy orthodontic treatment, as all oral health care, is not in charge of the National Health Care System, and, therefore, indices of normative orthodontic treatment are very useful to avoid over treatment and reveal the burden of health care need in this sector. The DHC of IOTN, used for the first time in an Italian population of children, represents a valid tool to measure prevalence and treatment need of malocclusion and its use should be encouraged.

In conclusion, our results have shown that a high proportion of children needs normative orthodontic treatment and that perceptions of orthodontic treatment do not overlap with normative need. Efforts to promote assessment of malocclusions and orthodontic treatment need are strongly needed and usefulness of IOTN should be assessed in further research.

Conflict of interest: None declared.

Key points

- Our objective was to detect prevalence of malocclusions needing orthodontic treatment in the population of children and adolescents in Southern Italy and the orthodontic treatment need as perceived by parents and children.
- This is the first report using the IOTN index in Italy.
- Dental health status was significantly related to orthodontic treatment need, since children with a higher DMFT were significantly more likely to need orthodontic treatment according to the IOTN DHC.
- Orthodontic treatment need as perceived by parents and by children was significantly predicted by treatment need for crowding/spacing and overjet as measured by IOTN.
- A high proportion of children needs normative orthodontic treatment and perceptions of orthodontic treatment do not overlap with normative need.

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