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Tesi di Dottorato

ORTHODONTIC TREATMENT NEED AND PREVALENCE OF MALOCCLUSIONS IN THE ORTHODONTIC UNIT OF "LA SAPIENZA - UNIVERSITY OF ROME"

A SIX-YEAR CLINICAL EXPERIENCE

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INDEX

INTRODUCTION

The National Health System (N.H.S.) should apply specific criteria to guarantee the orthodontic treatment to those patients having more severe malocclusions. These criteria shall not be arbitrary, but based on standardised diagnostic evaluations.

In the 1950s, Massler and Frankel were the first to propose a standardized, mensurable method of occlusal assessment.[1]

In the 1960s, other indexes have been established, including: the Occlusal Index (OI) by Summers, the Treatment Priority Index (TPI) by Grainger, and the Handicapping Malocclusion Assessment Record (HMAR) by Salzmann. [2, 3]

The characteristics of an "ideal index" are the "validity" (i.e. the ability to measure what is meant to be measured) and the "reproducibility" (i.e. the ability to reproduce the data or the original score, when they are detected again by the same examiner or by another examiner). The index should be also "easy-to-use", thus allowing gathering patients' information easily, as well as guaranteeing the possibility of rapid recordings also by non-expert examiners. (Table 1) [4, 5]

The Index of Orthodontic Treatment Need (I.O.T.N. - Brook and Shaw, 1989) grades malocclusion severity on the basis of a dental health component (DHC), and an aesthetic component (AC). [6]

Respectively, the two components describe the objective evaluation of the occlusal characteristics and the subject's aesthetic self-perception.

This study focused on the dental component (DHC), because from an analysis of the literature and from the clinical experience, an imperfect correspondence between the clinical objectivity and the patient's self-perception was detected.[7,8]

The objective of the current epidemiological survey was to assess the dental-skeletal traits of subjects attending the Public Dental Service in U.O.C. (Orthodontic Department of "La Sapienza University of Rome) and compare them with the existing body of evidence coming from other surveys. [9]

Accordingly, the Index of Orthodontic Treatment Need (I.O.T.N.) was employed, in order to achieve a common framework to allow the shaping of public health prevention practices. [10, 11]

The second purpose of this study was to identify, where present, any limitations of the I.O.T.N. in order to design an index that is as complete as possible in the future and through further analysis.

Table 1 – Malocclusion indexes from 1889 [12, 13, 14, 15]

Author	*Year*	*Index*
Angle	1889	*Molar Class*: based on the sagittal relationship between the upper and the lower first permanent molars, establishes three types of molar class (I, II, III)
Bkork, Kreb, Solow	1964	*Epidemiological method for registration of malocclusion*: the severity of the malocclusion is calculated considering dental anomalies, occlusal and space alterations, for each entry is assigned a number from 1 to 567
Summers	1966	*Occlusal Index (OI):* using 9 diffrerent clinical parameters sets out 5 degrees of severity and their need of treatment
National Swedish Board of Health	1967	*Index of Orthodontic Treatment Need*: divides malocclusion into 4 degrees of severity and their need of treatment
Howitt, Stricker, Handerson	1967	*Eastman Aesthetic Index*: consideres dental parameters particularly important for aesthetics
Ingervall and Ronnermann	1975	*Index of Orthodontic Treatment Need*: based on a morphological analysis for abnormalities and a functional analysis for occlusal disharmony
Jarvinen	1981	*Need for Orthodontic Treatment*: according to the "pathogenic potential of teething"

Cons and Jenny	1985	*Dental Aesthetic Index (DAI)* :uses aesthetic standards established based on the common opinion, have been mathematically associated with clinical and aestetic components to produce a single score that will be compared with the 4-level-scale of severity of DAI
Brooke e Shaw	1989	*Index of Orthodontic Treatment Need (IOTN)*: divides malocclusions into 5 degrees of severity and turn them into 3 priority levels of treatment; the classification consists of two elements: the dental components (DHC) and the aesthetic components (AC)
Richmond, Shaw, O'Brien, Buchanan, Jones, Stephens, Roberts, Andrews	1992	*Peer Assessment Rating (PAR)*: developed to provide a single score for all occlusal abnormalities that can be detected in a malocclusion and to assess the outcome of orthodontic treatment
Daniels and Richmond	2000	*Index of Complexity, Outcome and Need (ICON)*: it purposed to assess the need, complexity and the outcome of orthodontic therapy
Grippaudo, Paolantonio, Deli, La Torre	2007	*Risk of Malocclusion Assessment Index (ROMA)*: accurately identifies various dento-skeletal problems, determining the priority of each degree of risk and corresponding treatment timing

MATERIALS AND METHODS

The survey was conducted in the Orthodontic Department of "La Sapienza-University of Rome", analysing the IOTN-DHC components of 3491 subjects over the period 2012-2018. Visits were carried out using a probe, a small mirror, a white-light source and a meter gauge, and they were performed by three operators enrolled in the Postgraduate School of Orthodontics ("La Sapienza – University of Rome"), adequately trained and calibrated in accordance with the procedures established by the WHO.

First of all, a clinical anamnestic record was developed to collect each patient's personal data, general information, medical history (familiar, physiological, remote and proximate) and special examinations, assessment of oral hygiene and orthodontic record.

The Ethics Committee of the Policlinico "Umberto I" of Rome (Rif.3817/2015) has approved this study design in agreement with the guiding principles of the 1975 Declaration of Helsinki.

A written informed consent was requested before proceeding with clinical exam and processing of personal data. In case of underage subjects, the consent was signed by a parent or a legal guardian. Each patient was asked to bring a panoramic x-ray performed not sooner than one year.

Several occlusal and functional parameters necessary for the evaluation of oral health were detected, including:

- Deciduous/ mixed/ permanent dentition
- Molar class (right)
- Molar class (left)
- Canine class (right)
- Canine class (left)
- Overjet
- Overbite
- Crossbite
- Crowding (in the maxillary and in the mandibular arch)
- Deviation of the midlines
- Presence of decay
- Agenesis
- Supernumerary teeth
- TMJ disorders
- Oral/ nasal breathing
- Dyslalias
- Oral habits

Considering the overall evaluations of clinical parameters detailed in Table 2, it was possible to assign each subject to a different degree (from 1 to 5) of Dental Health Component (DHC) relating to the severity of malocclusion.

TABLE 2- Dental components of IOTN

IOTN	DHC
1	Extremely minor malocclusions, including displacements of less than 1 mm
2	• Increased Overjet> 3.5 mm but ≤6 mm (with competent lips) • Reverse overjet greater than 0 mm but ≤ 1mm • Anterior or posterior crossbite with ≤ 1mm discrepancy between retruded contact position and intercuspal position • Displacement of teeth > 1mm but ≤ 2mm • Anterior or posterior open bite > 1mm but ≤ 2mm • Increased overbite ≥ 3.5mm (without gingival contact)
3	• Increased overjet> 3.5 mm but ≤ 6 mm (incompetent lips) • Reverse overjet greater than 1 mm but ≤ 3.5m • Anterior or posterior crossbites with >1mm but ≤ 2mm discrepancy between the retruded contact position and intercuspal position • Displacement of teeth >2mm but ≤4mm • Lateral or anterior open bite > 2mm but ≤ 4mm • Increased and incomplete overbite without gingival or palatal trauma
4	• Increased overjet> 6mm but ≤ 9 mm • Reverse overjet> 3.5 mm with no masticatory or speech difficulties • Anterior or posterior crossbites with > 2 mm discrepancy between the retruded contact position and intercuspal position • Severe displacements of teeth > 4 • Extreme lateral or anterior open bites > 4 mm • Increased and complete overbite with gingival or palatal trauma • Less extensive hypodontia requiring pre-restorative orthodontics or orthodontic space closure to obviate the need for a prosthesis • Posterior lingual crossbite with no functional occlusal contact in one or more buccal segments • Reverse overjet> 1 mm but < 3.5 mm with recorded masticatory and speech difficulties • Partially erupted teeth, tipped and impacted against adjacent teeth • Existing supernumerary teeth
5	• Increased overjet> 9 mm • Extensive hypodontia with restorative implications (more than one tooth missing in any quadrant requiring pre-restorative orthodontics) • Impeded eruption of teeth (apart from 3rd molars) due to crowding, displacement, the presence of supernumerary teeth, retained deciduous teeth, and any pathological cause • Reverse overjet> 3.5 mm with reported masticatory and speech difficulties • Defects of cleft lip and palate • Submerged deciduous teeth

The sample was divided into 4 main groups, based on subjects' age:

- Group 1: ≤ 12 years
- Group 2: >12 ≤ 15 years
- Group 3: > 15 ≤ 18 years
- Group 4: > 18 years

Then, based on DHC grade, three levels of intervention and relative need for treatment were identified: [16, 17, 18, 19]

- Level 1: no need for treatment – including grade 1 and 2 of IOTN (mild dental malocclusions)
- Level 2: borderline need – grade 3 IOTN
- Level 3: high need for treatment – grade 4 and 5

Table 3 – Levels of intervention

LEVEL 1 No need for treatment	LEVEL 2 Borderline need	LEVEL 3 Strong need for treatment
- Normal occlusion without deviations - Mild deviation from ideal occlusion	- Functionally disturbing proclined or retroclined incisors - Deep bite without gingival contact - Moderate frontal teeth rotations - Moderate reduction or increase of overjet/overbite	- Deep bite with gingival irritation and occlusal trauma - Severe frontal crowding - Impacted teeth - Extreme pre-normal or post-normal occlusion - Severe open bite - Severe anterior or posterior cross bite - Cleft and lip palate - Severe cranio-facial deformities

The Wilson method with a 95 % Confidence Interval was employed to compute statistical prevalence. Comparison of orthodontic requirements according to sex and age was fulfilled by the Chi-square test of Pearson.

Statistical significance was contemplated for results with a p value <0.05. Calculations were performed by means of the software "Statistica 8.0 – 2007".

RESULTS

The study was performed on 3491 subjects (1708 males, 1783 females) as shown in the figure 1.

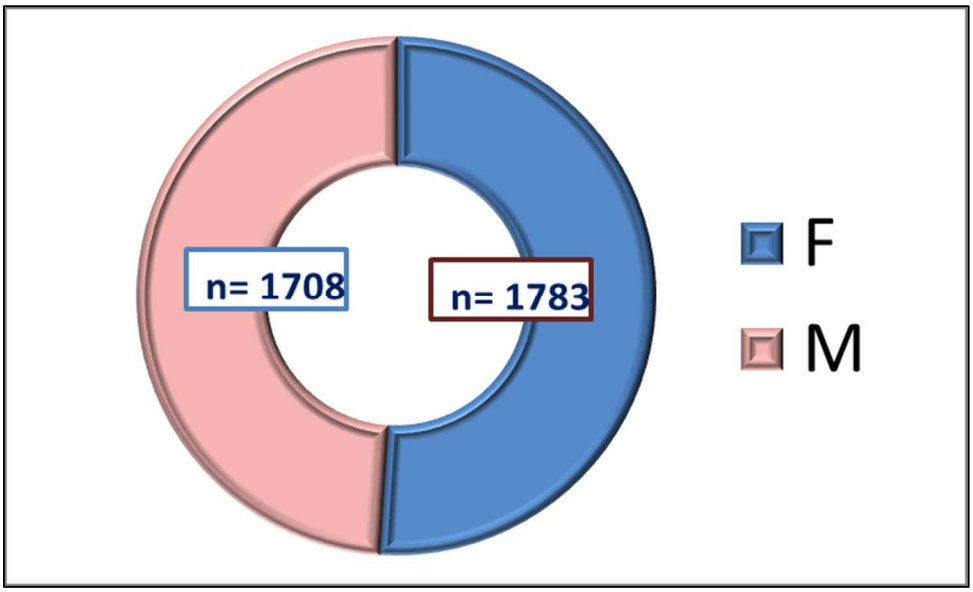

Fig. 1

The sample was divided into the above-mentioned 4 age groups (figure 2):

- Group 1: 1683 subjects
- Group 2: 1089 subjects
- Group 3: 353 subjects
- Group 4: 366 subjects

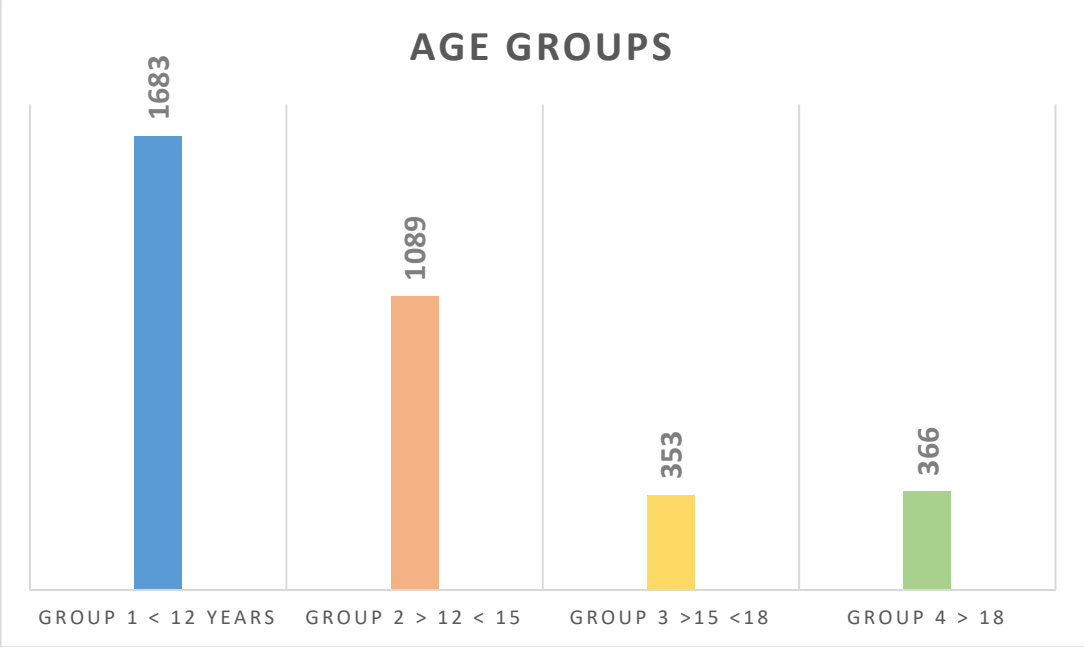

Fig. 2

Results for each variable, with the comprehensive IOTN-DHC grade are detailed in Table 4.

In particular, the parameter “dentition” (figure 3) was investigated: 33 subjects (0.95 %) were in deciduous dentition, 1767 subjects (50.62 %) were in mixed dentition and 1691 patients (48.44 %) were in permanent dentition.

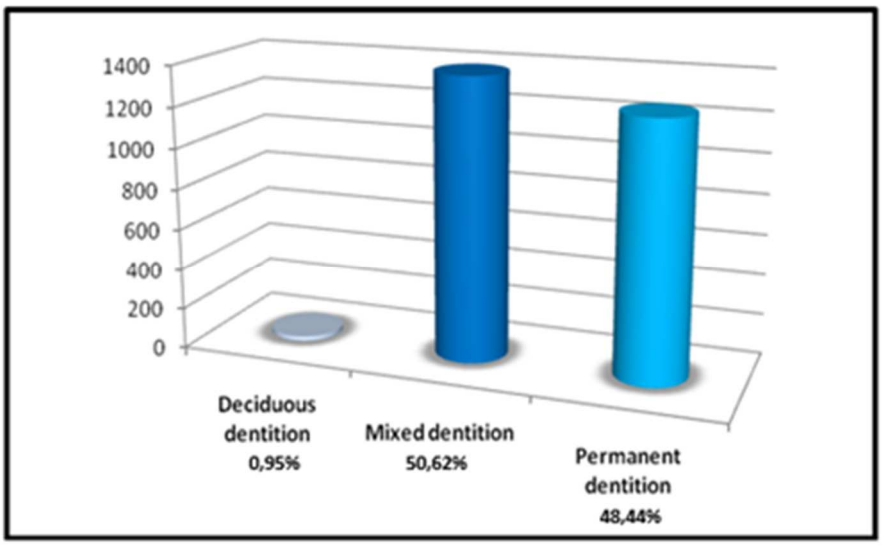

Fig. 3

Regarding any previous orthodontic treatment (figure 4), it was detected that 33.59 % of patients (1173) had been subjected to a previous orthodontic treatment; 66.40% (2318 subjects) had not been subjected to any treatment before.

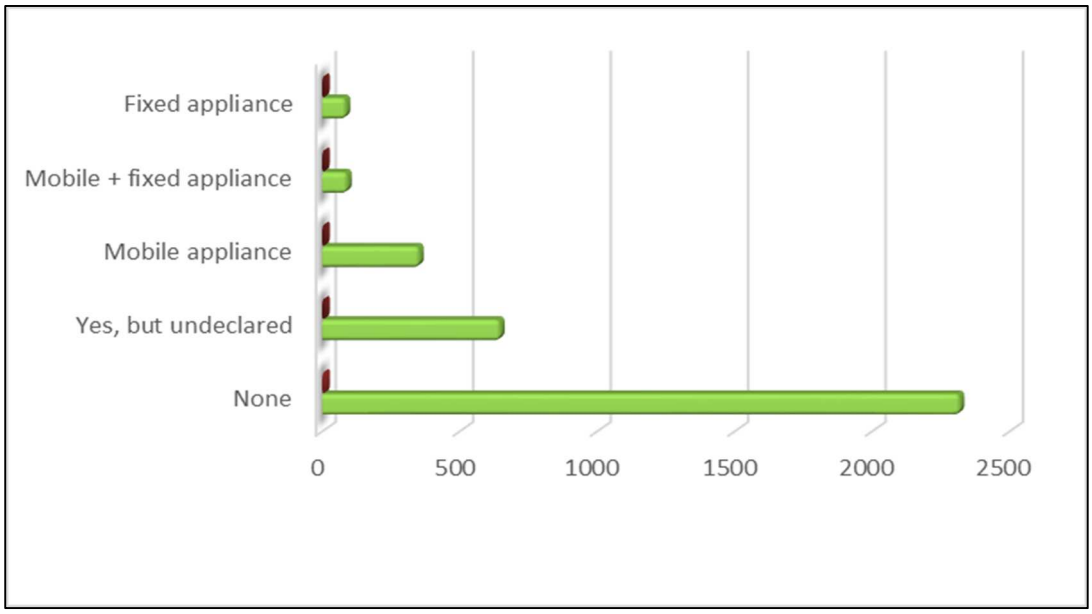

Fig. 4

In the graphs (figure 5 and 6) below the percentages concerning the canine and the molar class (on the right and on the left side) are shown.

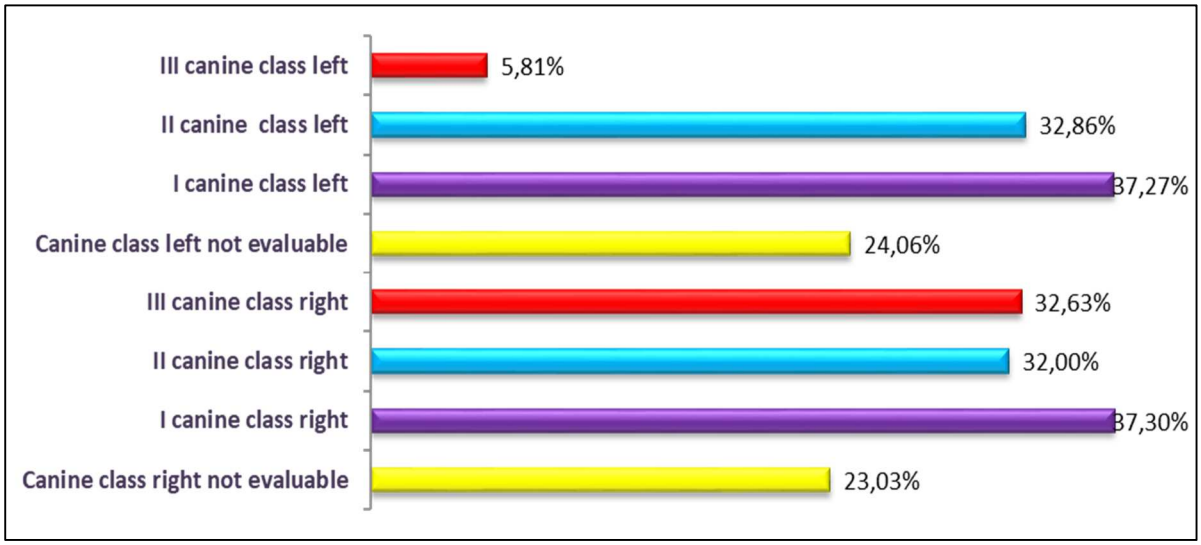

Fig. 5

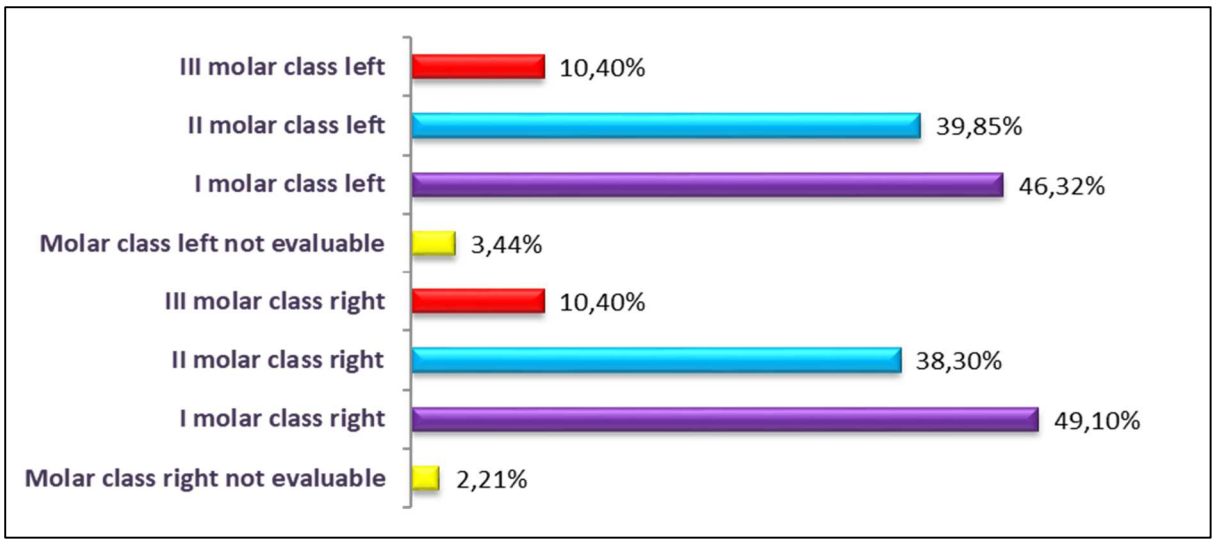

Fig.6

33.97% of the sample showed a cross bite (figure 7), while only 3.98% showed one or more agenesis (figure 8).

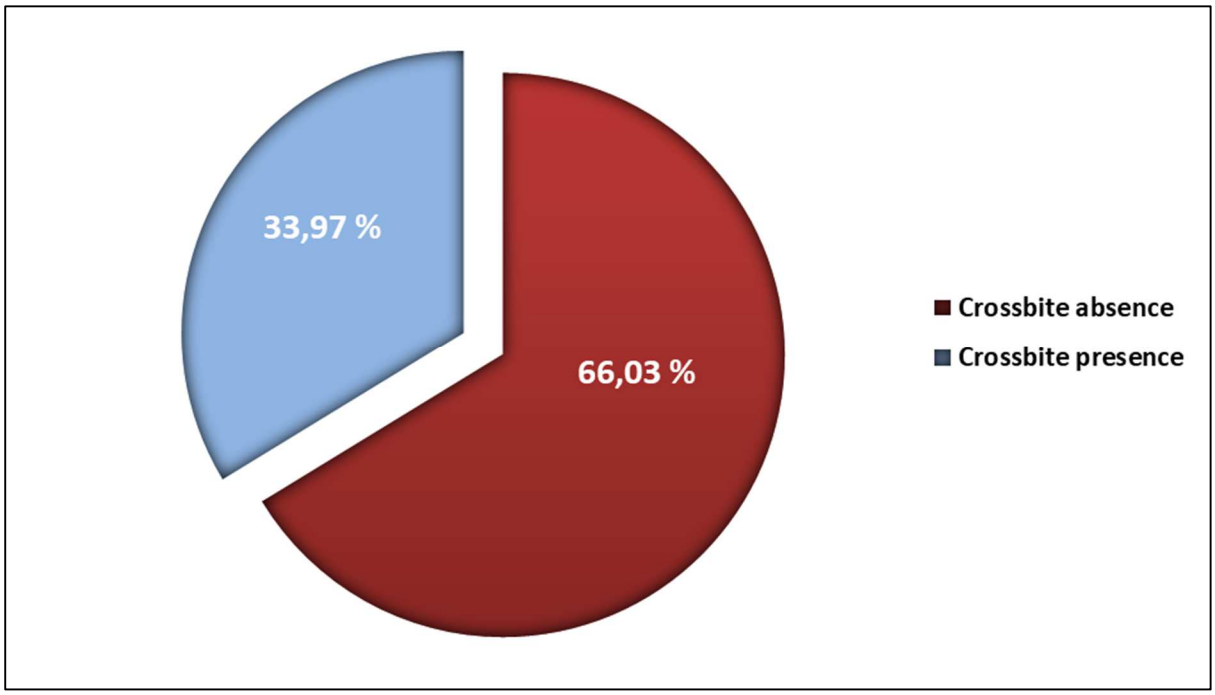

Fig. 7

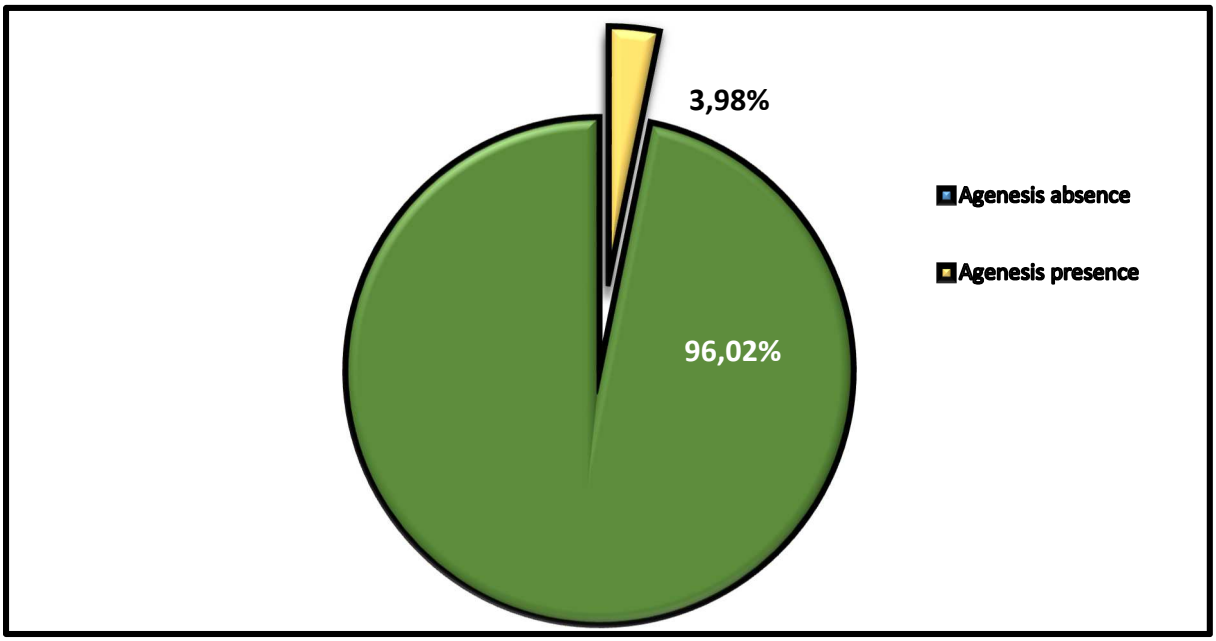

Fig. 8

Analysing the aforementioned results based on the age of the subjects (figure 9), it is possible to observe that among 1186 subjects with crossbite, 47.3% were under 12 years old, 33.2% were between 12- 15 years, 10.1% were between 15-18 years and 9.2% were over 18 years old.

Among the 139 subjects with one or more agenesis, 51 % were under 12 years old, 32.3% were between 12- 15 years, 7.1% were between 15- 18 years and 9.3% were over 18 years old.

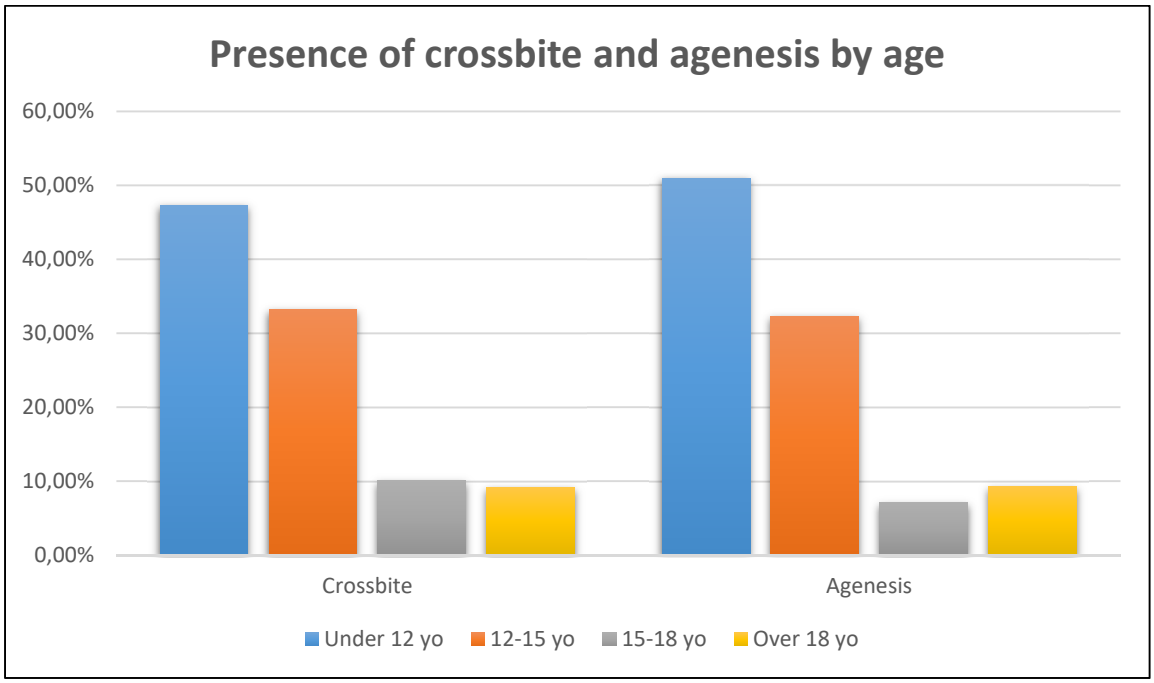

Fig. 9

Analyzing these age-related data, it can be seen that, based on the sample, these two parameters are more frequently found in the population under 12 years of age.

For the significance analysis, data with a *p value* < 0.05 ("*" in Table 4) were considered statistically significant.

Table 4 – Results, percentages and p values

Dentition

	Prevalence		95% C.I.	Male		Female		p	Age ≤12		12 < Age ≤15		15 < Age ≤18		Age >18		p
Decidous	33	0.95%	(0.67 - 1.32) %	17	1.00%	16	0.94%	0.024*	12	0.71%	13	1.19%	3	0.85%	5	1.37%	0.604
Mixed	1767	50.62%	(48.96 - 52.27) %	904	52.93%	863	50.53%		866	50.70%	552	32.32%	177	10.36%	172	10.07%	
Permanent	1691	48.44%	(46.78 - 50.10) %	787	46.08%	904	52.93%		805	47.13%	524	30.68%	173	10.13%	189	11.07%	

Labial Frenum

	Prevalence		95% C.I.	Male		Female		p	Age ≤12		12 < Age ≤15		15 < Age ≤18		Age >18		p
Normal	2999	85.91%	(84.71 - 87.02) %	1477	86.48%	1522	85.36%	0.344	1427	84.79%	955	87.70%	299	84.70%	318	86.89%	0.149
Short	492	14.09%	(12.98 - 15.29) %	231	13.52%	261	14.64%		256	15.21%	134	12.30%	54	15.30%	48	13.11%	

Lingual Frenum

	Prevalence		95% C.I.	Male		Female		p	Age ≤12		12 < Age ≤15		15 < Age ≤18		Age >18		p
Normal	3195	91.52%	(90.55 - 92.40) %	1545	90.46%	1650	92.54%	0.027*	1537	91.33%	1008	92.56%	317	89.80%	333	90.98%	0.004
Short	296	8.48%	(7.60 - 9.45) %	163	9.54%	133	7.46%		146	8.67%	81	7.44%	36	10.20%	33	9.02%	

Lips

	Prevalence		95% C.I.	Male		Female		p	Age ≤12		12 < Age ≤15		15 < Age ≤18		Age >18		p
Competent	2778	79.58%	(78.21 - 80.88) %	1337	78.28%	1441	80.82%	0.139	1335	79.32%	867	79.61%	285	80.74%	291	79.51%	0.507
Incompetent	700	20.05%	(18.76 - 21.41) %	363	21.25%	337	18.90%		344	20.44%	215	19.74%	66	18.70%	75	20.49%	
Everted	13	0.37%	(0.22 - 0.64) %	8	0.47%	5	0.28%		4	0.24%	7	0.64%	2	0.57%	0	0.00%	

Molar class (right side)

	Prevalence		95% C.I.	Male		Female		p	Age ≤12		12 < Age ≤15		15 < Age ≤18		Age >18		p
I	1714	49.10%	(47.44 - 50.76) %	830	48.59%	884	49.58%	0.049*	839	49.85%	539	79.61%	162	45.89%	174	47.54%	0.730
II	1337	38.30%	(36.70 - 39.92) %	650	38.06%	687	38.53%		637	37.85%	406	19.74%	144	40.79%	150	40.98%	
III	363	10.40%	(9.43 - 11.45) %	198	11.59%	165	9.25%		167	9.92%	124	0.64%	37	10.48%	35	9.56%	
N.V.	77	2.21%	(1.77 - 2.75) %	30	1.76%	47	2.64%		40	2.38%	20	0.00%	10	2.83%	7	1.91%	

Molar class (left side)

	Prevalence		95% C.I.	Male		Female		p	Age ≤12		12 < Age ≤15		15 < Age ≤18		Age >18		p
I	1617	46.32%	(44.67 - 47.98) %	769	45.02%	848	47.56%	0.064	794	47.18%	497	45.64%	164	46.46%	162	44.26%	0.702
II	1391	39.85%	(38.24 - 41.48) %	679	39.75%	712	39.93%		659	39.16%	427	39.21%	148	41.93%	157	42.90%	
III	363	10.40%	(9.43 - 11.45) %	201	11.77%	162	9.09%		174	10.34%	124	11.39%	28	7.93%	37	10.11%	
N.V.	120	3.44%	(2.88 - 4.09) %	59	3.45%	61	3.42%		56	3.33%	41	3.76%	13	3.68%	10	2.73%	

Canine class (right side)

	Prevalence		95% C.I.	Male		Female		p	Age ≤12		12 < Age ≤15		15 < Age ≤18		Age >18		p
I	1302	37.30%	(35.71 - 38.91) %	649	38.00%	653	36.62%	0.591	659	39.16%	376	34.53%	126	35.69%	141	38.52%	0.048*
II	1139	32.63%	(31.09 - 34.20) %	553	32.38%	586	32.87%		510	30.30%	372	34.16%	138	39.09%	119	32.51%	
III	246	7.05%	(6.24 - 7.94) %	126	7.38%	120	6.73%		114	6.77%	83	7.62%	21	5.95%	28	7.65%	
N.V.	804	23.03%	(21.66 - 24.46) %	380	22.25%	424	23.78%		400	23.77%	258	23.69%	68	19.26%	78	21.31%	

Canine class (left side)

	Prevalence		95% C.I.	Male		Female		p	Age ≤12		12 < Age ≤15		15 < Age ≤18		Age >18		p
I	1301	37.27%	(35.68 - 38.89) %	659	38.58%	642	36.01%	0.238	630	37.43%	411	37.74%	130	36.83%	130	35.52%	0.301
II	1147	32.86%	(31.32 - 34.43) %	559	32.73%	588	32.98%		542	32.20%	340	31.22%	135	38.24%	130	35.52%	
III	203	5.81%	(5.087 - 6.64) %	102	5.97%	101	5.66%		107	6.36%	63	5.79%	14	3.97%	19	5.19%	
N.V.	840	24.06%	(22.67 - 25.51) %	388	22.72%	452	25.35%		404	24.00%	275	25.25%	74	20.96%	87	23.77%	

Upper midline deviation

	Prevalence		95% C.I.	Male		Female		p	Age ≤12		12 < Age ≤15		15 < Age ≤18		Age >18		p
Absent	2797	80.12%	(78.76 - 81.41) %	1370	80.21%	1427	80.03%	0.896	1337	79.44%	893	82.00%	276	78.19%	291	79.51%	0.281
Present	694	19.88%	(18.59 - 21.24) %	338	19.79%	356	19.97%		346	20.56%	196	18.00%	77	21.81%	75	20.49%	

Lower midline deviation

	Prevalence		95% C.I.	Male		Female		p	Age ≤12		12 < Age ≤15		15 < Age ≤18		Age >18		p
Absent	1909	54.68%	(53.03 - 56.33) %	922	53.98%	987	55.36%	0.415	925	54.96%	588	53.99%	208	58.92%	188	51.37%	0.217
Present	1582	45.32%	(43.67 - 46.97) %	786	46.02%	796	44.64%		758	45.04%	501	46.01%	145	41.08%	178	48.63%	

Upper arch crowding

	Prevalence		95% C.I.	Male		Female		p	Age ≤12		12 < Age ≤15		15 < Age ≤18		Age >18		p
Absent	2423	69.41%	(67.86 - 70.91) %	1225	71.72%	1198	67.19%	0.004*	1157	68.75%	762	69.97%	250	70.82%	254	69.40%	0.839
Present	1068	30.59%	(29.09 - 32.14) %	483	28.28%	585	32.81%		526	31.25%	327	30.03%	103	29.18%	112	30.60%	

Lower arch crowding

	Prevalence		95% C.I.	Male		Female		p	Age ≤12		12 < Age ≤15		15 < Age ≤18		Age >18		p
Absent	1988	56.95%	(55.30 - 58.58) %	995	58.26%	993	55.69%	0.126	940	55.85%	619	56.84%	212	60.06%	217	59.29%	0.396
Present	1503	43.05%	(41.42 - 44.70) %	713	41.74%	790	44.31%		743	44.15%	470	43.16%	141	39.94%	149	40.71%	

Overjet

	Prevalence		95% C.I.	Male		Female		p	Age ≤12		12 < Age ≤15		15 < Age ≤18		Age >18		p
Normal	1903	54.51%	(52.86 - 56.16) %	895	52.40%	1008	56.53%	0,001*	934	55.50%	573	52.62%	202	57.22%	194	53.01%	0.481
Increased	1430	40.96%	(39.34 - 42.60) %	713	41.74%	717	40.21%		682	40.52%	458	42.06%	135	38.24%	155	42.35%	
Decreased	158	4.53%	(3.88 - 5.267) %	100	5.85%	57	3.20%		67	3.98%	58	5.33%	16	4.53%	17	4.64%	

Overbite

	Prevalence		95% C.I.	Male		Female		p	Age ≤12		12 < Age ≤15		15 < Age ≤18		Age >18		p
Normal	1929	55.26%	(53.60 - 56.90) %	900	52.69%	1029	57.71%	0,005*	941	55.91%	599	55.00%	199	56.37%	190	51.91%	0.873
Increased	1324	37.93%	(36.33 - 39.55) %	694	40.63%	630	35.33%		631	37.49%	413	37.92%	132	37.39%	148	40.44%	
Decreased	238	6.82%	(6.03 - 7.70) %	114	6.67%	124	6.95%		111	6.60%	77	7.07%	22	6.23%	28	7.65%	

Cross bite

	Prevalence		95% C.I.	Male		Female		p	Age ≤12		12 < Age ≤15		15 < Age ≤18		Age >18		p
Absent	2305	66.03%	(64.44 - 67.58) %	1118	65.46%	1187	66.57%	0.486	1121	66.61%	695	63.82%	233	66.01%	256	69.95%	0.163
Present	1186	33.97%	(32.42 - 35.56) %	590	34.54%	596	33.43%		562	33.39%	394	36.18%	120	33.99%	110	30.05%	

Dental caries

	Prevalence		95% C.I.	Male		Female		p	Age ≤12		12 < Age ≤15		15 < Age ≤18		Age >18		p
Absent	2086	59.75%	(58.12 - 61.37) %	1042	61.01%	1044	58.55%	0.139	998	59.30%	652	59.87%	217	61.47%	219	59.84%	0.900
Present	1405	40.25%	(38.63 - 41.88) %	666	38.99%	739	41.45%		685	40.70%	437	40.13%	136	38.53%	147	40.16%	

TMJ disorders

	Prevalence		95% C.I.	Male		Female		p	Age ≤12		12 < Age ≤15		15 < Age ≤18		Age >18		p
Absent	3017	86.42%	(85.25 - 87.52) %	1522	89.11%	1495	83.85%	0.001*	1462	86.87%	935	85.86%	300	84.99%	320	87.43%	0.678
Present	474	13.58%	(12.48 - 14.75) %	186	10.89%	288	16.15%		221	13.13%	154	14.14%	53	15.01%	46	12.57%	

Breathing

	Prevalence		95% C.I.	Male		Female		p	Age ≤12		12 < Age ≤15		15 < Age ≤18		Age >18		p
Nasal	2045	58.58%	(56.94 - 60.20) %	961	56.26%	1084	60.80%	0.018*	988	58.70%	656	60.24%	205	58.07%	196	53.55%	0.410
Mixed	1095	31.37%	(29.85 - 32.93) %	559	32.73%	536	30.06%		533	31.67%	327	30.03%	110	31.16%	125	34.15%	
Oral	351	10.05%	(9.10 - 11.10) %	188	11.01%	163	9.14%		162	9.63%	106	9.73%	38	10.76%	45	12.30%	

Atypical swallowing

	Prevalence		95% C.I.	Male		Female		p	Age ≤12		12 < Age ≤15		15 < Age ≤18		Age >18		p
Absent	1908	54.65%	(53.00 - 56.30) %	930	54.45%	978	54.85%	0.812	911	54.13%	624	57.30%	192	54.39%	181	49.45%	0.064
Present	1583	45.35%	(43.70 - 47.00) %	778	45.55%	805	45.15%		772	45.87%	465	42.70%	161	45.61%	185	50.55%	

Dislalias

	Prevalence		95% C.I.	Male		Female		p	Age ≤12		12 < Age ≤15		15 < Age ≤18		Age >18		p
Absent	2504	71.73%	(70.21 - 73.20) %	1215	71.14%	1289	72.29%	0.448	1207	71.72%	805	73.92%	244	69.12%	248	67.76%	0.086
Present	987	28.27%	(26.80 - 29.79) %	493	28.86%	494	27.71%		476	28.28%	284	26.08%	109	30.88%	118	32.24%	

Bad habits

	Prevalence		95% C.I.	Male		Female		p	Age ≤12		12 < Age ≤15		15 < Age ≤18		Age >18		p
Absent	1777	50.90%	(49.24 - 52.56) %	898	52.58%	879	49.30%	0.053	852	50.62%	546	50.14%	196	55.52%	183	50.00%	0.328
Present	1714	49.10%	(47.44 - 50.76) %	810	47.42%	904	50.70%		831	49.38%	543	49.86%	157	44.48%	183	50.00%	

Agenesis

	Prevalence		95% C.I.	Male		Female		p	Age ≤12		12 < Age ≤15		15 < Age ≤18		Age >18		p
Absent	3352	96.02%	(95.32 - 96.62) %	1640	96.02%	1712	96.02%	0.999	1612	95.78%	1044	95.87%	343	97.17%	353	96.45%	0.635
Present	139	3.98%	(3.38 - 4.68) %	68	3.98%	71	3.98%		71	4.22%	45	4.13%	10	2.83%	13	3.55%	

IOTN

	Prevalence		95% C.I.	Male		Female		p	Age ≤12		12 < Age ≤15		15 < Age ≤18		Age >18		p
1	436	12.49%	(11.43 - 13.63) %	190	11.12%	246	13.80%	0.098	213	12.66%	132	12.12%	51	14.45%	40	10.93%	0.546
2	1391	39.85%	(38.23 - 41.48) %	676	39.58%	715	40.10%		686	40.76%	422	38.75%	138	39.09%	145	39.62%	
3	470	13.46%	(12.37 - 14.64) %	250	14.64%	220	12.34%		203	12.06%	166	15.24%	55	15.58%	46	12.57%	
4	704	20.17%	(18.87 - 21.53) %	355	20.78%	349	19.57%		338	20.08%	225	20.66%	66	18.70%	75	20.49%	
5	219	6.27%	(5.52 - 7.13) %	104	6.09%	115	6.45%		104	6.18%	66	6.06%	22	6.23%	27	7.38%	
0	271	7.76%	(6.92 - 8.70) %	133	7.79%	138	7.74%		139	8.26%	78	7.16%	21	5.95%	33	9.02%	

Previous orthodontic therapy

	Prevalence		95% C.I.	Male		Female		p	Age ≤12		12 < Age ≤15		15 < Age ≤18		Age >18		p
Yes, but undeclared	646	18.50%	(17.25 - 19.83) %	300	17.56%	346	19.41%	0.534	310	18.42%	192	17.63%	63	17.85%	81	22.13%	0.049*
Mobile appliance	352	10.08%	(9.13 - 11.13) %	166	9.72%	186	10.43%		168	9.98%	108	9.92%	45	12.75%	31	8.47%	
Mobile + Fixed	90	2.58%	(2.10 - 3.16) %	44	2.58%	46	2.58%		37	2.20%	32	2.94%	15	4.25%	6	1.64%	
Fixed appliance	85	2.43%	(1.973 - 3.00) %	40	2.34%	45	2.52%		49	2.91%	28	2.57%	2	0.57%	6	1.64%	
No	2318	66.40%	(64.82 - 67.95) %	1158	67.80%	1160	65.06%		1119	66.49%	729	66.94%	228	64.59%	242	66.12%	

Accordingly, significant results ($p < 0.05$) from the comparison between male and female subjects are shown below:

- Dentition (p 0.024)
- Lingual frenulum (p 0.27)
- Molar Class on the right side (p 0.049)
- Upper dental crowding (p 0.004)
- Overjet (p 0.001)
- Overbite (0.005)
- TMJ disorders (p 0.001)
- Breathing (p 0.018)

In the comparison among age groups, canine class on the right side (p 0.048) and the presence of previous orthodontic treatments (p 0.049) were statistically significant.

Based on the assessment of the dental health components, 436 subjects (12.49%) have been assigned to I.O.T.N. grade 1, 1391 (39.85 %) to grade 2, 470 (13.46 %) to grade 3, 704 (20.17 %) to grade 4 and 219 (6.27 %) to grade 5. These results are shown in figure 10.

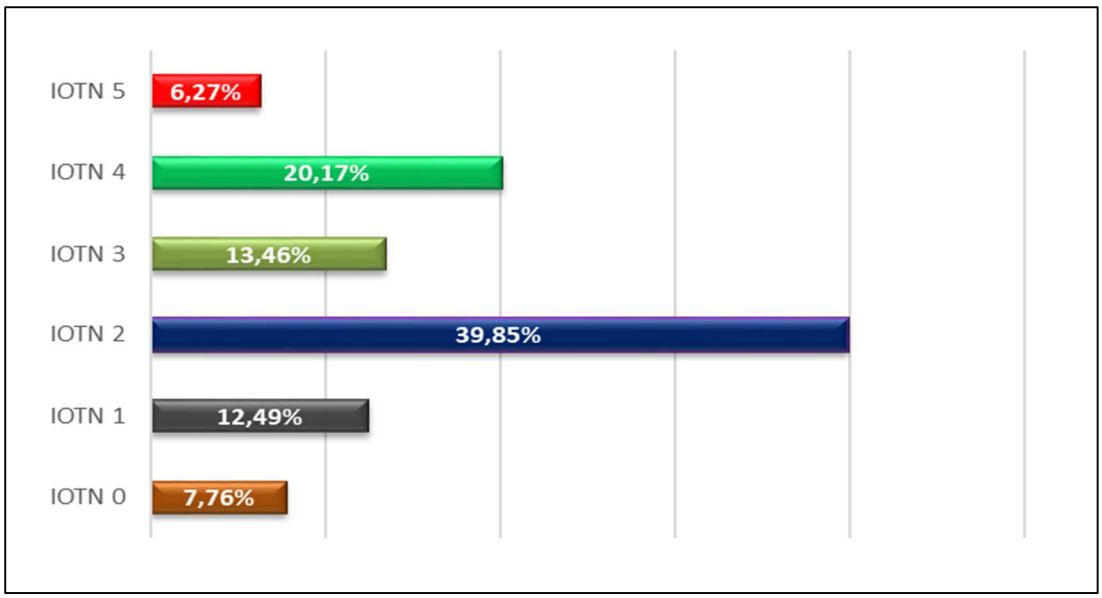

Fig. 10

In the graph below (figure 11), I.O.T.N. grades by age-groups are shown. Vertical bars indicate the 95% C.I.

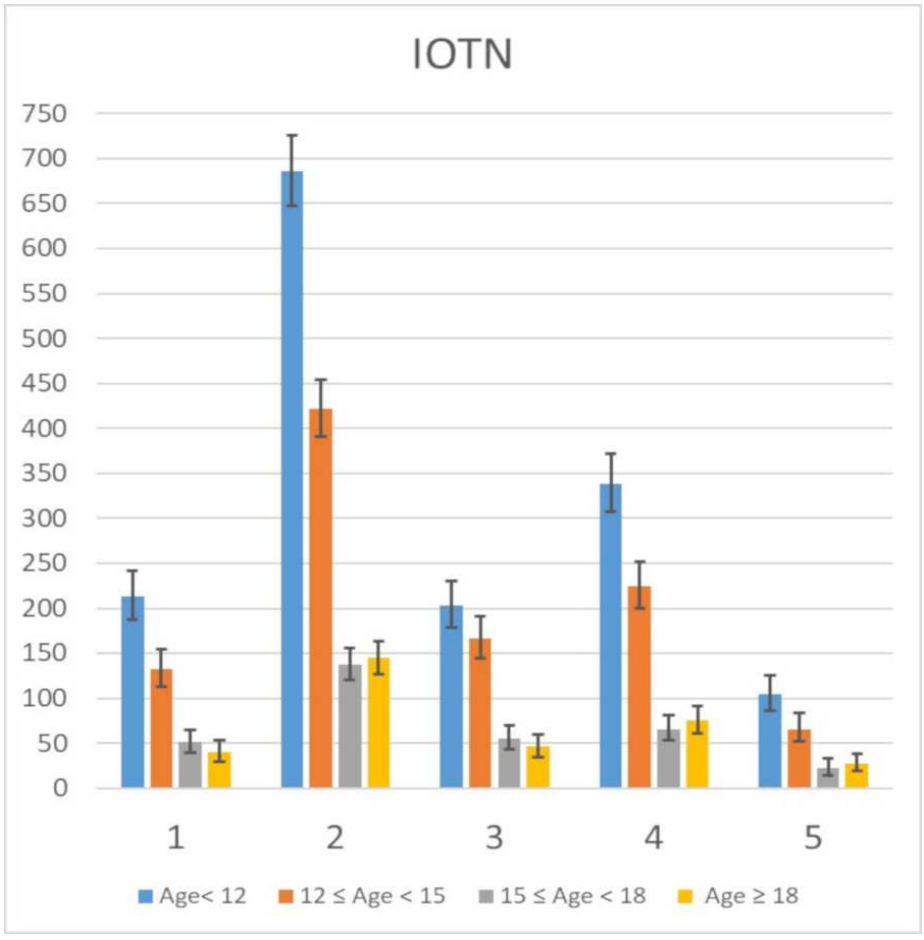

Fig. 11

It has not been possible to identify the I.O.T.N. (grade 0) for 271 subjects (7.76%) because of the absence of radiographic examinations at the first access moment. According to the index as shown in figure 12, 26.44 % of the whole sample was classified as being in strong need for orthodontic treatment (i.e. I.O.T.N. grades 4 and 5, corresponding to aforementioned 3rd level of intervention and relative need for treatment).

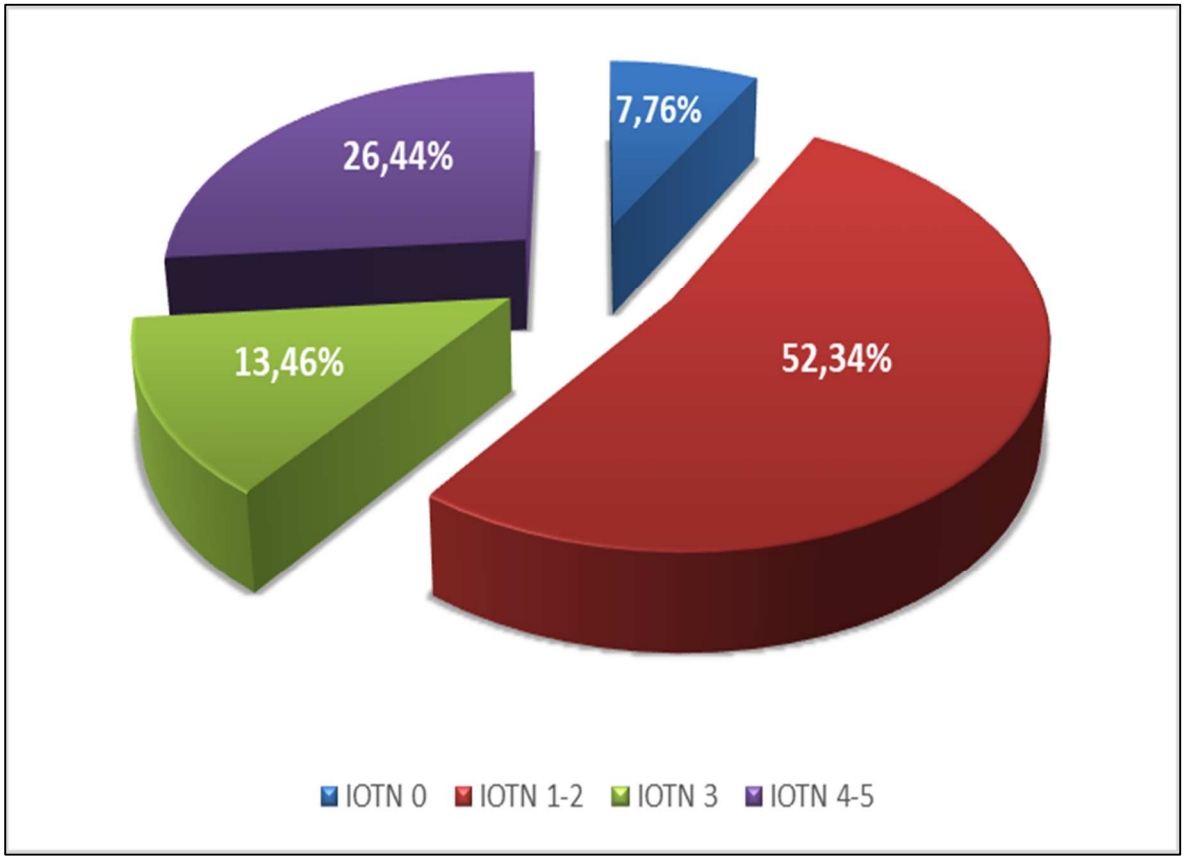

Fig. 12

In the graph below (figure 13), IOTN severity distribution by age is shown

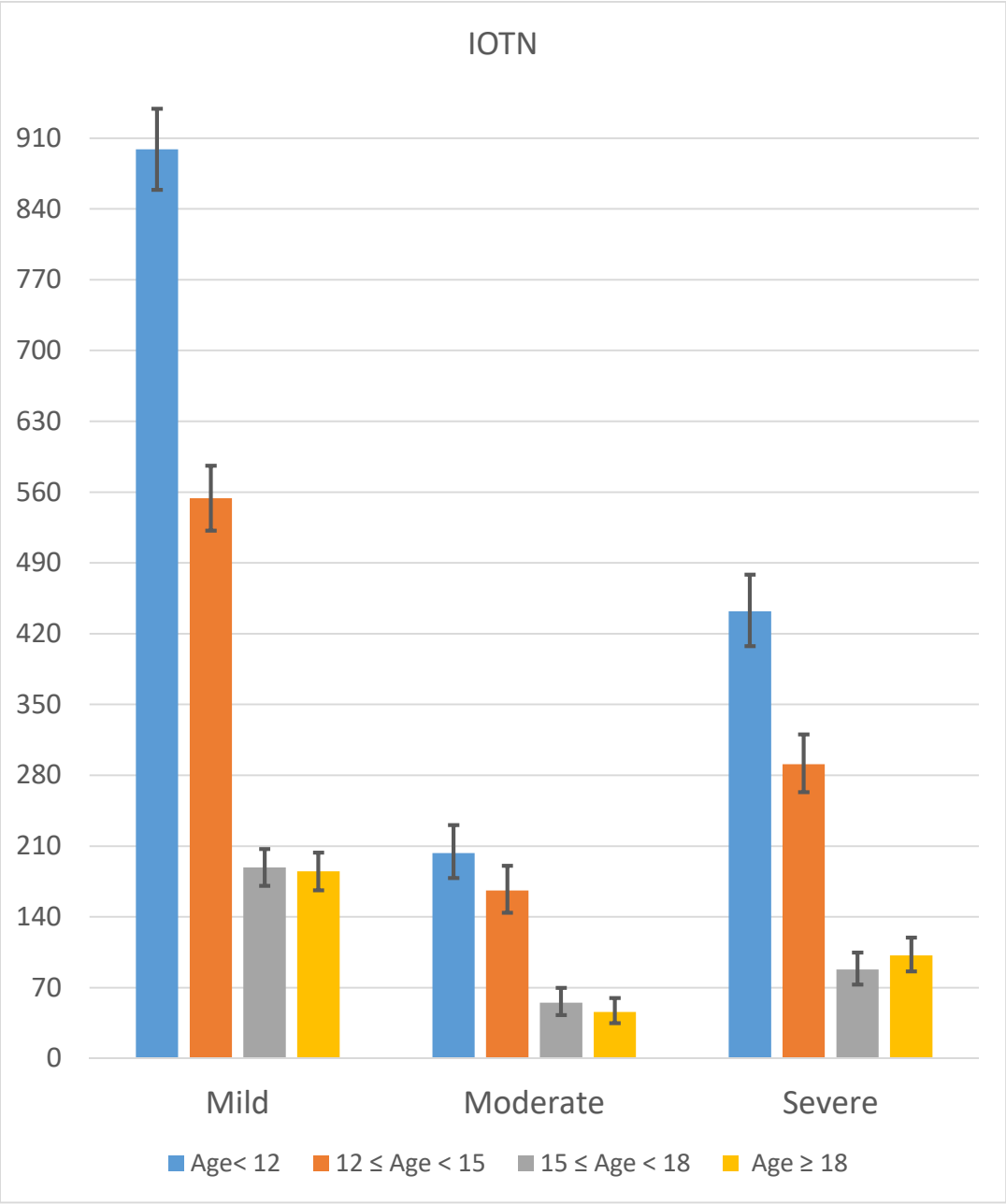

Fig. 13

Among the 923 subjects with a strong need for orthodontic treatment, it is interesting to note that 47.8 % are under the age of 12, as shown below in figure 14.

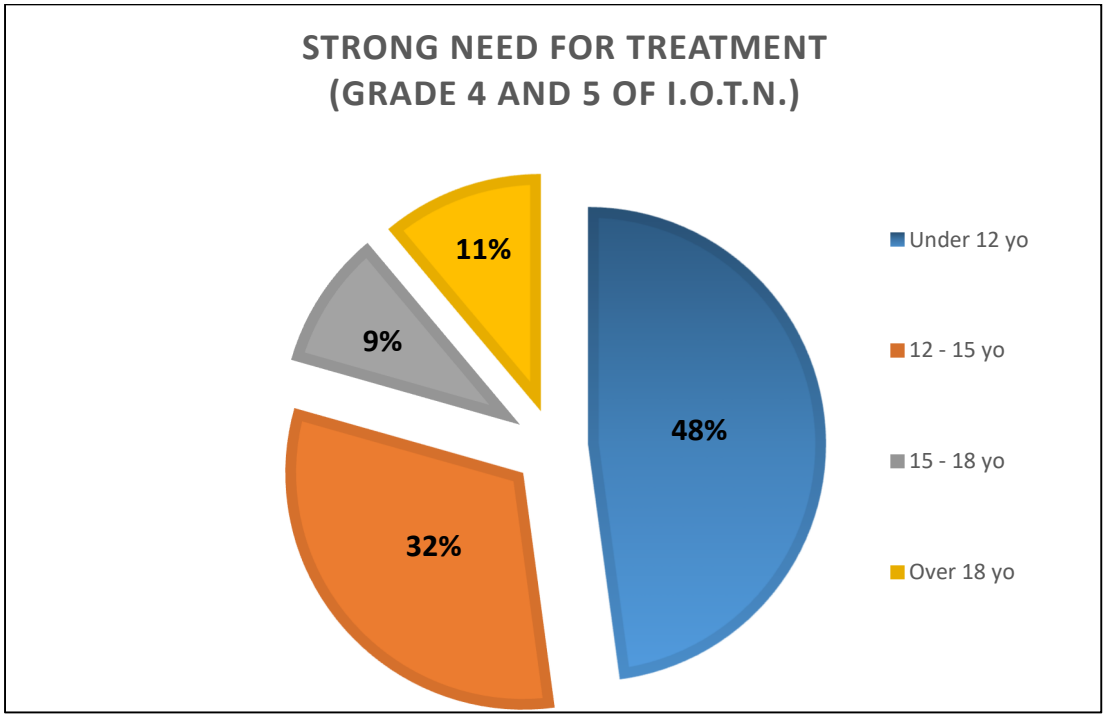

Fig. 14

At the same time a critical analysis of the IOTN was carried out: from the review of the literature and especially from the clinical experience of Orthodontic Unit (La Sapienza-University of Rome), it emerged that the IOTN could have some "limitations".

For this reason, it was decided to administer a questionnaire (figure 15) to 50 health workers of the aforementioned department (4 medical executives and 46 residents in Postgraduate School of Orthodontics with at least one year of clinical experience in the department).

1. **According to you, which among the following parameters is not adequately represented by IOTN?**
- Crowding
- Overjet
- Overbite
- Anterior crossbite
- Posterior crossbite
- Class II/1
- Class II/2
- Class III
- Asymmetry
- Impacted elements
- Agenesis
- Age
- Other

2. **Do you consider the OPT x-ray as a fundamental exam for IOTN definition?**
- Yes
- No

3. **If you answered yes to question number 2, Which parameter do you consider the OPT assessment crucial for?**
- Crowding
- Overjet
- Overbite
- Anterior crossbite
- Posterior crossbite
- Class II/1
- Class II/2
- Class III
- Asymmetry
- Impacted elements
- Agenesis
- Age
- Other

4. **Express your opinion or any annotations regarding the IOTN index**

.....

.....

Fig. 15

Question n. 1 and question n. 3 also envisaged the possibility of giving more answers, according to the clinical experience of the interviewed subject.

Analysing the answers given to the questionnaire, the following results emerged.

To the question n. 1, the parameter "asymmetry" has been quoted 35 times and the "class III" parameter has been mentioned 26 times.

The "age" factor has been named 14 times. Also interesting is the data related to the 11 citations of the "agenesis" parameter.

These answers are shown in figure 16.

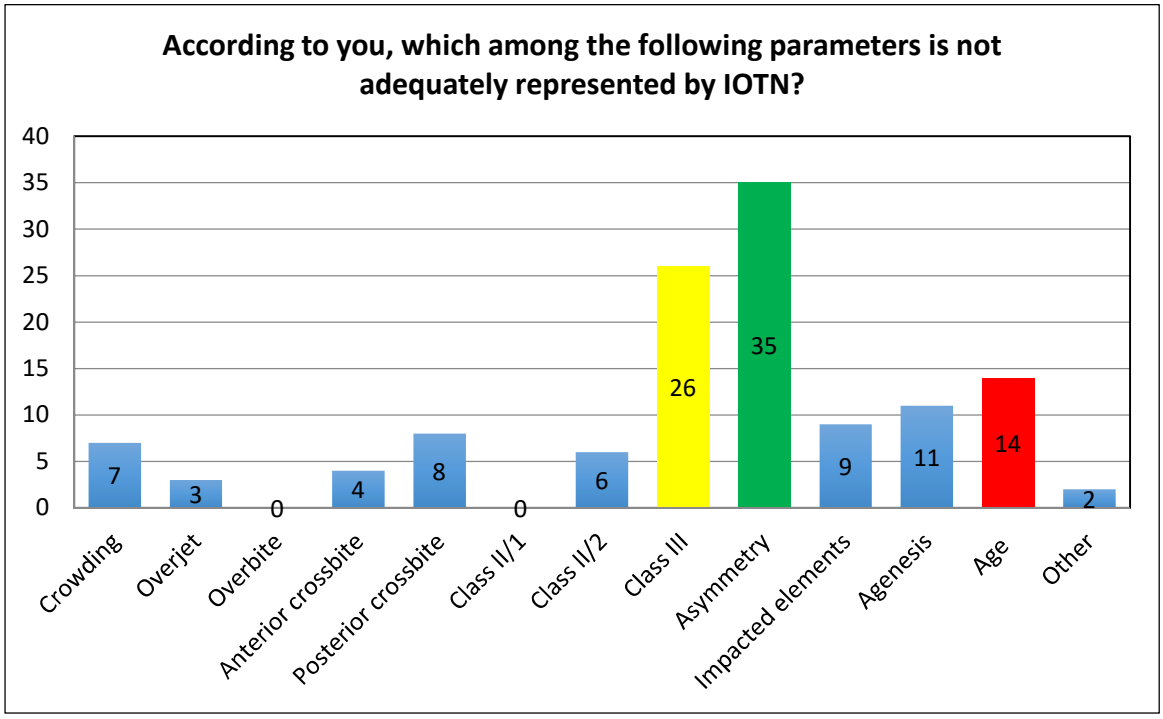

Fig. 16

To question n. 2 (figure 17), 48 people answered “yes”

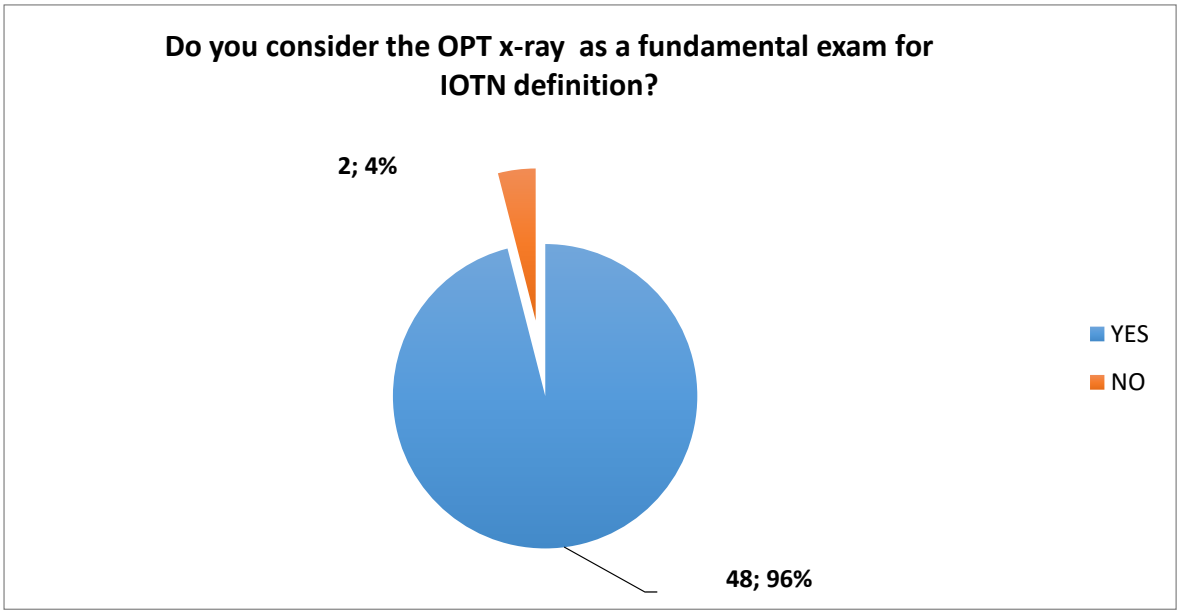

Fig. 17

To question n. 3 (for which parameter the use of an OPT is important – figure 18), the "agenesis" parameter has been quoted 35 times, "impacted elements" 34 times and the "asymmetry" parameter 13 times.

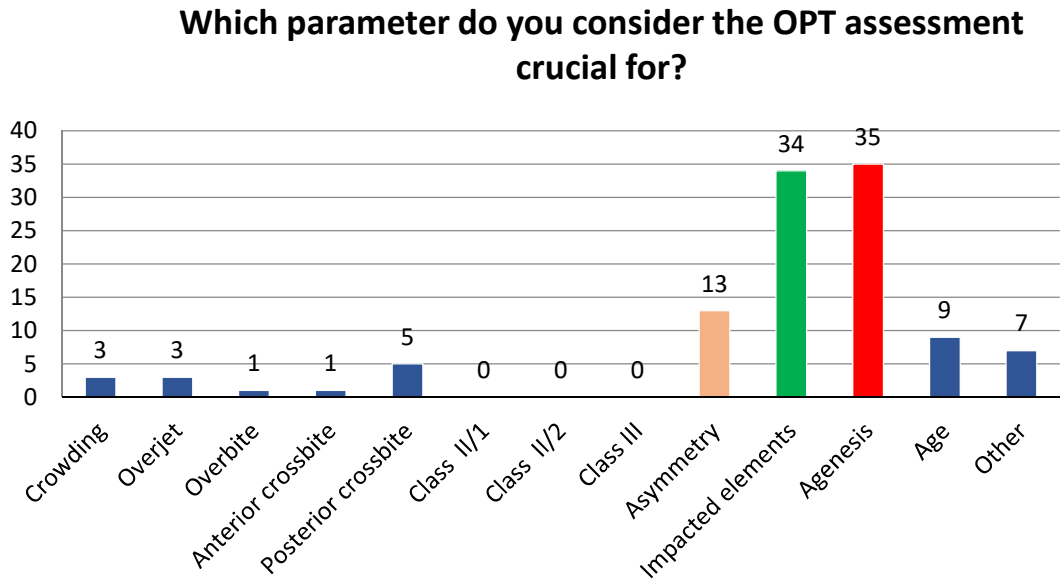

FIg. 18

Analyzing the various answers given to question n. 4, it was possible to outline the following concepts about the I.O.T.N.

- Clinical worsening of malocclusions unrelated to age
- It does not consider growth potential and functional problems
- It does not consider the class III malocclusions without negative overjet
- It “underestimates” Class III malocclusions
- Greater relevance should be given to posterior cross-bite with lateral deviation depending on the patient's age
- It is useful for fast general screening, but does not allow inclusion in the highest classes of diseases with a certain progressively worsening trend
- there is no need to request an OPT x-ray to specifically evaluate some clinical situations
- It is not enough just the OPT X-ray for a correct interpretation of the IOTN index but also a Teleradiography of the skull in lateral projection to evaluate the skeletal class and possibly a Teleradiography of the skull in postero-anterior projection for asymmetries
- It does not adequately take into account the class III malocclusions and some parameters such as overjet should be related to the age of the patient

- The index is a method of assessing the patient's orthodontic situation valid only for the time period in which the anamnesis is performed
- Preventive / prospective evaluation is missing
- More attention should be given to the patient's age

DISCUSSION

This prevalence rate of orthodontic treatment need was compared with that deriving from the analysis of similar samples in the setting of most European studies.

Souames (2006), in a survey including 9- to 12-year-old French schoolchildren, reported a percentage of 21.3 %.[19]

Three British surveys on analogous populations reported higher figures: 32.7 % (Brook and Shaw, 1989), 33 % (Burden and Holmes, 1994), and 35 % (Chestnutt, 2006). [20, 21, 22, 23, 24]

A percentage of 39.5% resulted from studies on a comparable Swedish sample (Josefsson, 2007). [25, 26]

Therefore, outcomes of the current study point towards a similarity with the need for orthodontic intervention among French study participants. Nevertheless, in general, this prevalence rate was lower than the one recorded among populations in the Northern Europe.

Several authors have conducted epidemiological studies in different countries on children, adolescents and/or adults evaluating the IOTN. The collected data have confirmed the findings of the investigations in the present paper, in relations to the prevalence of subjects belonging to the third level of the DHC-IOTN.

This finding was also confirmed in a survey of 1999, in which it was found that 23.6 % of the sample under analysis needed orthodontic treatment (3rd level of DHC-IOTN). [27, 28]

Class II malocclusion was present in over one third (39%) of the examined population, crossbites in 34 % and Class III malocclusion in 10 %. These results can be instrumental in planning an age-targeted treatment protocol for malocclusions). [29, 30, 31, 32, 33]

Some studies reported higher percentages because the survey would be carried out on an orthodontic population (i.e. younger or already preliminarily selected). [34, 35, 36, 37, 38]

The detection of occlusal abnormalities, especially in growing children, is the most important basis for the knowledge of malocclusions: only in this way it will be possible to implement a proper social program of prevention, to reduce the severity of some occlusal disharmonies and simplify any subsequent phases of therapy. [39, 40, 41, 42, 43, 44]

So, the majority of the previous studies have been conducted to subjects in primary or mixed dentition, while investigations on samples in the permanent dentition are few and often limited to groups selected by specific criteria. [45, 46, 47,48]

Our results show that the majority of subjects (65.8 %, corresponding to 1st and 2nd levels of intervention and relative need for treatment) have no need for treatment according to dental components of I.O.T.N.

Despite the variability of clinical conditions, it is necessary to use standardised assessment parameters, thus allowing the identification of those cases who will benefit from orthodontic treatment in public spending. [49, 50, 51, 52]

Only in this way, it is possible to avoid fragmentation of the limited available resources, using them for patients with an objective need.

Two major limitations were found in the present survey. The sample population was numerically broad, but geographically localized.

Hence, the results might not be applicable to other Italian and international realities.

Furthermore, age subgroups were not numerically homogenous, possibly making some results more relevant according to their relative age prevalence. [53, 54, 55, 56,57]

The results of our study show that 1827 patients (52.34 %) were in the first level of the DHC of IOTN, which, as it is known, provides “no need for treatment”.

Only the 26.44 % (923 subjects) needs orthodontic treatment. This group includes individuals who can most benefit from therapy, as the severity of the malocclusion cannot be regarded merely as a deviation from the norm, but it

involves an apparent or potential functional impairment and/or structure of the stomatognatic system.

Several authors, as shown in table 5, have conducted epidemiological studies in different countries on children, adolescents and/or adults evaluating the IOTN. The collected data have confirmed the findings of our investigations, in relations to the prevalence of subjects belonging to the third level of the DHC-IOTN.[58, 59, 60, 61, 62, 63, 64]

Table 5

AUTHOR	YEAR	3RD LEVEL DHC-IOTN
Brook and Shaw	1989	32.7 %
Lunn	1993	23 %
Burden and Holmes	1994	33 %
Burden	1995	23 %
Tuominem	1995	11.2 %
Birkeland	1996	9 %
Bossù	1996	14 %
Giudice	1999	23.6 %
Migale	2009	21.6 %
Perillo	2010	27.3 %

This finding was also confirmed in a survey of 1999 by the same working group, in which it was found that 23.6 % of the sample under analysis needed orthodontic treatment (3rd level of DHC-IOTN). [65, 66, 67, 68, 69, 70]

Some studies reported higher percentages because the survey would be carried out on an orthodontic population (i.e. younger or already preliminarily selected).[71, 72, 73,74]

Indexes based on qualitative methods employ descriptions to detail the range of treatment need (e.g. extreme, marked, extensive) and, as such, they might be adopted in an inconsistent way, which may lead to an increased risk of bias (i.e. methodological mistake). The correct application of these indexes is dependent on the operator's capability and experience.

Indexes based on quantitative methods allow for the measurement of established occlusal components, thus assigning a score or a grade of intervention need that is realized by summation of the scores and/or the most severe characteristics. In this case, the result does not depend on the operator's ability, especially if the operator who recollects data has been "calibrated". [75, 76, 77]

An ideal index can be utilized as a means to regulate waiting lists in public healthcare institutions and as a guide for the financial assessment of orthodontic treatment by Italian welfare institutions. [79]

Kisely et al. contend that, in absence of sufficient resources, using IOTN allows to assign the funds available in a proper and rational manner. Several authors consider the IOTN a valuable tool to identify priorities for orthodontic treatment even within the public services. [80]

CONCLUSIONS

The realization of epidemiologic investigations to establish priority for treatment need is therefore particularly useful, not only to estimate the prevalence of some clinical conditions in the observed population, but also to plan targeted interventions, such as interceptive and corrective therapies in growing children. These interventions could solve specific clinical situations and/or prevent their escalation, with a better use of resources and a reduction in treatment times. [81,82]

The advantages of I.O.T.N. are:

1. IOTN is a clinical index to assess Orthodontic treatment need
2. The index can be used either directly on the patient or on the plaster model
3. The validity and reliability of the IOTN have been verified
4. IOTN is one of the most commonly used occlusal indices to assess the Orthodontic treatment need among children and adults
5. The index defines specific, distinct categories of treatment need, whist including a measure of function
6. The use of IOTN index allows improved focusing of services and has the potential to induce greater uniformity throughout the profession and standardization in the assessment of Orthodontic treatment need.
7. IOTN has gained international recognition as a method of objectively assessing treatment need

8. IOTN is objective, synthetic and allows for comparison between different population groups
9. IOTN is proved to be an easy-to-use and reliable method to describe the need for Orthodontic treatment need.
10. The DHC of IOTN helps in determining manpower requirements for planning Orthodontic treatment need.

The use of IOTN could be included in screening programs in schools for epidemiological investigations, because it is quick and easy to use.

There is no doubt that IOTN, despite some imperfections on certain components, represents a valuable tool to discriminate cases that primarily require orthodontic treatment.

Therefore, it would be appropriate to use standardised metrics to be used as a discriminating factor for the development of a therapeutic intervention, especially in public facilities.

In addition, defining the nature and extent of community health problems provides the necessary foundation for health planning and scheduling. [83]

CLINICAL SIGNIFICANCE

- The use of I.O.T.N. could be included in screening programs in schools for epidemiological investigations, because it is quick and easy to use.
- Patients with more severe diseases/disorders are immediately taken into care basing on a criterion of priority treatment and not on a chronological one.
- The Orthodontic Unit (U.O.) is now able to promptly treat all patients with urgent need of therapy; in the order of a time criterion based on the first access to U.O., these patients may see delayed their access to care.
- Although it has some limitations, the IOTN allows us to identify people who need orthodontic treatment based on an objective clinical measure, with the possibility to establish a priority of treatment in relation to dental values (DHC)
- Based on the I.O.T.N. and on critical considerations, the Orthodontic Unit is now able to recognize not only those who have a real need for orthodontic treatment, but also those who are in an active phase of skeletal growth.

  These patients will benefit the most from priority and timely treatment.

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