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ORIGINAL RESEARCH

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The knowledge of orthodontic and craniofacial growth amongst Italian Pediatric Medical Residents for early diagnosis in growing patients: a cross-sectional study

Maria Francesca Sfondrini[1], Simone Gallo[1], Maurizio Pascadopoli[1,*], Amelia Licari[2,3], Gian Luigi Marseglia[2,3], Paola Gandini[1], Benedetta Turcato[1], Maria Gloria Nardi[1], Andrea Scribante[1]

[1]Unit of Orthodontics and Pediatric Dentistry, Section of Dentistry, Department of Clinical, Surgical, Diagnostic and Pediatric Sciences, University of Pavia, 27100 Pavia, Italy
[2]Pediatric Clinic, Fondazione IRCCS Policlinico San Matteo, 27100 Pavia, Italy
[3]Department of Clinical, Surgical, Diagnostic and Pediatric Sciences, University of Pavia, 27100 Pavia, Italy

***Correspondence**
maurizio.pascadopoli01@universitadipavia.it
(Maurizio Pascadopoli)

Abstract

Paediatric residents usually visit children since the first years of life and can potentially diagnose craniofacial anomalies and malocclusions. Therefore, the aim of this study was to assess the ability of paediatric medical residents to diagnose malocclusions in growing subjects at an early stage. Eighty-three paediatric medical residents from the University of Pavia, Italy, who were enrolled in the Paediatric Residency program, participated in an online questionnaire. The questionnaire covered demographic variables, oral examination practices, dental and orthodontic knowledge, and sources of information. Following this, the residents were presented with a photographic analysis and asked to determine the treatment priority for 10 patients with malocclusions using the Index of Orthodontic Treatment Need (IOTN). On average, it was recommended that the first orthodontic visit should occur at around 4.92 years of age. The results showed that 75.9% of the residents always performed oral examinations on their patients, and 48.1% assigned a priority score of 8 or higher. The scores obtained by the paediatric residents did not significantly differ based on the year of study, frequency of oral examinations, or sources of information reported. Notably, there was a particular underestimation of treatment priority for malocclusions characterized by a significant increase in overjet. The findings suggest a potential lack of improvement in orthodontic knowledge during the medical residency program. It is recommended to increase the availability of orthodontic information sources for paediatric residents to enhance their understanding in this area.

Keywords

Paediatricians; Malocclusions; Priority treatment; Orthodontics; Dentistry

1. Introduction

Oral health plays a fundamental role in the child's development, and oral diseases should be prevented from the earliest years of life [1]. Paediatricians are a reference point for growing patients and their families since they deal with developmental issues [2]. It has been reported that children are more likely to visit the paediatrician for their healthcare needs than dentists [3], therefore it is indisputable that paediatricians should be aware of oral diseases and related risk factors during growth [4]. In addition, paediatricians should be able to intercept malocclusions in growing patients and refer them to an orthodontist who can assess and create an appropriate diagnosis and treatment plan [5]. An early diagnosis and a timely, suitable therapeutic intervention can positively affect the patient's prognosis [6]: without early diagnosis, achieving satisfactory treatment outcomes may be challenging [7].

Nevertheless, skeletal malocclusions can be eligible for orthodontic treatment only in growing subjects, while orthognathic surgery is required in adulthood [8].

Cooperation between paediatricians and orthodontists is desirable, since craniofacial and dental alterations can significantly impact the patient's physical and mental health and should be appropriately diagnosed and treated [9]. Paediatricians should detect risk factors that can lead to the development of malocclusions, such as bottle-feeding and non-nutritive suction [10], oral breathing [11] and dentoalveolar injuries [12]. Paediatricians also have to monitor dental changes and teeth eruption [13] and observe the presence of diastemas and dental abnormalities [14]. Nevertheless, several studies have demonstrated that there is a lack of knowledge among paediatricians concerning orthodontic issues [15, 16] and have advocated for increased cooperation between paediatricians and orthodontists, as the former could play a significant role in the prevention of malocclusions in growing patients [17]. To the best of our knowledge, no studies have been con-

ducted to evaluate paediatric medical residents' orthodontic acquaintances. Therefore, the current study aimed to assess the orthodontic knowledge and the ability of Italian paediatric residents to perform an early interception of malocclusions and associated risk factors to evaluate the related education provided by the Paediatric Residency Program.

The null hypothesis of the study was that no differences should occur between the Index of Orthodontic Treatment Needs (IOTN) assigned by pediatric medical residents to the evaluation of ten clinical cases and the correct IOTN of each case. The second null hypothesis was that no significant differences were to be found between the scores assigned by paediatric medical residents belonging to different years of attendance of the Residency Program.

2. Materials and methods

2.1 Study design

This was an observational cross-sectional study. The manuscript follows STROBE guidelines (Strengthening the Reporting of Observational studies in Epidemiology).

2.2 Setting

The study was conducted in Pavia, Italy. Recruitment and data collection were carried out between March and May 2022 through the administration of a questionnaire, which was firstly piloted with a group of 18 orthodontic residents who were not included in the study results.

2.3 Participants

The study population included 83 paediatric medical residents attending the Paediatric Residency Program at the Pediatric Clinic, Fondazione IRCCS Policlinico San Matteo, Pavia, Italy. The questionnaire was sent as a Google Form and anonymity was guaranteed for the answers provided. The test-retest reliability of the questionnaire was determined using Cohen's Kappa. This was performed using ten paediatric residents two weeks apart.

2.4 Variables

The questionnaire consisted of two parts. The first part included four sections. The first section contained demographic questions about the age, gender and year of study of paediatric residents. The second section involved questions to ascertain whether the paediatric residents perform an oral cavity examination of their patients, to determine the level of priority (on a scale from 1 to 10) they assign to it, as well as the average age of their patients. The third section was meant to investigate at what age and for what reasons paediatric residents generally recommend an orthodontic consult. The fourth section was about continuing professional education: paediatric residents were asked about courses and conferences attended every year, especially those relating to paediatric dentistry and craniofacial growth, and the primary sources of information as far as paediatric dentistry and orthodontics are concerned (more sources of information could be declared).

The second part of the questionnaire consisted of the examination of a photographic analysis of 10 patients aged between 3 and 12 years old who were referred to the Unit of Orthodontics and Paediatric Dentistry, Section of Dentistry, Department of Clinical Surgical, Diagnostic and Paediatric Sciences, University of Pavia, Pavia, Italy for an orthodontic consultation. The Index of Orthodontic Need (IOTN) value was assigned to each clinical case, as one of the main parameters to define priority treatment need [18]. The selected patients suffered from the main skeletal/dental malocclusions (reverse overjet, increased overjet, anterior/posterior crossbite, deepbite, openbite and dental misalignment) providing different values of Index of Orthodontic Need (IOTN) in order to collect a heterogeneous sample as far as priority treatment need is concerned. The criteria for IOTN are described in Table 1. In Table 2, the IOTN assigned to each clinical case is presented. All photos were taken using the same digital camera (D3500, Nikon Corporation, Tokyo, Japan). For each patient, the photographic analysis included 6 extraoral and 4 intraoral photos (the ten clinical cases are available as **Supplementary material**). To make an objective evaluation, paediatric residents were invited to determine the priority of orthodontic treatment with the IOTN that was previously adopted.

2.5 Data sources/measurement

Data related to questionnaire responses and the evaluation of treatment priority of malocclusions were collected in an Excel v. 16.7 (Microsoft 365, Microsoft Corporation, Redmond, WA, USA) spreadsheet.

2.6 Bias

The sample is not homogeneous as far as the year of study is concerned. More than half of the participants were in the first or second year of paediatric residency, while fewer participants were in their final years of study.

2.7 Study size

Sample size calculation (a = 0.05; power = 85%) for a dichotomous primary endpoint was performed concerning the variable "age of recommendation of the first dental/orthodontic visit". An expected value of 25.1 for the age of >3 years old was hypothesised, and the expected difference between the percentages was determined to be 31.4% [19]; therefore, 84 participants were required for the observational study.

2.8 Quantitative variables

For each variable, absolute values and percentages were calculated. Subsequently, the difference between IOTN values assigned by each paediatric resident to each clinical case and the IOTN score properly assessed (Δn) was calculated to define the underestimation ($\Delta n < 0$) or the overestimation of treatment priority ($\Delta n > 0$).

2.9 Statistical methods

Data were statistically analysed using the software R (R version 3.1.3, R Development Core Team, R Foundation for Statistical Computing, Wien, Austria). Descriptive statistics

TABLE 1. Index of Orthodontic Treatment Need (IOTN) by Brook and Shaw [18].

IOTN	
5	Defects of deft lip and/or palate. Increased overjet greater than 9 mm. Reverse overjet greater than 3.5 mm with reported masticatory or speech difficulties. Impeded eruption of teeth (with the exception of third molars) due to crowding, displacement, the presence of supernumerary teeth, retained deciduous teeth and any other pathological cause. Extensive hypodontia with restorative implications (more than one tooth missing in any quadrant) requiring pre-restorative orthodontics.
4	Increased overjet greater than 6 mm but less than or equal to 9 mm. Reverse overjet greater than 3.5 mm with no reported masticatory or speech difficulties. Reverse overjet greater than 1 mm but less than or equal to 3.5 mm with reported masticatory or speech difficulties. Anterior or posterior crossbites with greater than 2 mm displacement between retruded contact position and intercuspal position. Posterior lingual crossbites with no occlusal contact in one or both buccal segments. Severe displacement of teeth greater than 4 mm. Extreme lateral or anterior open bite greater than 4 mm. Increased and complete overbite causing notable indentations on the palate or labial gingivae. Patient referred by colleague for collaborative care, *e.g.*, periodontal, restorative or TMJ considerations. Less extensive hypodontia requiring pre-restorative orthodontics or orthodontic space closure to obviate the need for a prosthesis (not more than 1 tooth missing in any quadrant).
3	Increased overjet greater than 3.5 mm but less than or equal to 6 mm with incompetent lips at rest. Reverse overjet greater than 1 mm but less than or equal to 3.5 mm. Increased and complete overbite with gingival contact but without indentations or signs of trauma. Anterior or posterior crossbite with less than or equal to 2 mm but greater than 1 mm displacement between retruded contact position and intercuspal position. Moderate lateral or anterior open bite greater than 2 mm but less than or equal to 4 mm. Moderate displacement of teeth greater than 2 mm but less than or equal to 4 mm.
2	Increased overjet greater than 3.5 mm but less than or equal to 6 mm with lips competent at rest. Reverse overjet greater than 0 mm but less than or equal to 1 mm. Increased overbite greater than 3.5 mm with no gingival contact. Anterior or posterior crossbite with less than or equal to 1 mm displacement between retruded contact position and intercuspal position. Small lateral or anterior open bites greater than 1 mm but less than or equal to 2 mm. Pre-normal or post-normal occlusions with no other anomalies. Mild displacement of teeth greater than 1 mm but less than or equal to 2 mm.
1	Other variations in occlusion including displacement less than or equal to 1 mm.

TMJ: temporomandibular joint.

TABLE 2. Malocclusions presented by patients selected.

Case	Malocclusion	IOTN index
1	reverse overjet >3.5 mm, chewing and speech difficulties	5
2	reverse overjet <3.5 mm, displacement of teeth <4 mm	3
3	overjet >9 mm	5
4	anterior/posterior crossbite with >2 mm discrepancy	4
5	overbite >3.5 mm without gingival contact	2
6	openbite <2 mm	2
7	displacement of teeth <2 mm	1
8	openbite >2 mm	3
9	displacement of teeth <2 mm	1
10	displacement of teeth >4 mm	4

IOTN: Index of Orthodontic Treatment Need.

(mean, standard deviation, median, maximum and minimum values) were calculated for each question of the questionnaire. The normal distribution of the data was evaluated using the Kolmogorov-Smirnov test. The repeated measures Analysis of Variance (ANOVA) test was used followed by Tukey's test for *post-hoc* analysis in case of statistical significance of priority assignment error and over-/underestimation of priority. Non-parametric data were analysed using the Kruskal-Wallis test followed by the Mann-Whitney U test as *post-hoc* testing for the assessment of right answers about the number of years of training in paediatric residency. Linear regressions were performed to evaluate the effect of variables on the scores obtained. A significance threshold of $p < 0.05$ was considered.

3. Results

Kappa statistics for test-retest was found to be 0.93, thus demonstrating high reliability. All participants involved answered all the questions of the questionnaire, which are enlisted in Table 3. 75.9% of the sample always performs oral examinations of patients, 21.7% of the study population does it sometimes, while 2.4% of paediatric residents never examine their patients' oral cavity. On average, priority attributed to oral examination of paediatric/child patients was equal to 7.88. 48.1% of the sample attributed to oral examination a priority value equal or superior to 8. The average age at which the first dental/orthodontic visit was recommended is 4 years and 11 months. The reasons to ask for an orthodontic consult are set out below: dental misalignment (73.5%), agenesis (20.5%), genetic predisposition for agenesis (6%), bite alterations (57.8%), unfavourable craniofacial growth (13.2%) and genetic predisposition for unfavourable craniofacial growth (2%), facial asymmetry (14.4%), poor oral habits (33.7%), incorrect eating habits (38.5%), breathing disorders (14.4%), swallowing disorders (15.6%), phonation disorders (14.4%).

Fig. 1 shows the priority assignment error made by paediatric residents while evaluating treatment priority, while Fig. 2 explains how treatment priority was overestimated or underestimated according to the clinical case.

A priority assignment error was reported concerning all clinical cases. It has been shown that the treatment priority of the 3rd clinical case was mostly improperly evaluated, while the best scores were reported in the evaluation of the 1st, 2nd, 5th, 6th, 8th and 10th clinical cases (Fig. 1).

On average, treatment priority was underestimated for the 1st, 3rd, 4th and 10th clinical cases, while treatment priority of the 2nd, 5th, 6th, 7th, 8th and 9th clinical cases was overestimated (Fig. 2).

Linear regressions showed that the score obtained in the evaluation of treatment priority did not vary significantly according to the age ($p = 0.6492$), gender ($p = 0.993$) and year of study ($p = 0.865$) of paediatric residents, as well as the frequency at which they perform oral examinations on their patients ($p = 0.0633$). The number of courses and conferences attended every year ($p = 0.729$) did not significantly affect the score either, not even the ones about paediatric dentistry and craniofacial growth ($p = 0.38$), neither did the type of source of information about paediatric dentistry and orthodontics ($p > 0.05$).

No significant influence of the mean age of the patients of the paediatric residents was found on the age at which the latter usually recommends having the first dental/orthodontic visit ($p = 0.469$).

In the 4th clinical case, the score varied significantly according to the frequency of referring patients to an orthodontist for breathing disorders ($p = 0.0103$), but not for bite abnormalities ($p = 0.757$) and poor oral habits ($p = 0.524$).

As far as the other clinical cases are concerned, no significant differences in the score reported were found according to the frequency of referring patients to an orthodontist because of malocclusions considered and related risk factors ($p > 0.05$).

4. Discussion

The first null hypothesis of the study was partially rejected, as significant differences were found in the priority assignment of the clinical cases presented. The second null hypothesis was necessary to detect any improvement of paediatric residents' knowledge over time and it was accepted as no significant differences occurred between the IOTN scores assigned by pediatric residents from different years of Residency Program attendance.

An early orthodontic evaluation performed by paediatricians is critical to allow for early orthodontic visits, prompt interception of malocclusions, and timely treatment [20, 21]. Paediatricians should be able to recognize malocclusions associated with a higher priority treatment in order to properly refer patients to an orthodontist, allowing a timely and successful treatment [8]. Several research groups have tried to evaluate the knowledge of paediatricians concerning oral health and craniofacial growth [22, 23]. Many studies conducted in different countries have reported a lack of ability of pediatricians in referring patients to an orthodontist, which reduces the probability of prevention and timely therapeutic intervention [1, 24, 25].

During the five-year training path, Paediatric Residency Program provides several lessons, some of which are related to orthodontic topics. Paediatric residents should thus acquire specific knowledge over time. Therefore, the current study aimed to evaluate the orthodontic knowledge and the ability of Italian paediatric residents to perform an early interception of malocclusions and associated risk factors to evaluate whether the related education provided by paediatric residency is appropriate. Results were collected through an online questionnaire to guarantee anonymity and collect reliable and authentic answers, as in previous studies [26, 27].

In the present study, the majority of the study sample attributed high priority to oral examination (scores 8 to 10), with 75.9% stating that they always examine the oral cavity of their patients.

According to the American Academy of Pediatrics guidelines, a first dental visit should occur within the first year of life [28]. Fernandes *et al.* [29], instead, assert that the first orthodontic visit should take place once all deciduous teeth have erupted (2.5–3 years old) to detect risk factors and prevent the development of malocclusions in the future. In Italy, most insurance companies provide policies involving dental and orthodontic treatments for children and teenagers under 18, but

TABLE 3. Questionnaire composed of four parts and related answers provided by paediatric residents.

First part: demographic variables		
Age (yr)		N (%)
	24	1 (1.2)
	25	3 (3.6)
	26	10 (12)
	27	11 (13.3)
	28	16 (19.3)
	29	17 (20.5)
	30	15 (18.1)
	31	3 (3.6)
	32	2 (2.4)
	33	1 (1.2)
	34	1 (1.2)
	35	1 (1.2)
	36	0 (0)
	37	1 (1.2)
	38	1 (1.2)
Gender		N (%)
	Male	21 (25.3)
	Female	62 (74.7)
Year of study		N (%)
	First	21 (25.3)
	Second	22 (26.5)
	Third	15 (18)
	Fourth	13 (15.7)
	Fifth	12 (14.5)
Second part: oral examination		
Do you periodically perform your patients' oral examination?		N (%)
	Yes, always	63 (75.9)
	No	2 (2.4)
	Sometimes	18 (21.7)
On a range from 1 to 10 (with 1 being low priority and 10 being the highest priority), which priority do you attribute to oral examination?	Priority	N (%)
	1	0 (0)
	2	0 (0)
	3	1 (1.2)
	4	0 (0)
	5	0 (0)
	6	13 (15.7)
	7	14 (16.9)
	8	18 (21.7)
	9	9 (10.7)
	10	13 (15.7)
Which is your patients' average age? (yr)		N (%)
	3	2 (2.4)
	4	1 (1.2)
	5	16 (19.3)
	6	16 (19.3)
	7	20 (24.1)
	8	18 (21.7)
	9	2 (2.4)
	10	8 (9.6)

TABLE 3. Continued.

Third part: orthodontic consult		
At what age do you usually recommend a first dental/orthodontic visit? (yr)		N (%)
	1	3 (3.6)
	2	7 (8.4)
	3	12 (14.6)
	4	7 (8.4)
	5	19 (22.9)
	6	26 (31.3)
	7	2 (2.4)
	8	4 (4.8)
	9	0 (0)
	10	3 (3.6)
Which is the reason why you generally recommend an orthodontic consult?		N (%)
	Dental misalignment	61 (73.5)
	Agenesis	17 (20.5)
	Genetic predisposition for agenesis	5 (6)
	Bite alterations	48 (57.8)
	Unfavourable craniofacial growth	11 (13.3)
	Genetic predisposition for unfavourable craniofacial growth	2 (2.4)
	Facial asymmetry	12 (14.5)
	Poor oral habits	28 (33.7)
	Incorrect eating habits	32 (38.6)
	Breathing disorders	12 (14.5)
	Swallowing disorders	13 (15.7)
	Phonation disorders	12 (14.5)
Fourth part: sources of information		
How many courses and conferences do you attend every year?	Courses and conferences	N (%)
	0	6 (7.2)
	1	9 (10.8)
	2	8 (9.6)
	3	16 (19.4)
	4	7 (8.4)
	5	13 (15.7)
	6	4 (4.8)
	7	1 (1.2)
	8	3 (3.6)
	9	0 (0)
	10	15 (18.1)
	50	1 (1.2)
How many courses and conferences about paediatric dentistry and craniofacial growth have you attended so far?	Courses and conferences	N (%)
	0	83 (100)
Which are your main sources of information regarding paediatric dentistry and orthodontics?		N (%)
	Books	31 (37.3)
	Scientific journals	14 (16.9)
	Scientific articles	27 (32.5)
	Courses and conferences	6 (7.2)
	Colleagues	26 (31.3)
	None	24 (28.9)

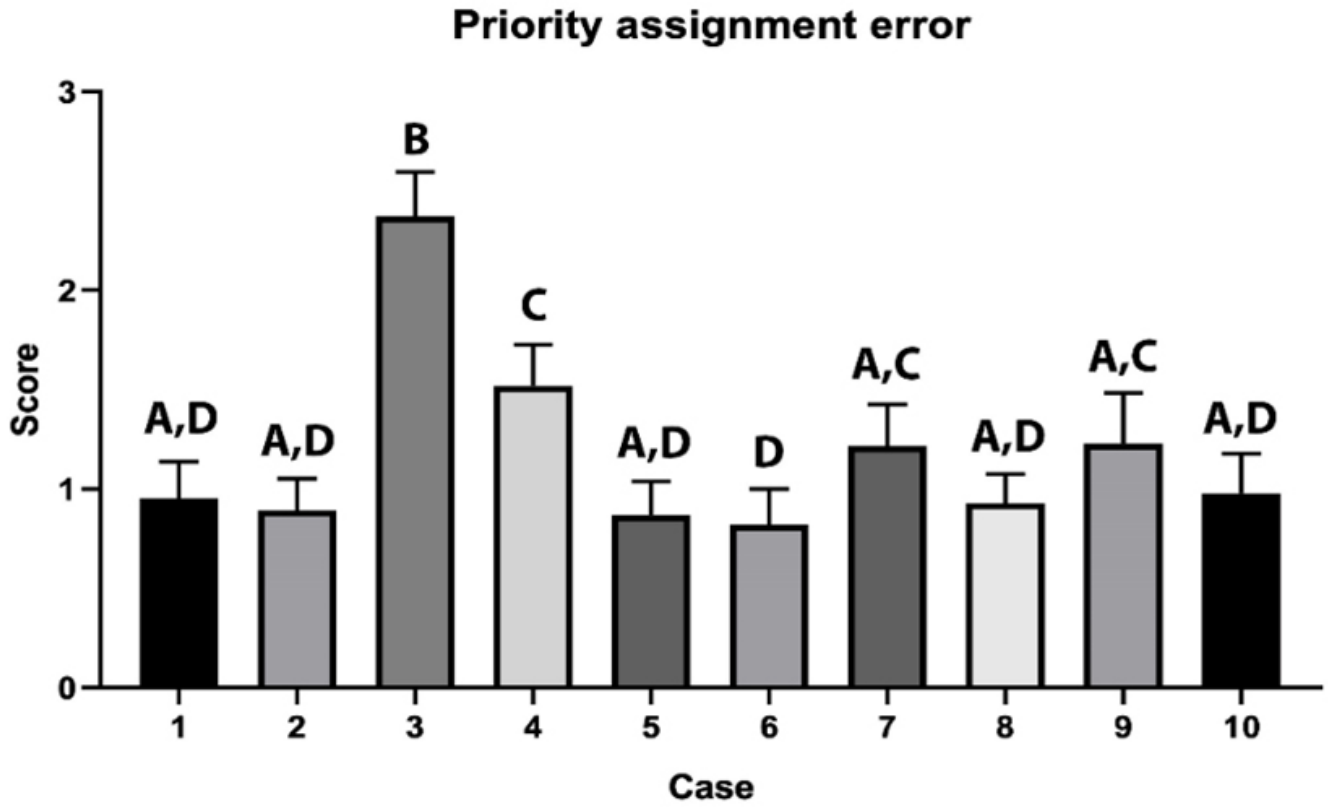

FIGURE 1. Priority assignment error. Priority assignment error made by paediatric residents while evaluating the treatment priority of malocclusions. Higher values correspond to higher errors in the assignment of treatment priority. Means with the same letters are not significantly different from each other ($p > 0.05$).

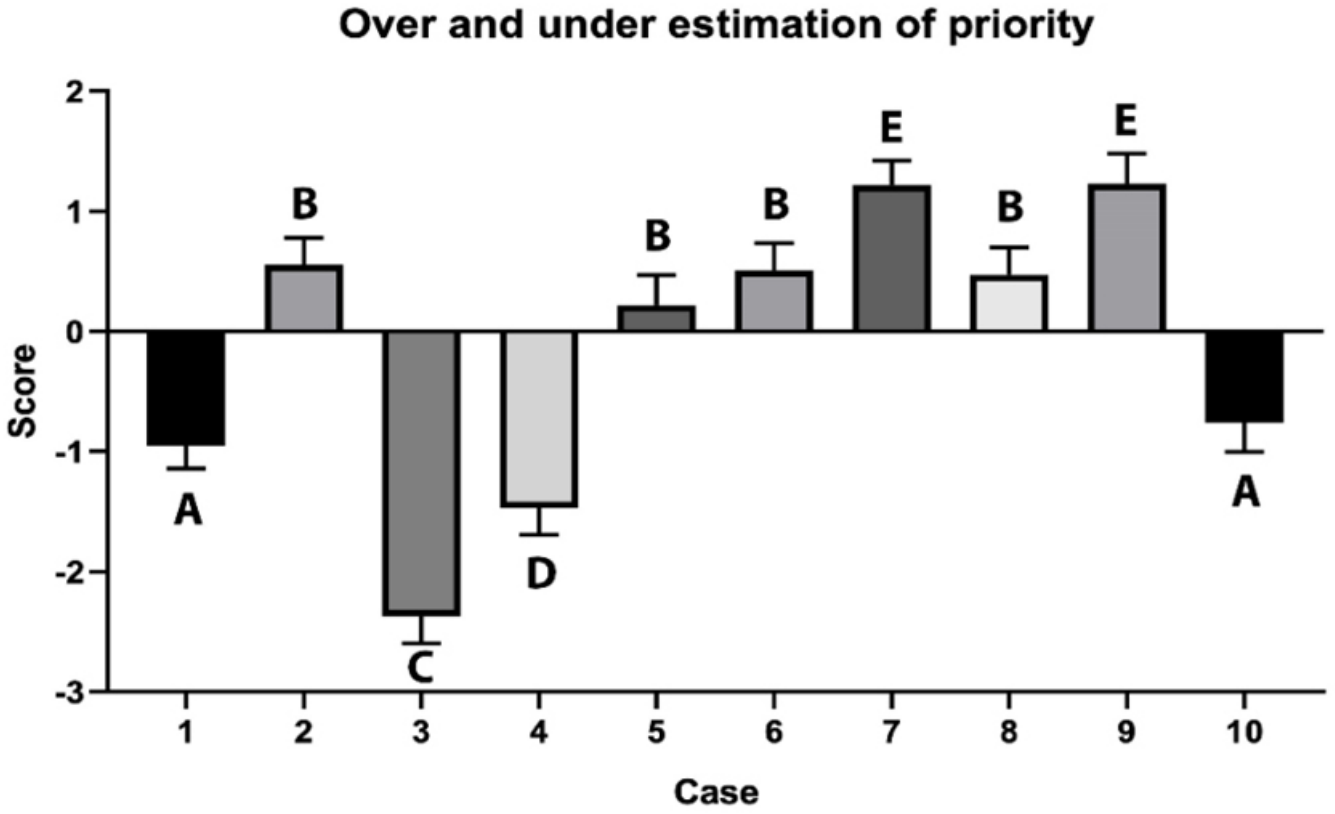

FIGURE 2. Over and underestimation of priority treatment. Over- and underestimation of clinical cases' priority treatment by paediatric residents. Means with the same letters are not significantly different from each other ($p > 0.05$).

without further specifications on first dental/orthodontic visit recommendations.

The present study showed that the average age at which paediatric residents recommend the first dental/orthodontic visit is 4.92 years old. Only 26.5% of the study population recommended it within 3 years of age, while 42% at least at the age of six, and 8.4% of the sample even at the age of eight.

The score obtained by paediatric residents determining treatment priority did not significantly differ concerning the frequency of oral examination ($p = 0.0633$). On the other hand, Chay *et al.* [30] remarked in a study of 122 paediatricians working in Singapore how doctors who felt more confident about their orthodontic knowledge tended to perform oral examinations more often and to refer patients to an orthodontist. According to the present study, a deepening of orthodontic knowledge should be encouraged: on average, paediatric residents attend 5 courses and conferences per year, but none have ever attended those about paediatric dentistry and craniofacial growth. 28.9% of the sample did not report any source of information on paediatric dentistry and orthodontics. However, the score obtained by paediatric residents determining treatment priority did not significantly vary according to the sources of information as far as paediatric dentistry and orthodontics are concerned. No significant differences in the score obtained by paediatric medical residents concerning the year of study have been remarked: this might suggest a lack of improvement in dental and orthodontic knowledge during the Paediatric Residency program.

The most common reason for referring patients to an orthodontist was dental misalignment (73.49%), while genetic predisposition for unfavourable craniofacial growth was the most unpopular one (2.41%). According to a study on 126 Greek paediatricians, the main reasons to ask for an orthodontic consult are dental and facial asymmetries (87%), while the most uncommon ones are breathing disorders and snoring (24%) [7]. Both studies show a good propensity of paediatricians to detect dental misalignment; Greek paediatricians detected facial asymmetries more often as compared to Italian ones, while both Greek and Italian practitioners rarely ask for an orthodontic consult because of breathing disorders.

In the present study, paediatric residents were invited to examine 10 clinical cases and to properly determine orthodontic treatment priority. Patient n°3 is characterised by an overjet superior to 9 mm requiring the maximum treatment priority. Nevertheless, only 3.6% of the paediatric residents could recognise it, while most of the sample significantly underestimated it. It is essential to highlight this aspect since, in the literature, many studies correlate an increased overjet to a major risk of dental trauma [31]. In addition, an increased overjet is also remarkably associated with bullying at school age, and this is the reason why an early diagnosis and a timely orthodontic consult can positively impact children's mental health [32]. A relationship between poor oral habits, such as thumb sucking after one year of age, and oral breathing was also found [33].

Nevertheless, the score reported did not significantly differ according to the frequency of asking for an orthodontic consult because of breathing disorders ($p = 0.445$) and poor oral habits ($p = 0.742$).

Patient n°4 presents an anterior and posterior crossbite with a discrepancy superior to 2 mm and providing an IOTN index equal to 4. 13.2% of paediatric residents properly determined the treatment priority and a tendency to underestimate the gravity of the clinical case was remarked ($\Delta 4 = -1.47$). Paolantonio *et al.* [34] correlated anterior and posterior crossbite to sucking habits, and oral breathing. The score obtained by paediatric residents did not significantly vary according to the frequency of asking for an orthodontic consult due to bite alterations ($p = 0.757$) and poor oral habits ($p = 0.524$), but it significantly differed as far as breathing disorders were concerned ($p = 0.0103$). Only 14.4% of the sample declared that they generally refer patients to an orthodontist due to breathing disorders and only 13.2% of the sample properly determined the treatment priority of this malocclusion which is mainly caused by oral breathing.

Patient n°6 is characterised by an open bite inferior to 2 mm, for which an IOTN index equal to 2 is attributed. 41% of the study population could define this clinical case's treatment priority, though many paediatric residents tended to overestimate it ($\Delta 6 = 0.51$). An openbite is a malocclusion due to a lack of overlap of the upper and lower incisors which can be caused by various factors, such as oral breathing, poor oral habits and unfavourable craniofacial growth [35]. The score obtained by paediatric residents did not significantly differ according to the frequency of asking for an orthodontic consult because of poor oral habits ($p = 0.856$), a genetic predisposition for unfavourable craniofacial growth ($p = 0.178$), breathing disorders ($p = 0.0714$) and unfavourable craniofacial growth ($p = 0.0947$).

Patients n°1 and n°3 show different malocclusions corresponding to the maximum treatment priority. Results suggest that treatment priority was understood by a higher percentage of paediatric residents when it came to patient n°1 (33.7%) as opposed to patient n°3 (3.6%). Significant differences in underestimating treatment priority of the two clinical cases were found ($p < 0.0001$), suggesting that paediatric residents might be more inclined to intercept a negative overjet than a strongly increased one.

Patients n°4 and n°8 suffered from different malocclusions providing an IOTN index equal to 4. The proper treatment priority was correctly defined by 13.2% of the sample, as compared to 36.1% in the case of patient n°10. Significant differences between the underestimation of the treatment priority of the two clinical cases were found ($p = 0.0002$) and this might suggest that paediatric residents have greater difficulty understanding the severity of a crossbite rather than a dental misalignment.

The treatment priority of patients n°3 and n°4 priority treatment was significantly misunderstood and underestimated as compared to all the other clinical cases ($p < 0.0005$), whilst the treatment priority of patients n°7 and n°8 were significantly overestimated as compared to most of all the other clinical cases ($p < 0.005$), perhaps because paediatric residents may not be aware of the different outcomes of untreated skeletal malocclusions and tend to focus their attention only on dental features.

The current study has some limitations: firstly, a questionnaire might not be sufficient for evaluating the complete depth

of orthodontic knowledge of paediatric residents; secondly, this is a single-centre study, which should be carried out in other institutions in order to draw more reliable conclusions. The sample was not homogeneous as far as the year of study was concerned since most of the paediatric medical residents were at the beginning of their training path, so perhaps many of them did not have the opportunity to attend all the lessons planned regarding pedodontics and orthodontic topics yet. Consequently, they might not have developed adequate diagnostic skills, thereby reducing the average level of knowledge remarked.

In the expectation of having raised attention to early diagnosis of malocclusions, it would be interesting to reproduce this study in the future in the Paediatric Residency of the University of Pavia to remark on any improvements in the orthodontic knowledge of paediatric residents. It would also be desirable to involve a larger sample of Italian paediatric residents and to conduct this study on paediatricians who have completed their paediatric residency and are carrying out their clinical practice.

5. Conclusions

The current study shows how the ability of paediatric medical residents to properly estimate orthodontic treatment priority does not significantly differ according to the year of training: this suggests a lack of training in orthodontic knowledge during paediatric residency. Furthermore, the sources of dental/orthodontic information for paediatric medical residents should be enhanced. Dental misalignment represents the most common reason for which paediatric residents refer their patients to an orthodontist, whilst greater attention should be given to skeletal features in order to allow for early treatment and to facilitate craniofacial growth.

AVAILABILITY OF DATA AND MATERIALS

The data presented in this study are available on reasonable request from the corresponding author.

AUTHOR CONTRIBUTIONS

MFS, AL and AS—designed the study. BT and MGN—performed the research and collected the data. AS—analysed the data. SG and MP—wrote and revised the manuscript. PG and GLM—supervised the study.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by the Unit Internal Review Board (approval number: 2022-0323). Written informed consent from the patients involved was previously collected.

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CONFLICT OF INTEREST

The authors declare no conflict of interest. Simone Gallo, Maurizio Pascadopoli and Andrea Scribante are serving as Editorial Board members of this journal. We declare that Simone Gallo, Maurizio Pascadopoli and Andrea Scribante had no involvement in the peer review of this article and has no access to information regarding its peer review. Full responsibility for the editorial process for this article was delegated to JD.

SUPPLEMENTARY MATERIAL

Supplementary material associated with this article can be found, in the online version, at https://oss.jocpd.com/files/article/1717085909703114752/attachment/Supplementary%20material.pdf.

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