European Journal of Orthodontics 32 (2010) 49–53
doi:10.1093/ejo/cjp050
Advance Access Publication 25 August 2009

Prevalence of orthodontic treatment need in southern Italian schoolchildren

Letizia Perillo*, Caterina Masucci**, Fabrizia Ferro*, Davide Apicella* and Tiziano Baccetti**
Departments of Orthodontics, *University of Naples (Second University) and **University of Florence, Italy

SUMMARY The present survey was performed to determine orthodontic treatment need in a large sample (n = 703) of 12-year-old schoolchildren from the southern part of Italy. The sample comprised 331 males (47 per cent) and 372 females (53 per cent), all orthodontically untreated. Two examiners, who had been previously trained in the use of occlusal indices, screened all the schoolchildren. The prevalence rates for the Dental Health Component (DHC) of the Index of Orthodontic Treatment Need (IOTN) as well as for occlusal features (Angle Class, overjet, overbite, crowding, posterior crossbite) were calculated for the total sample. The IOTN grades were statistically compared in the two genders using the chi-square test.

The findings indicated that this southern Italian school population showed a rather low prevalence rate for objective need for treatment (grades 4 and 5; 27.3 per cent of the total sample). This prevalence rate is generally lower than those reported in northern and central European countries (Sweden, Germany, and UK) but slightly greater than those in France. No significant differences in the DHC grades of the IOTN were found between genders. Among the occlusal features diagnosed in the subjects examined, a high prevalence rate was found for crowding (45.9 per cent). Moreover, posterior crossbites and Class III malocclusions, which would presumably have benefited from early orthodontic intervention, were still present in 14.2 and 4.3 per cent of the students, respectively.

Introduction

During the last three decades, a notable increase in orthodontic treatment demand has occurred as a consequence of the high perception rate of malocclusions, along with a greater attention to aesthetics. However, disagreement still exists regarding the definition of 'normal occlusion', while objective methods to define orthodontic treatment need are necessary.

Several studies have attempted to provide epidemiological reports of the prevalence of malocclusions in different ethnic groups (Brunelle *et al.*, 1996; Tschill *et al.*, 1997; Thilander *et al.*, 2001). With this aim, some authors (Brunelle *et al.*, 1996; Tschill *et al.*, 1997) have chosen measures of single occlusal traits (Björk *et al.*, 1964) as well as Angle's classification (Angle 1907). Recently, orthodontic treatment need has been expressed by a series of indices including the Dental Aesthetic Index (Baca-Garcia *et al.*, 2004), the Treatment Priority Index (Uğur *et al.*, 1998), the Index of Complexity Outcome and Need (Liepa *et al.*, 2003), and the Index of Orthodontic Treatment Need (IOTN; Brook and Shaw, 1989). The IOTN is based on a Dental Health Component (DHC) and an Aesthetic Component; it has been described extensively (Brook and Shaw, 1989). With regard to previous methods, the IOTN is objective, synthetic, and allows for comparisons between different population groups (Shaw *et al.*, 1991; Cooper *et al.*, 2000).

Whereas northern and central European populations, such as Swedes (Josefsson *et al.*, 2007), Britains (Chestnutt *et al.*, 2006), Germans (Tausche *et al.*, 2004), and French (Souames *et al.*, 2006), have been the object of a great number of surveys, there are very few investigations that have evaluated the prevalence of malocclusions (Ciuffolo *et al.*, 2005) and orthodontic treatment need (Nobile *et al.*, 2007) in southern European ethnic groups.

The purpose of the present epidemiologic study was to evaluate the orthodontic features of 12-year-old schoolchildren in southern Italy by means of the IOTN, with the aim of obtaining information for public health planning for orthodontic screening and prevention and of providing data that could be compared with the findings of other European surveys.

Subjects and methods

Study population

The study target population consisted of schoolchildren attending the second year of secondary school (corresponding to the eighth grade) of state-funded schools in Naples (Southern Italy). Forty-eight schools (13 000 pupils) were randomly selected according to a cluster sampling design from an initial pool of 79 schools that had been previously identified by the school district to avoid possible biases ensuing from social heterogeneity. Classes within schools were sampled systematically. All students belonging to the sampled classes were examined, both to improve study feasibility and so as not to discriminate among pupils in the

same class. Written consent to the examination was obtained from the children and their parents.

Final sample

Sample size was calculated assuming a 50 per cent prevalence ratio for any characteristics to be estimated, and a precision of the estimate of ±3 with a 95 per cent confidence interval (sampling from finite population, nQuery Advisor, v. 4.0, Statistical Solution Ltd, Cork, Ireland). This assumption leads to the highest sample size with the given precision. Nine hundred and eighty-seven students were randomly selected according to a cluster sampling design.

All selected children present at the schools on the day of the examination (888 subjects) participated in the study. Students who had already finished their orthodontic treatment and those who were undergoing treatment at the time of the study were excluded. Therefore, the sample for final analysis comprised only orthodontically untreated subjects.

Clinical examination

The students were examined at the schools, in a quiet classroom without external interference, under natural or artificial illumination. The examination lasted approximately 15 minutes per child, following the World Health Organisation (1985) guidelines. The assessment of dental occlusion was carried out using latex gloves, dental mouth mirrors, and millimetric rulers. No radiographs, study casts, or previous written records were used. Personal data and information about orthodontic treatment were obtained directly from the students. The clinical examination was carried out by two examiners (LP and FF), who had previously undergone calibration to standardize their procedures.

Orthodontic variables

Molar relationship. The relationship between the upper and lower first permanent molars was determined according to Angle's classification. Patients with subdivision malocclusions were included in the Class II or Class III groups on the basis of the predominant occlusal characteristic, or according to the relationship between the canines.

Overjet and Overbite. Values between 0 and 4 mm were considered normal.

Posterior crossbite. A posterior crossbite was diagnosed when there was a crossover of at least one tooth in the posterior segments of the dental arches. A posterior crossbite could be unilateral (right or left) or bilateral.

Scissor bite. A scissor bite was considered to be present when the palatal cusps of the upper molars were positioned buccally in relation to the buccal cusps of the lower molars.

Crowding and diastemas. These were recorded for the anterior as well as for the posterior segments. A midline diastema was considered to be present when there was a space of at least 2 mm between the maxillary central incisors.

Orthodontic treatment need

The need for orthodontic treatment was assessed by means of the DHC of the IOTN (Brook and Shaw, 1989). The DHC of the IOTN has five grades: grades 4 and 5 represent high priority for treatment, grade 3 borderline need, and grades 1 and 2 no or little need for treatment (Table 1).

Statistical methods

Descriptive statistics were calculated for the prevalence ratio (and confidence intervals) of orthodontic variables and IOTN DHC grades. The significance of differences for IOTN DHC grades between genders was assessed by means of chi-square tests ($P < 0.05$). All statistical analyses were performed using S-Plus (S-Plus 8 Enterprise Developer, Insightful, Seattle, Washington, USA).

Results

A total of 888 students (mean age 12.2 years with a standard deviation of 0.6 years) from 44 secondary schools in Naples were examined. One hundred and eighty-five students were excluded because either they had received orthodontic treatment (65) or were currently undergoing orthodontic treatment (120). The final sample comprised 703 subjects (331 males, 47 per cent, and 372 females, 53 per cent).

Table 2 shows the distribution of the sample according to the DHC of the IOTN. An objective treatment need was recorded in 27.3 per cent of the schoolchildren (grades 5 and 4); 36.7 per cent were assigned to borderline need (grade 3) and 35.8 per cent to little/no need of orthodontic treatment (grades 1 and 2). No statistical difference with regard to DHC grades was found between genders ($P = 0.43$; Table 3).

The prevalence of each occlusal trait in the total sample is reported in Table 4. The highest prevalence was found for a Class I malocclusion (59.5 per cent), which was followed by crowding (45.9 per cent). Class II and Class III prevalence rates were 36.3 and 4.2 per cent, respectively. An overjet greater than 4 mm was present in 144 subjects (16.2 per cent), while 0.6 per cent had a negative overjet. Open bite prevalence was 0.7 per cent, and a deep bite was recorded in 179 subjects (20.2 per cent). For the variables in the transverse plane, a crossbite was present in 14.2 per cent, with a unilateral crossbite (11.2 per cent) more frequent than a bilateral crossbite (2.9 per cent).

Discussion

The orthodontic features of single populations have been the object of several investigations in different European countries

Table 1 Grades of the Dental Health Component of the Index of Orthodontic Treatment Need. (Reproduced from Brook P H, Shaw WC 1989 The development of an index of treatment priority. European Journal of Orthodontics 11: 309–320, with permission of Oxford University Press).

Grade 5—Very great
Defects of cleft 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 primary teeth, and any other pathological cause.
Extensive hypodontia with restorative implication (more than one tooth missing in any quadrant) requiring pre-restorative orthodontics.
Grade 4—Great
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 or teeth greater than 4 mm.
Extreme lateral or anterior open bite greater than 4 mm.
Increased and complete overbite causing notable indentation 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 one tooth missing in any quadrant).
Grade 3—Moderate
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 crossbites 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.
Grade 2—Little
Increased overjet greater than 3.5 mm but less than or equal to 6 mm with competent lips 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 crossbites 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.
Grade 1—None
Other variation in occlusion including displacement less than or equal to 1 mm.

Table 2 Prevalence of the grades of the Dental Health Component of the Index of Orthodontic Treatment Need as assessed in the total sample ($n = 703$).

Grade	*n*	%	95% Confidence interval*
1	49	6.9	4.8–8.2
2	203	28.9	26–32.0
3	258	36.7	33.7–40.2
4	173	24.6	22.1–27.8
5	20	2.7	1.7–3.9

*Exact binomial test.

Table 3 Prevalence of the grades of the Dental Health Component of the Index of Orthodontic Treatment Need in the total sample ($n = 703$) divided according to gender. No statistical difference with regard to DHC grades was found between genders ($P = 0.43$).

Grades	Females ($n = 372$)	Males ($n = 331$)
1	28 (4.0%)	21 (2.9%)
2	114 (15.9%)	89 (13.0%)
3	138 (19.7%)	120 (17.0%)
4	83 (11.**6%**)	90 (13.0%)
5	9 (1.2%)	11 (1.5%)

with the purpose of recording the prevalence of malocclusions and of evaluating orthodontic treatment need. While data are widely available with regard to northern and central European populations, there is a lack of surveys that have analysed the oral health status of southern Europeans.

In the present study, the DHC of the IOTN was used to record the orthodontic treatment need of the population by means of an objective and synthetic method (Shaw *et al.*, 1991; Cooper *et al.*, 2000). According to the index, 27.3 per cent of the whole sample, that included 703 schoolchildren, was classified as being in need of orthodontic treatment (grades 5 and 4). This prevalence rate is useful for comparison with that reported by the vast majority of European surveys on similar samples of orthodontically untreated subjects. The results show that the percentage is relatively greater than those reported by Souames *et al.* (2006)

Table 4 Prevalence of occlusal variables in the total sample (n = 703).

Occlusal variables	*n*	%	95% Confidence interval*
Sagittal variables			
Class I	418	59.5	56.1–62.7
Class I—incisal relationship 1	402	57.2	53.8–60.5
Class I—incisal relationship 2	14	1.9	1.1–3.0
Class I—incisal relationship 3	2	0.3	0.1–0.9
Class II	255	36.3	33.1–39.5
Class II division 1	92	13.1	10.9–15.4
Class II division 1 subdivision	145	20.6	17.9–23.4
Class II division 2	18	2.6	1.6–3.9
Class II division 2 subdivision	0	0	
Class III	30	4.3	3.0–5.8
Class III subdivision	12	1.7	0.09–2.8
Overjet >4 mm	114	16.2	13.8–18.8
Overjet 0–4 mm	585	83.2	80.6–85.6
Overjet <0 mm	4	0.6	0.2–1.3
Vertical variables			
Overjet >4 mm	142	20.2	17.6–22.9
Overbite 0–4 mm	556	79.2	76.3–81.8
Overbite <0 mm	5	0.7	0.2–1.4
Transverse variables			
Crossbite	100	14.2	11.9–16.7
Unilateral right	40	5.7	4.3–7.5
Unilateral left	39	5.5	4.1–7.2
Bilateral	21	2.9	1.9–4.3
Scissor bite	22	3.5	2.1–4.5
Crowding and diastemas			
Crowding	323	45.9	42.6–49.2
Upper arch—anterior	92	13.1	10.9–15.4
Upper arch—diffuse	28	4.1	2.8–5.6
Lower arch—anterior	264	37.5	34.3–40.8
Lower arch—diffuse	27	3.8	2.6–5.3
Diastemas	161	22.9	20.2–25.9
Upper arch—midline	68	9.9	7.8–11.8
Upper arch—diffuse	58	8.2	6.5–10.2
Lower arch—midline	15	2.1	1.2–3.3
Lower arch—diffuse	46	6.5	4.9–8.4

*Exact binomial test.

of schoolchildren aged 9–12 years from the Department of Val d'Oise, France (21.3 per cent). On the contrary, the majority of the British studies conducted on similar target populations found a higher prevalence rate for objective orthodontic treatment need in previously untreated subjects: 32.7 per cent (Brook and Shaw, 1989), 33 per cent (Burden and Holmes, 1994) in 11- to 12-year-old school populations in Manchester and Sheffield, and approximately 35 per cent in more recent British reports (Chestnutt *et al.*, 2006). Finally, in a Swedish sample of 12- to 13-year-old students, objective orthodontic treatment need was found in 39.5 per cent of the examined subjects (Josefsson *et al.*, 2007). The findings of the present study, therefore, indicate that a substantial need for orthodontic intervention was present at a similar level to French children but generally lower than northern European populations (United Kingdom and Sweden).

With regard to the occlusal findings, the highest prevalence was for crowding, which affected more than 45 per cent of the subjects, mostly within a Class I malocclusion. Over one-third (36.3 per cent) of the examined population had a Class II malocclusion. These findings serve as reference data for the epidemiology of malocclusions at an age which is frequently considered as the optimal time for treatment of many of these dentoskeletal disharmonies (Malmgren *et al.*, 1987; Gianelly, 1995; Baccetti *et al.*, 2000; McNamara and Brudon, 2001). However, the Swedish population (Josefsson *et al.*, 2007) exhibited a higher percentage of Class II malocclusions (48.8 per cent). Posterior crossbites were present in 14.2 per cent of the subjects and Class III malocclusions in 4.3 per cent. The prevalence rates for these occlusal disharmonies appear to be very high especially when early treatment in the primary or early mixed dentition has been recommended for these types of malocclusions (Thilander *et al.*, 1984; McNamara and Brudon, 2001; Franchi *et al.*, 2004).

The present study examined the occlusal conditions of orthodontically untreated schoolchildren in southern Italy. During examination of the initial total sample of subjects participating in the survey (n = 888), it was found that 185 students (21 per cent) had been previously treated or were currently undergoing orthodontic treatment. This prevalence rate is less than that reported in studies conducted in Sweden (Josefsson *et al.*, 2005) and Germany (Bissar *et al.*, 2007; 28 per cent and 48 per cent, respectively). It should be noted that the age of the subjects examined corresponded to the phase of change from the mixed to the permanent dentition during the circumpubertal period, a physiological stage when the majority of orthodontic treatment approaches are recommended (Malmgren *et al.*, 1987; Gianelly, 1995; Baccetti *et al.*, 2000; McNamara and Brudon, 2001). The results of the present study are thus similar to the findings of Nobile *et al.* (2007) in a sample of 546 students who were 12 years old in Calabria, southern Italy (15.9 per cent). Therefore, it appears that in the late mixed or early permanent phases of the dentition, in Southern Italy only one subject in five is an orthodontic patient, a prevalence rate which is lower than northern or central European countries (Sweden and Germany).

It appears that there is a reasonable balance between a definite orthodontic treatment need and the actual implementation of orthodontic treatment in some of the European countries considered. For instance, the increased need for orthodontic treatment in the Swedish population corresponds to a rather high prevalence of orthodontic therapies (Josefsson *et al.*, 2005), and a similar correlation can be derived from the southern Italian data, where a rather low prevalence rate of orthodontic treatment is associated with a rather low prevalence of treatment need. On the other hand, different countries may present with discrepancies in this relationship: in the UK a very low percentage (8 per cent) of subjects exhibited an orthodontic treatment need at the age of 12 years in contrast with a high prevalence rate of treatment need (35 per cent; Chestnutt *et al.*, 2006). It should be taken into account, however, that the current survey

found a high prevalence (37 per cent) of schoolchildren assigned to grade 3 of the DHC of the IOTN. These subjects, with borderline malocclusions, such as increased overjet (ranging from 3.5 to 6 mm), reverse overjet (from −1 to −3.5 mm), and anterior or posterior crossbites, can be regarded also as potential orthodontic patients since these types of dentoskeletal disharmonies can be treated favourably in growing patients. The results of investigations in those European countries where the prevalence rate for subjects undergoing orthodontic treatment is higher may show a lower percentage of grade 3 subjects: for instance, 26.1 per cent in the Swedish population (Josefsson *et al.*, 2007) at an average age of 11–12 years and 25.5 per cent in a German sample (Tausche *et al.*, 2004) at the age of 6–8 years.

Conclusions

The DHC of the IOTN proved to be an easy-to-use and reliable method to describe the need for orthodontic treatment in a southern Italian population. The findings in 703 schoolchildren who were 12 years old from the area of Naples, Italy, indicated that this population shows a rather low prevalence rate for objective orthodontic treatment need (grades 4 and 5). This prevalence rate is generally lower than those reported in northern and central European countries (Sweden, Germany, and UK), but slightly greater than in France. Among the occlusal problems diagnosed in the subjects examined, high prevalence rates were found for posterior crossbites and Class III malocclusions, which would presumably have benefited from early orthodontic intervention.

Address for correspondence

Tiziano Baccetti
Department of Orthodontics
Università degli Studi di Firenze
Via del Ponte di Mezzo, 46-48
50127 Firenze
Italy
E-mail: t.baccetti@odonto.unifi.it

References

Angle E H 1907 Treatment of malocclusion of the teeth. Angle's system. S S White Dental Manufacturing Company, Philadelphia

Baca-Garcia A, Bravo M, Baca P, Baca A, Junco P 2004 Malocclusions and orthodontic treatment needs in a group of Spanish adolescents using the Dental Aesthetic Index. International Dental Journal 54: 138–142

Baccetti T, Franchi L, Toth L R, McNamara J A 2000 Treatment timing for twin block therapy. American Journal of Orthodontics and Dentofacial Orthopedics 118: 159–170

Bissar A R, Oikonomou C, Koch M J, Schulte A G 2007 Dental health, received care, and treatment needs in 11- to 13-year-old children with immigrant background in Heidelberg, Germany. International Journal of Paediatric Dentistry 27: 364–370

Björk A, Krebs A, Solow B 1964 A method for epidemiological registration of malocclusion. Acta Odontologica Scandinavica 22: 27–41

Brook P H, Shaw W C 1989 The development of an index of orthodontic treatment priority. European Journal of Orthodontics 11: 309–320

Brunelle J A, Bhat M, Lipton J A 1996 Prevalence and distribution of selected occlusal characteristics in the US population, 1988–1991. Journal of Dental Research 75: 706–713

Burden D J, Holmes A 1994 The need for orthodontic treatment in the child population of the United Kingdom. European Journal of Orthodontics 16: 395–399

Chestnutt I G, Burden D J, Steele J P, Pitts N B, Nuttall N M, Morris A J 2006 The orthodontic condition of children in the United Kingdom, 2003. British Dental Journal 200: 609–612

Ciuffolo F *et al.* 2005 Prevalence and distribution by gender of occlusal characteristics in a sample of Italian secondary school students: a cross-sectional study. European Journal of Orthodontics 27: 601–606

Cooper S, Mandall N A, DiBiase D, Shaw W C 2000 The reliability of the Index of Orthodontic Treatment Need over time. Journal of Orthodontics 27: 47–53

Franchi L, Baccetti T, McNamara J A 2004 Postpubertal assessment of treatment timing for maxillary expansion and protraction therapy followed by fixed appliances. American Journal of Orthodontics and Dentofacial Orthopedics 126: 555–568

Gianelly A A 1995 One-phase versus two-phase treatment. American Journal of Orthodontics and Dentofacial Orthopedics 108: 556–559

Josefsson E, Bjerklin K, Halling A 2005 Self-perceived orthodontic treatment need and culturally related differences among adolescents in Sweden. European Journal of Orthodontics 27: 140–147

Josefsson E, Bjerklin K, Lindsten R 2007 Malocclusion frequency in Swedish and immigrant adolescents—influence of origin on orthodontic treatment need. European Journal of Orthodontics 29: 79–87

Liepa A, Urtane I, Richmond S, Dunstan F 2003 Orthodontic treatment need in Latvia. European Journal of Orthodontics 25: 279–284

Malmgren O, Ömblus J, Hägg U, Pancherz H 1987 Treatment with an appliance system in relation to treatment intensity and growth periods. American Journal of Orthodontics and Dentofacial Orthopedics 91: 143–151

McNamara J A, Brudon W L 2001 Orthodontics and dentofacial orthopedics. Needham Press, Inc, Ann Arbor, p. 272

Nobile C G, Pavia M, Fortunato L, Angelilo I F 2007 Prevalence and factors related to malocclusion and orthodontic treatment need in children and adolescents in Italy. European Journal of Public Health 17: 637–641

Shaw W C, Richmond S, O'Brien K D, Brook P, Stephens C D 1991 Quality control in orthodontics: indices of treatment need and treatment standards. British Dental Journal 170: 107–112

Souames M, Bassigny F, Zenati N, Riordan P J, Boy-Lefevre M L 2006 Orthodontic treatment need in French schoolchildren: an epidemiological study using the Index of Orthodontic Treatment Need. European Journal of Orthodontics 28: 605–609

Tausche E, Luck O, Harzer W 2004 Prevalence of malocclusions in the early mixed dentition and orthodontic treatment need. European Journal of Orthodontics 26: 237–244

Thilander B, Wahlund S, Lennartsson B 1984 The effect of early interceptive treatment in children with posterior cross-bite. European Journal of Orthodontics 6: 25–34

Thilander B, Pena L, Infante C, Parada S S, de Mayorga C 2001 Prevalence of malocclusion and orthodontic treatment need in children and adolescents in Bogotà, Colombia. An epidemiologic study related to different stages of dental development. European Journal of Orthodontics 23: 153–167

Tschill P, Bacon W, Sonko A 1997 Malocclusion in the deciduous dentition of Caucasian children. European Journal of Orthodontics 19: 361–367

Uğur T, Ciğer S, Aksoy A, Telli A 1998 An epidemiological survey using the Treatment Priority Index (TPI). European Journal of Orthodontics 20: 189–193

World Health Organisation1985 Oral health care systems. An international collaborative study. WHO, Geneva