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Orthodontic treatment need in Spanish schoolchildren: an epidemiological study using the Index of Orthodontic Treatment Need

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SUMMARY The aim of this study was to determine the prevalence of malocclusion and orthodontic treatment need in 12- to 16-year-old Spanish schoolchildren using the aesthetic component (AC) and Dental Health Component (DHC) of the Index of Orthodontic Treatment Need (IOTN) and to analyse the relationship with gender and age. The study followed the World Health Organization recommendations for oral health surveys. The sample comprised 655 schoolchildren (306 males and 349 females) who had not undergone orthodontic treatment, divided into two groups: 363 12-year-olds and 292 15- to 16-year-olds, out of a representative sample of the school population of the Valencian Community. The IOTN results were analysed with regard to gender using the chi-square test.

Orthodontic treatment need, using the DHC, was found in 21.8 per cent of the 12-year-olds and in 17.1 per cent of the 15- to 16-year-olds; and with the AC in 4.4 and 2.4 per cent, respectively. Considering both components together, 23.5 per cent of the population [confidence interval (CI) 95%: 19.2–28.1] of 12-year-olds and 18.5 per cent (CI 95% 14.2–23.4) of 15- to 16-year-olds had a definite treatment need. No gender dependent differences were found. Spanish orthodontic treatment need is similar to that reported in most recent studies in Europe, with approximately one in five to six children with an orthodontic treatment need.

Introduction

Although there is no universal consensus concerning the use of any particular index to detect orthodontic treatment need, since its development by Brook and Shaw (1989), the index of orthodontic treatment need (IOTN) has been widely used, in many different epidemiological studies, to analyse orthodontic treatment need in the general population. The IOTN classifies malocclusions according to the presence of particular occlusal features which are considered important for dental health and aesthetics, in order to identify individuals who would derive the most benefit from orthodontic treatment. This index includes an Aesthetic Component (AC) with 10 severity levels and a Dental Health Component (DHC) with five severity levels. The two are analysed separately and although they cannot be united into a single score, they can be combined to classify the patient as 'orthodontic treatment need, Yes or No', following the modifications made by Burden *et al.* (1999). The IOTN has only been used in a Spanish population on one occasion and that was in a non-randomized sample which was not representative of the child population (Manzanera *et al.*, 2004). Recent investigations have been carried out using the IOTN in many European countries such as the United Kingdom (Chestnutt *et al.*, 2006), France (Souames *et al.*, 2006), Italy (Nobile *et al.*, 2007), and Sweden (Josefsson *et al.*, 2007).

The aim of this study was to determine the orthodontic treatment need of the population of Valencia (a region on the Mediterranean coast of Spain) through a broad, representative sample of the schoolchild population, following the World Health Organization (WHO), 1997 recommendations and employing the IOTN. A further aim was to compare the results with those from other populations and to relate them to the gender and age of the subjects.

Subjects and methods

Ethical approval

The study was approved by the ethical committee of the University of Valencia. The examinations were conducted with permission from the education authorities and head teachers and the informed consent of the pupils' parents.

Study group

Four hundred and seventy-five 12-year-old and 398 15- to 16-year-old Spanish schoolchildren were initially examined. The final sample comprised 363 schoolchildren aged 12 (175 boys and 188 girls) and 292 aged 15–16 (131 boys and 161 girls) years from the Valencian community. One

hundred and twelve 12-year-old (23.5 per cent) and 108 15- to 16-year-old (26.6 per cent) of the initial sample were excluded from the study due to a previous or current history of orthodontic treatment.

This study followed the WHO (1997) recommendations with regard to the aims, selection of the sample, authorization, calibration, training and assessment of the examiners, materials used, examination area and conditions. The sample was chosen in order to obtain reliable data concerning the schoolchild population of the Valencian Community at 12 and 15–16 years of age through stratified random sampling within clusters, given that the pupils are clustered in classrooms. A total of 39 schools were selected and between 20 and 30 pupils were examined in each.

Clinical examinations

The fieldwork in the epidemiological study was carried out by six dental graduates who were divided into three examination teams, assigning them the function of examiner or recorder depending on their calibration. Prior to the examinations, sessions were conducted to explain the diagnostic criteria and to train the clinicians in the use of the IOTN. The necessary calibrations were then conducted with the examiners to ensure the validity and reliability of the results obtained, first using plaster models and then under examination conditions in a school. The results were compared with the measurements carried out by a specialist in orthodontics (DM) who had previously been trained in the use of IOTN, which were used as the gold standard. The kappa indices of the three examiners compared with the gold standard examiner were 0.86, 0.88, and 0.98 (reliable). One month after the examination, repeat examinations were carried out on approximately 10 per cent of the sample to ensure the repeatability of the study (kappa 0.92). The clinical examinations were performed in the schools, with the child seated on a chair, using a portable 60 W white–blue spectrum lamp as the source of illumination. No more than 25 children were examined during one session to avoid the effects of tiredness. No radiographs or plaster models were taken. The examination instruments employed were a WHO-type periodontal probe and a number 5 plain mouth mirror. The examinations conducted by the three teams of dentists were carried out between November and December 2004 and the duplicate examinations in January 2005.

All the malocclusion features needed to determine the DHC (overjet, overbite, anterior and posterior crossbite, openbite, displacement of the teeth, impeded eruption, hypodontia, clefts of lip and/or the palate and Class II and III molar relationship), as well as personal details, name, gender and age, were included. To determine the AC, the guidelines laid down by Brook and Shaw (1989) were employed: the subjects observed their own teeth in the mirror, without cheek retractors, and compared them with one of the 10 photographs or levels of the AC. Those who met the conditions specified in the modified IOTN, i.e. IOTN DHC ≥4 and/or IOTN AC ≥8 (Burden *et al.*, 1999), were considered as having a definite treatment need.

Statistical analysis

Statistical analysis was undertaken using the Statistical Package for Social Sciences (SPSS Inc., Chicago, Illinois, USA) version 12.0®. The IOTN results were analysed with regard to gender using the chi-square test. Differences greater than ($P < 0.05$) were considered statistically significant.

Results

Table 1 shows the different IOTN DHC levels. Orthodontic treatment need grades 4 and 5 according to this index was 21.8 per cent [95% confidence interval (CI) 17.6–26.4] in

Table 1 Dental Health Component of the Index of Orthodontic Treatment Need: frequency by gender and age.

	12 years			15–16 years		
	Males, $n = 175$ %	Females, $n = 188$ %	Total, $n = 363$ %	Males, $n = 131$ %	Females, $n = 161$ %	Total, $n = 292$ %
Grade 1. Normal or minor malocclusion. No need.	13.7 (8.9–19.7)	17.0 (11.9–23.2)	15.4 (11.8–19.6)	17.6 (11.5–25.2)	16.8 (11.4–23.5)	17.1 (12.9–21.9)
Grade 2. Minor malocclusion. Little need.	32.6 (25.7–40.1)	29.8 (23.4–36.9)	31.1 (26.4–36.2)	39.7 (31.3–48.6)	51.6 (43.6–59.5)	46.3 (40.4–52.1)
Grade 3. Moderate malocclusion. Borderline need.	33.7 (26.2–40.6)	29.8 (23.4–36.9)	31.7 (26.9–36.7)	25.1 (18.0–33.5)	14.9 (9.8–21.4)	19.5 (15.1–24.5)
Grade 4. Severe malocclusion. Need Treatment.	14.3 (9.5–20.4)	17.6 (12.4–23.8)	16.0 (12.4–20.1)	16 (10.2–23.5)	14.9 (9.8–21.4)	15.4 (11.4–20.1)
Grade 5. Very severe malocclusion. Need Treatment.	5.7 (2.8–10.3)	5.9 (2.9–10.2)	5.8 (3.6–8.7)	1.6 (0.2–5.4)	1.9 (0.4–5.3)	1.7 (1.3–2.2)

No significant differences by gender ($P > 0.05$). 95% confidence interval in parenthesis.

the 12-year-old group and 17.1 per cent (95% CI 12.9–21.9) for the 15- to 16-year age group. No significant differences by gender were found ($P > 0.05$). According to the IOTN AC (Table 2), treatment need was 4.4 per cent (95% CI 2.5–7.1) at 12 years and 2.4 per cent (95% CI 0.9–4.9) at 15–16 years. No significant differences by gender were found ($P > 0.05$).

Table 3 shows the results obtained when the two components were combined (Burden *et al.*, 1999): treatment need was 23.5 per cent (95% CI 19.2–28.1) at 12 years and 18.5 per cent (95% CI 14.2–23.4) at 15–16 years. The differences by gender were not significant ($P > 0.05$).

The percentage of agreement (proportion of results in diagnostic agreement) between the AC and DHC of the IOTN in the determination of treatment need or no need, for the total sample (both age groups combined), was 80.8 per cent with a kappa of 0.13, indicating very low agreement (Table 4).

Discussion

The present investigation is the first Spanish epidemiological study of malocclusion using the IOTN with a large, representative sample from one region of Spain (Valencia). The results obtained allow comparisons to be made with recent studies carried out in western European countries. The present findings concerning orthodontic treatment need, according to the IOTN, among the schoolchildren are not representative of the totality of the population, because those pupils (25 per cent) with a previous or current history of orthodontic treatment who must also have or have had an orthodontic treatment need were excluded.

The percentage of the population needing orthodontic treatment according to the IOTN DHC in the present study at 12 years of age was 21.8 per cent, similar to that in France (Souames *et al.*, 2006), of 21 per cent in a sample of 9- to 12-year-olds, and in Iran (Hedayati *et al.*, 2007), of 18.4 per cent 11- and 14-year-olds. Other studies have reported higher percentages: 59.5 per cent in 11- and 15-year-old Italian children (Nobile *et al.*, 2007), 37 per cent in 12- to 13-year-old Swedish children (Josefsson *et al.*, 2007), 36 per cent in Northern Ireland (Burden, 1995), 31 per cent in Jordanians (Hamdan, 2001), and 47.9 per cent in 12- to 13-year-old Malays (Abdullah and Rock, 2001).

As regards the AC, the results of the present investigation (4.4 per cent at 12 years and 2.4 per cent at 15–16 years) are very similar to those obtained in the above-mentioned studies: Souames *et al.* (2006) 7 per cent, Josefsson *et al.* (2007) 2.2–3.9 per cent, Nobile *et al.* (2007) 3.2–8.6 per cent, Hamdan (2001) 7 per cent, and Hedayati *et al.* (2007) 4.1 per cent, although Abdullah and Rock (2001) found a much higher percentage (22.8 per cent).

Taking the two components together (modified IOTN), the results obtained (23.5 per cent at 12 years and 18.5 per cent at 15–16 years) indicating a definite need, are very similar to those found in France (Souames *et al.*, 2006) but less than the 34 per cent found in the Jordanian population (Hamdan, 2001). In the United Kingdom, the proportion (21 per cent)

Table 2 Aesthetic Component (AC) of the index of orthodontic treatment need: frequency by gender and age.

AC	12 years			15–16 years		
	Males, $n = 175$ %	Females, $n = 188$ %	Total, $n = 363$ %	Males, $n = 131$ %	Females, $n = 161$ %	Total, $n = 292$ %
Grades 1–4. No need.	85.7 (79.6–90.5)	85.0 (79.2–89.9)	85.4 (81.3–88.9)	92.4 (86.4–96.3)	94.4 (89.7–97.4)	93.5 (90.0–96.0)
Grades 5–7. Moderate need.	10.3 (6.2–15.8)	10.2 (6.1–15.3)	10.2 (7.2–13.8)	5.3 (2.2–10.7)	3.1 (1.0–7.1)	4.1 (2.1–7.1)
Grades 8–10. Definite need.	4.0 (1.6–8.1)	4.8 (2.2–8.9)	4.4 (2.5–7.1)	2.3 (0.5–6.5)	2.5 (0.6–6.2)	2.4 (0.9–4.9)

No significant differences by gender ($P > 0.05$). 95% confidence interval in parenthesis.

Table 3 Index of Orthodontic Treatment Need (IOTN) results (%) considering the Aesthetic Component (AC) and Dental Health Component (DHC) together (Burden *et al.*, 1999).

	12 years			15–16 years		
	Males, $n = 175$ %	Females, $n = 188$ %	Total, $n = 363$ %	Males, $n = 131$ %	Females, $n = 161$ %	Total, $n = 292$ %
No need. IOTN DHC <4 and IOTN AC <8.	78.3 (71.4–84.2)	74.9 (68.2–81.0)	76.5 (71.9–80.8)	80.9 (73.1–87.3)	82 (75.2–87.6)	81.5 (76.5–85.8)
Definite need. IOTN DHC ≥4 and/or IOTN AC ≥8.	21.7 (15.8–28.6)	25.1 (18.9–31.8)	23.5 (19.2–28.1)	19.1 (12.7–26.9)	18 (12.4–24.8)	18.5 (14.2–23.4)

No significant differences by gender were found ($P > 0.05$). 95% confidence interval in parenthesis.

Table 4 Contingency table showing the determination of orthodontic treatment need by patient-assessed Aesthetic Component (AC) and the Dental Health Component (DHC) of the Index of Orthodontic Treatment Need (IOTN) in the total sample (both age groups combined).

		IOTN AC		Total
		No need	Need	
IOTN DHC	No need	515	10	525
	Need	116	14	130
	Total	631	24	655

Kappa: 0.13; percentage agreement: 80.8%.

was similar for 15-year-olds but much higher (35 per cent) for 12-year-olds (Chestnutt *et al.*, 2006).

In agreement with most studies, no significant differences in orthodontic treatment need between males and females were observed.

The agreement between the two components of the IOTN was very low (kappa 0.13). A weak correlation was also found in the Iranian population (Hedayati *et al.*, 2007) and, presumably, in most of the studies cited, as the treatment need percentages differ considerably depending on whether the DHC or AC is used. This is largely because the AC assesses the individual's own perception of the aesthetic appearance of their teeth, whereas the DHC is an objective analysis of the occlusal characteristics of their dentition. Consequently, in accordance with Burden *et al.* (2001), the use of the modified IOTN, which takes the two components together, classifying the subject as having a treatment need when an IOTN DHC score is 4 or more and an the AC score is 8 or more seems to be more suitable than using the two components separately.

The proportion of subjects with a past or present history of orthodontic treatment (23.5 and 26.6 per cent at 12 and 15–16 years, respectively) is remarkably high compared with the percentages found in other western European countries: 8 and 14 per cent at 12 and 15/16 years, respectively, in the United Kingdom (Chestnutt *et al.*, 2006) and 2.4 per cent in France (Souames *et al.*, 2006). It is important to bear this fact in mind, as if the aim is to determine the orthodontic treatment need of the child population as a whole, the results obtained should be considered on the low side, since one in four children presented a history of orthodontic treatment and were therefore excluded from the final sample. In different studies of individuals who had received orthodontic treatment, between 70 and 80 per cent of them were found to be in need of treatment according to the IOTN (Brook and Shaw, 1989; Ucuncu and Ertugay, 2001). There are no studies of the Spanish population concerning subjects who have already received orthodontic treatment that assess the need for treatment of those individuals according to the IOTN.

Conclusions

Widespread use of the IOTN in epidemiological studies could be useful for comparing the treatment need in different populations and is suitable for planning community dental health resources. In the Spanish population studied, one in every five to six school children presented an orthodontic treatment need, a similar proportion to that obtained in the most recent investigations carried out in Europe. However, it should be noted that one in four children in the initial sample was receiving or had received orthodontic treatment.

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