

The Use of the Index of Orthodontic Treatment Need (IOTN) in a School Population and Referred Population

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Abstract. *The aim of this study is to assess the need for orthodontic treatment in a Turkish school population and a group of population referred for orthodontic treatment. The study groups were 250 school children, 11-14 years of age, and 250 patients, 11-14 years of age, referred to the department of orthodontics. The Index of Orthodontic Treatment Need (IOTN) was used by two examiner in order to estimate the treatment need. The differences between the IOTN values for the boys and girls were also not statistically significant in both groups. When the dental health component of IOTN is considered, 38.8 per cent of Turkish school population showed great need treatment, 24.0 per cent moderate need treatment and slight or no need was 37.2 per cent. On the other hand, the referred population represented an 83.2 per cent great need treatment, 12.0 per cent moderate need treatment, 4.8 per cent no need treatment according to the DHC.*

The AC of IOTN in school population resulted in 4.8 per cent great need, 4.8 per cent moderate need, 90.4 per cent no need. These percentage were 36.8 per cent great need, 17.6 per cent moderate need, 45.2 per cent no need in referred population. Grade 8 was 28.8 per cent out of the 36.8 per cent great need percentage in referred population. Therefore, it can be concluded that the ectopic canines were the driving factor for the referred population.

Index words: IOTN, Occlusal Indices.

Introduction

Occlusal indices have been widely used as a method of achieving a more uniform evaluation of orthodontic treatment need for many years. Several indices have been developed to categorise malocclusion into groups according to the level of treatment need. Some examples of these indices are Grainger's Treatment Priority Index (1967), Salzmann's Handicapping Malocclusion Assessment Record (1968) and Summer's Occlusal Index (1971). Additionally, the authors have described two recently developed orthodontic indices that are being used in orthodontic treatment need, priority, and evaluation of treatment success, the Index of Orthodontic Treatment Need and the Peer Assessment Rating. The Index of Orthodontic Treatment Need (IOTN), described by Brook and Shaw (1989) and Shaw *et al.*, (1991) and modified by Richmond (1990) has been gaining national and international recognition as a method of objectively assessing treatment need. This index ranks malocclusion in terms of the significance of various occlusal traits for the person's dental health and perceived aesthetic impairment with the intention of identifying those persons who would be most likely to benefit from orthodontic treatment.

In various populations, malocclusion was examined by using the IOTN (Brook and Shaw, 1989; Burden and Holmes, 1994; Burden *et al.*, 1994), and the reproductibility of IOTN was examined and the values indicated substantial agreement (Brook and Shaw 1989, So and Tang, 1993, Burden and Holmes, 1994; Burden *et al.*, 1994; Richmond *et al.*, 1994). When the results of the above studies are exam-

ined, it can be concluded that there is a need of orthodontic treatment at least in one-third of the population.

The demand for orthodontic treatment is also increasing in Turkey as in the other countries. In Turkey, there are 12 universities that provide orthodontic treatment. Beside these universities, there are 325 orthodontist working in different cities of Turkey. When the large geographic area and 65 million population of Turkey are considered, the subject universities and the orthodontists are not enough to provide a sufficient orthodontic treatment to serve all the needs. Therefore, there are long waiting times for the patients after they apply for orthodontic treatment. In this case, it is important to determine the patients who is in great need of treatment, and give a high priority to these patients in order to achieve a high standard for orthodontic treatment and reduce the waiting times.

In Turkey, the first evaluation of the need of orthodontic treatment was carried out by using Treatment Priority Index (TPI). However, the implementation of TPI is difficult. Therefore, IOTN, which is known to provide reliable and practical results, was used in our study to determine the need for orthodontic treatment in the school and referred population, and to compare the results with other studies.

Materials and Methods

The study group consisted of 250 school children and 250 referred patients who applied to our department of orthodontics, a total of 500 individuals. The school children

ages were between 11 and 14 years old. The referred patients ages were also 11–14 years old. There were a small proportion of children already undergoing orthodontic treatment in school population (10 among 250 students). These children were excluded from the study. IOTN was used in the school children and the patients referred to the department of the orthodontics by two calibrated examiners in order to estimate the treatment need.

As it is known, IOTN has two parts; the Aesthetic (AC) and Dental Health (DHC) components.

The Aesthetic Component consists of a scale of 10 color photographs showing different levels of dental attractiveness, grade 1 representing the most attractive and grade 10 the least attractive dentitions (Figure 1a).

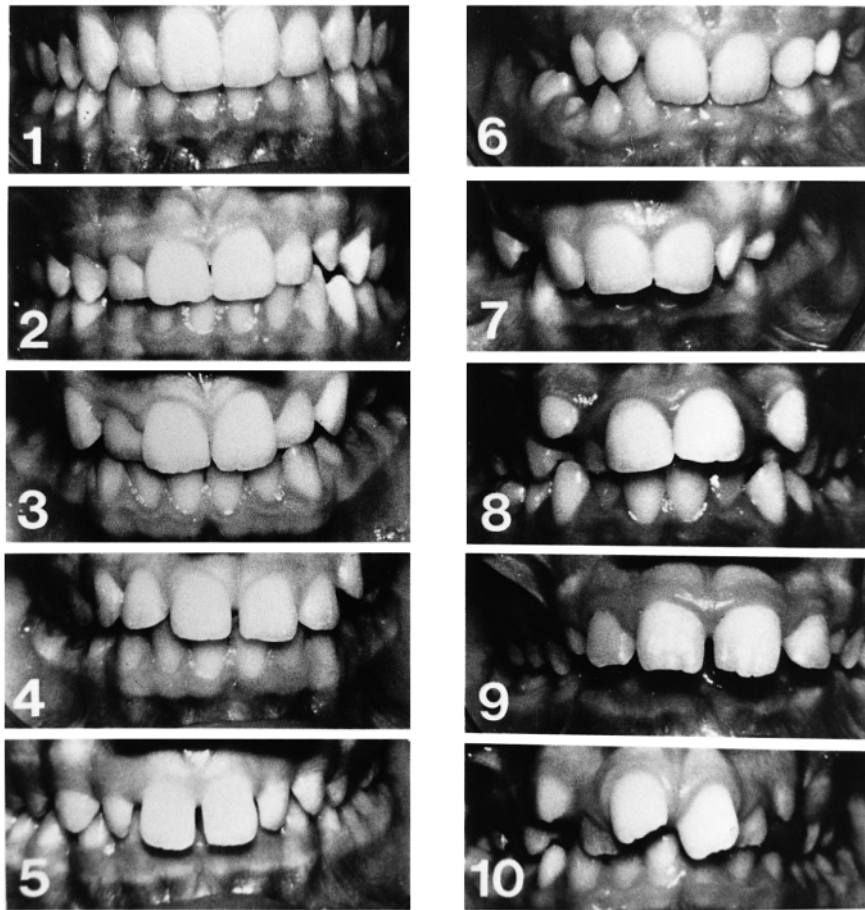
There are five grades within the DHC which have been grouped following validation into grades 1 and 2 representing 'slight or no need for treatment', grade 3 represent-

ing 'borderline' cases, and grades 4 and 5 representing those in 'great need of orthodontic treatment' (Table 1). The DHC may be applied both clinically and to study model with a specially designed ruler (Figure 1b).

The IOTN components were determined in percentage separately.

To test intra-examiner agreement, 64 of the referred population were re-examined, 6 weeks after their initial examination. The assignment of grades was also done by two examiners to test inter-examiner agreement.

Kappa statistics (Agresti, 1990) was used to evaluate the consistency of both intra-examiner and inter-examiner agreement. The significance of the dependency on sex of DHC and AC grades is checked by using Chi-Square test (Agresti, 1990). The significance of the percentages in two populations for each grade of DHC and AC was evaluated by using Z-test (Agresti, 1990).



0	3	4	5	5 Defect of CLP	3 O.B. with NO G + P trauma	DISPLACEMENT OPEN BITE V 4 3 2 1
1	2	3	4	5 Non eruption of teeth	3 crossbite 1-2 mm discrepancy	
2	1	2	3	5 Extensive hypodontia	2 O.B. > —	
3	0	1	2	4 Less extensive hypodontia	2 Dev. From full interdig	
4	0	1	2	4 Crossbite >2 mm discrepancy	2 Crossbite < 1mm discrepancy	
4- ms - 5	0	1	2	4 Scissors bite		
				4 O.B. with G + P trauma		

IOTN © VICTORIA UNIVERSITY OF MANCHESTER

FIG. 1 (a) Aesthetic Component of IOTN. (b) Index of Orthodontic Treatment Need (DHC) ruler. (The scan scale was first published by the European Orthodontic Society; Evans, M. R. and Shaw, W. C. *European Journal of Orthodontics*, 9, 314–18, 1987)

TABLE 1 *The Dental Health Component of the Index of Orthodontic Treatment Need (IOTN)*

Grade 5 (Need treatment)	
5-i	Impeded eruption of teeth (except for third molars) due to crowding, displacement, the presence of supernumerary teeth, retained deciduous teeth and any pathological cause.
5-h	Extensive hypodontia with restorative implications (more than 1 tooth missing in any quadrant) requiring pre-restorative orthodontics.
5-a	Increased overjet greater than 9 mm.
5-m	Reverse overjet greater than 3.5 mm with reported masticatory and speech difficulties.
5-p	Defects of cleft lip and palate and other craniofacial anomalies.
5-s	Submerged deciduous teeth.
Grade 4 (Need treatment)	
4-h	Less extensive hypodontia requiring pre-restorative orthodontics or orthodontic space closure to obviate the need for a prosthesis.
4-a	Increased overjet greater than 6 mm, but less than or equal to 9 mm.
4-b	Reverse overjet greater than 3.5 mm with no masticatory or speech difficulties.
4-m	Reverse overjet greater than 1 mm but less than 3.5 mm with recorded masticatory and speech difficulties.
4-c	Anterior or posterior crossbites with greater than 2 mm discrepancy between retruded contact position and intercuspal position.
4-l	Posterior lingual crossbite with no functional occlusal contact in one or both buccal segments.
4-d	Severe contact point displacements greater than 4 mm.
4-e	Extreme lateral or anterior open bites greater than 4 mm.
4-f	Increased and complete overbite with gingival or palatal trauma.
4-t	Partially erupted teeth, tipped and impacted against adjacent teeth.
4-x	Presence of supernumerary teeth.
Grade 3 (Borderline need)	
3-a	Increased overjet greater than 3.5 mm, but less than or equal to 6 mm with incompetent lips.
3-b	Reverse overjet greater than 1 mm, but less than or equal to 3.5 mm.
3-c	Anterior or posterior crossbites with greater than 1 mm, but less than or equal to 2 mm discrepancy between retruded contact position and intercuspal position.
3-d	Contact point displacements greater than 2 mm, but less than or equal to 4 mm.
3-e	Lateral or anterior open bite greater than 2 mm, but less than or equal to 4 mm.
3-f	Deep overbite complete on gingival or palatal tissues, but no trauma.
Grade 2 (Slight)	
2-a	Increased overjet greater than 3.5 mm, but less than or equal to 6 mm with competent lips.
2-b	Reverse overjet greater than 0 mm but less than or equal to 1 mm.
2-c	Anterior or posterior crossbite with less than or equal to 1 mm discrepancy between retruded contact position and intercuspal position.
2-d	Contact point displacements greater than 1 mm but less than or equal to 2 mm.
2-e	Anterior or posterior open bite greater than 1 mm but less than or equal to 2 mm.
2-f	Increased overbite greater than or equal to 3.5 mm without gingival contact.
2-g	Pre- or post-normal occlusions with no other anomalies (includes up to half a unit discrepancy).
Grade 1 (None)	
1-	Extremely minor malocclusions including contact point displacements less than 1 mm.

Results

The Kappa values of the intra-examiner reproducibility for the DHC and AC were 0.91 and 0.78, respectively. On the other hand, the kappa values of the inter-examiner for the DHC and AC were 0.82 and 0.73, as depicted in Table 2.

When the sex distribution of the DHC and AC components of the IOTN in both population was considered, the difference between the IOTN values of boys and girls were not statistically significant (Table 3 and 4).

The rating for the DHC of IOTN in the school population was found to be distributed as follows; 38.8 per cent in great need for treatment, 24.0 per cent in moderate need

for treatment, and 37.2 per cent slight or no need for treatment (Figure 2).

The results of the rating for the DHC of IOTN for the referred population were 83.2 per cent in great need for treatment, 12.0 per cent in moderate need for treatment, and 4.8 per cent in slight or no need for treatment (Figure 2).

The distribution of ratings for the AC of IOTN in the school population was 4.8 per cent in great need for treatment, 4.8 per cent in moderate need for treatment, and 90.4 per cent in slight or no need for treatment (Figure 3). On the other hand the distribution of ratings for the AC of IOTN in the referred population was 36.8 per cent great need for treatment, 17.6 per cent moderate need for treatment and 45.6 per cent slight or no need for treatment (Figure 3).

The difference between the percentages of the IOTN values in two populations are listed in Table 5a,b. Both DHC and AC of IOTN in all grades were found to be statistically significant in school and referred population.

The component of DHC and AC of IOTN in different population groups are summarised in Table 6a,b.

TABLE 2 *Intra- and inter-examiner variability (Kappa analysis)*

	DHC	AC
Intra-examiner	0.91	0.78
Inter-examiner	0.82	0.73

Kappa values above 0.61–0.80 indicate substantial agreement.

Kappa values above 0.81–1.00 indicate perfect agreement.

TABLE 3 (a) Sex distribution of DHC grades of IOTN in school population

DHC	Girls	Boys	Girls and boys
Grade 1	25 (17.4)	11 (10.3)	36 (14.4)
Grade 2	31 (21.7)	26 (24.3)	57 (22.8)
Grade 3	37 (25.9)	23 (21.5)	60 (24.0)
Grade 4	46 (32.1)	44 (41.1)	90 (36.0)
Grade 5	4 (2.8)	3 (2.8)	7 (2.8)
Total	143 (100.0)	107 (100.0)	250 (100.0)

Chi-square = 4.24 $d_f = 4$ $P > 0.05$.
 Values in brackets are percentages.

TABLE 3 (b) Sex distribution of AC grades of IOTN in school population

AC	Girls	Boys	Girls and boys
Grade 1	35 (24.5)	37 (34.6)	72 (28.8)
Grade 2	42 (29.4)	29 (27.1)	71 (28.4)
Grade 3	38 (26.6)	20 (18.7)	58 (23.2)
Grade 4	12 (8.3)	13 (12.1)	25 (10.0)
Grade 5	2 (1.4)	—	2 (0.8)
Grade 6	1 (0.7)	3 (2.8)	4 (1.6)
Grade 7	4 (2.8)	2 (1.9)	6 (2.4)
Grade 8	7 (4.9)	3 (2.8)	10 (4.0)
Grade 9	2 (1.4)	—	2 (0.8)
Grade 10	—	—	—
Total	143 (100.0)	107 (100.0)	250 (100.0)

Chi-square = 10.36 $d_f = 8$ $P > 0.05$.
 Values in brackets are percentages.

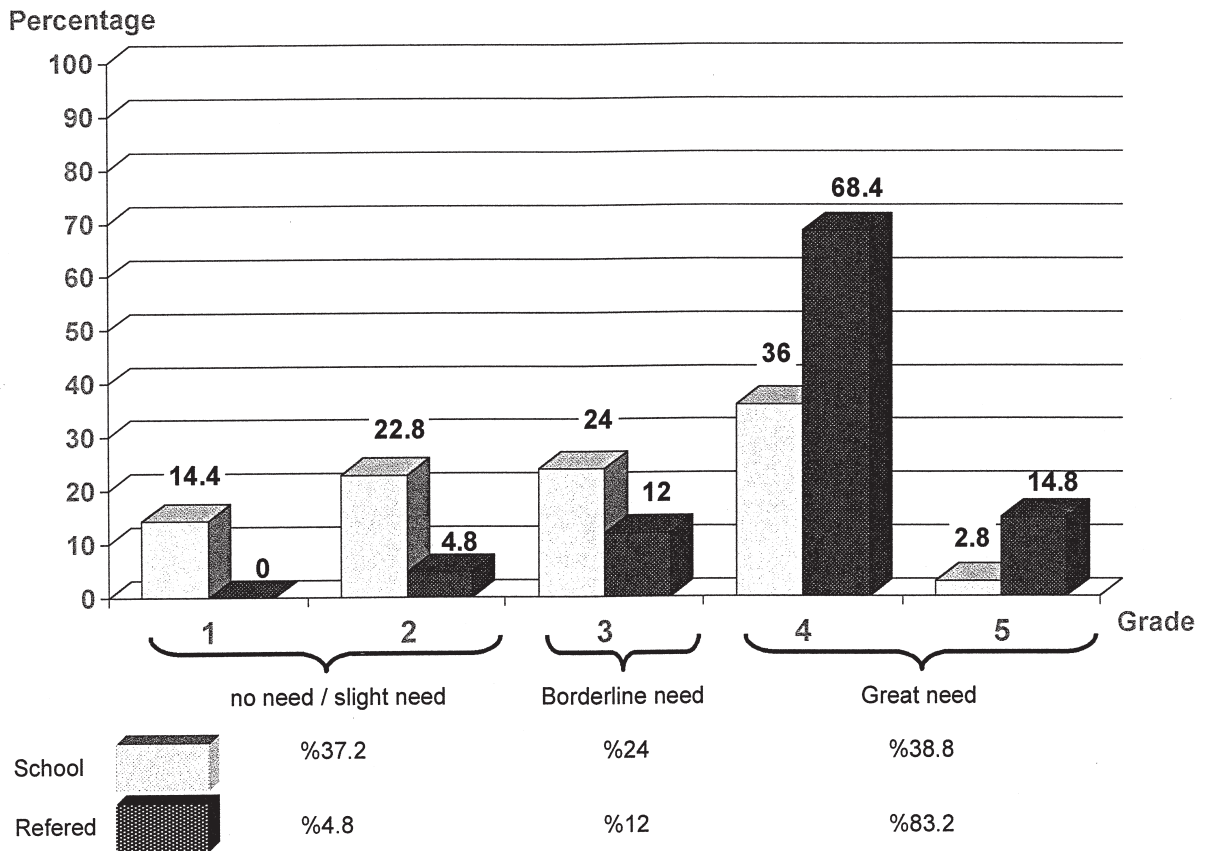


FIG. 2 Distribution of ratings for the DHC of IOTN in school population and referred population.

TABLE 4 (a) Sex distribution of DHC grades of IOTN in referred population

DHC	Girls	Boys	Girls and boys
Grade 1	—	—	—
Grade 2 No/little need	5 (3.25)	7 (7.29)	12 (4.80)
Grade 3 Moderate/borderline need	20 (12.98)	10 (10.41)	30 (12.00)
Grade 4	109 (70.79)	62 (64.58)	171 (68.40)
Grade 5 Great need	20 (12.98)	17 (17.72)	37 (14.80)
Total	154 (100.0)	96 (100.0)	250 (100.0)

Chi-square = 2.83 $d_f = 3$ $P > 0.05$.
 Values in brackets are percentages.

TABLE 4 (b) Sex distribution of AC grades of IOTN in referred population

AC	Girls	Boys	Girls and boys
Grade 1	3 (1.95)	7 (7.29)	10 (4.00)
Grade 2	17 (11.04)	3 (3.13)	20 (8.00)
Grade 3 No/slight need	47 (30.52)	23 (23.96)	70 (28.00)
Grade 4	7 (4.55)	7 (7.29)	14 (5.60)
Grade 5	3 (1.95)	7 (7.29)	10 (4.00)
Grade 6 Moderate/borderline need	12 (7.79)	7 (7.29)	19 (7.60)
Grade 7	8 (5.19)	7 (7.29)	15 (6.00)
Grade 8	47 (30.52)	25 (26.04)	72 (28.80)
Grade 9 Great need	2 (1.30)	3 (3.13)	5 (2.00)
Grade 10	8 (5.19)	7 (7.29)	15 (6.00)
Total	154 (100.0)	96 (100.0)	250 (100.0)

Chi-square = 8.50 $d_f = 9$ $P > 0.05$.
 Values in brackets are percentages.

Percentage

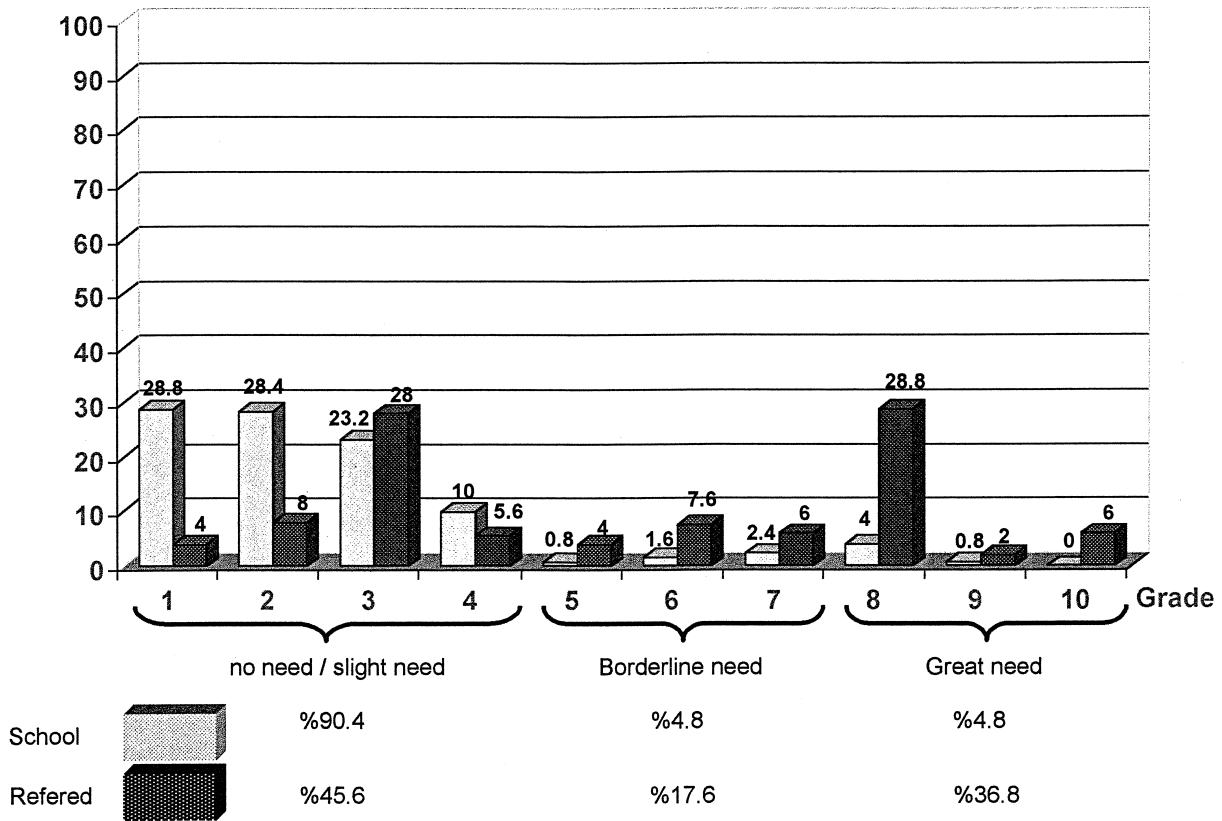


FIG. 3 Distribution of ratings for the AC of IOTN in school population and referred population.

TABLE 5 (a) Distribution of DHC grades and the significant test results (Z-test for two proportions from independent groups)

DHC		School population		Referred population	
		Count (%)	Count (%)	Count (%)	Count (%)
No/little need	Grade 1	36 (14.4)		—	
	Grade 2	57 (22.8) ¹	93 (37.2) ^a	12 (4.8) ²	12 (4.8) ^b
Moderate/borderline need	Grade 3	60 (24.0) ¹	60 (24.0) ^a	30 (12.0) ²	30 (12.0) ^b
	Grade 4	90 (36.0) ¹		171 (68.4) ²	
Great need	Grade 5	7 (2.8) ¹	97 (38.8) ^a	37 (14.8) ²	208 (83.2) ^b
	Total	250 (100.0)		250 (100.0)	

The difference between the percentages shown with different numbers/letters (superscript) on the same row are significant ($P < 0.01$).

TABLE 5 (b) Distribution of AC grades and the significant test results (Z-test for two proportions from independent groups)

AC		School population		Referred population	
		Count (%)	Count (%)	Count (%)	Count (%)
No/slight need	Grade 1	72 (28.8) ¹		10 (4.0) ²	
	Grade 2	71 (28.4) ¹		20 (8.0) ²	
	Grade 3	58 (23.2) ¹	226 (90.4) ^a	70 (28.0) ²	114 (45.6) ^b
	Grade 4	25 (10.0) ¹		14 (5.6) ²	
Moderate/borderline need	Grade 5	2 (0.8) ¹		10 (4.0) ²	
	Grade 6	4 (1.6) ¹	12 (4.8) ^a	19 (7.6) ²	44 (17.6) ^b
	Grade 7	6 (2.4) ¹		15 (6.0) ²	
Great need	Grade 8	10 (4.0) ¹		72 (28.8) ²	
	Grade 9	2 (0.8) ¹	12 (4.8) ^a	5 (2.0) ²	92 (36.8) ^b
	Grade 10	—		15 (6.0)	
Total		250 (100.0)		250 (100.0)	

The difference between the percentages shown with different numbers/letters (superscript) on the same row are significant ($P < 0.01$).

Discussion

There has been an increase in the use of IOTN, recently (Holmes and Willmot 1996). The validity of the use of IOTN index has also been verified by several researchers (Richmond *et al.*, 1994, Burden *et al.*, 1994, Burden and Holmes 1994, Shaw *et al.*, 1995).

In 1994, Burden *et al.* assessed the intraexaminer reproducibility of the IOTN index. The Kappa values were found to be 0.73 and 0.77 for the DHC and AC, respectively. In the same year, Burden and Holmes (1994) also tested the intra examiner reproducibility using Kappa statistics. The values were 0.75 for the DHC and 0.71 for the AC in one study group. In the other study group, the DHC and AC were 0.84 and 0.88, respectively.

In this study, intra-examiner Kappa values were 0.91 and 0.78 for the DHC and AC respectively. On the other side, inter-examiner Kappa values were 0.82 and 0.73 DHC and AC, respectively. When these values were considered, almost perfect agreement was obtained for the DHC and substantial agreement for AC.

The distribution with respect to males and females of orthodontic treatment need has been studied by several researchers (Burden *et al.*, 1994; Güray *et al.*, 1994; Uğur *et al.*, 1998) In 1994, Burden *et al.* found that significantly more males than females were in the need for orthodontic treatment.

In our study, the difference between the IOTN values of boys and girls were not statistically significant (Tables 3a,b and 4a,b). It is interesting to note that this result is in line with the results in Güray *et al.* (1994) and Uğur *et al.* (1998), where the evaluation of orthodontic treatment need was carried out by using the TPI.

The distribution of DHC grades and AC grades has been studied by several researchers (Brook and Shaw, 1989; Burden and Holmes, 1994; Richmond *et al.*, 1994) in the UK. Brook and Shaw (1989) found that, the DHC proportions in 333 school children being 11–12 years old were 32.7 per cent for great need, 35.1 per cent for no need or little treatment need. Burden and Holmes (1994) found that 21–24 per cent of the population were in the great need when DHC was assessed for 1829 school children being 11–12 years old. So and Tang (1993) examined 100 dental students in University of Hong Kong and the result was 52 per cent great need. On the other hand, Güray *et al.* (1994) examined 483 Turkish primary school students in a low socio-economic region. The results was 27.74 per cent normal occlusion, 72.26 per cent need treatment. Uğur *et al.*'s (1998) study resulted in 40.38 per cent normal occlusion, 59.62 per cent need treatment for 572 Turkish primary school children of 6–10 years old. However, Güray *et al.* (1994) and Uğur *et al.* (1998) used TPI. In our study, the DHC scores were found as 38.8 per cent for great need, 37.2 per cent for no or little treatment need in school popula-

TABLE 6 (a) Distribution of ratings for the IOTN in school population according to the several researchers

	School population			
		DHC		AC
Brook and Shaw (1989) England (333 cases)	No need	35.1%	No need	58.2%
	Moderate	32.1%	Moderate	36.3%
	Great need	32.7%	Great need	5.4%
So and Tank (1993) China (100 cases)	No need	23%	—	—
	Moderate	25%	—	—
	Great need	52%	—	—
Burden and Holmes (1994) England (1829 cases)	Great need	21.0–24.0%	Great need	0.5–2.0%
In this study Turkey (250 cases)	No need	37.2%	No need	90.4%
	Moderate	24.0%	Moderate	4.8%
	Great need	38.8%	Great need	4.8%

TABLE 6 (b) Distribution of ratings for the IOTN in referred population according to the several researchers

	Referred population			
		DHC		AC
Brook and Shaw (1989) England (222 cases)	No need	5.9%	No need	18.8%
	Moderate	19.7%	Moderate	49.3%
	Great need	74.4%	Great need	31.4%
Richmond <i>et al.</i> (1994) England (1025 cases)	No need	3.0%	No need	12.0%
	Moderate	19.0%	Moderate	41.0%
	Great need	78.0%	Great need	47.0%
Firestone <i>et al.</i> (1999) Switzerland (95 cases)	No need	4.1%	—	—
	Moderate	14.3%	—	—
	Great need	81.6%	—	—
In this study Turkey (250 cases)	No need	4.8%	No need	45.6%
	Moderate	12.0%	Moderate	17.6%
	Great need	83.2%	Great need	36.8%

tion. When the moderate need and great need for treatment assessment, the need for orthodontic treatment in Turkish school population was found to be 62.8 per cent, which is very near to the result of Brook and Shaw's study (1989, Table 6a). The percentage of great need found by Brook and Shaw (1989) was 74.4 per cent whereas the percentage of great need examined by Richmond *et al.* (1994) was 78 per cent for DHC in referred population. Firestone *et al.*'s study (1999) resulted in 81.6 per cent great need for 95 referred patients who were 12 years old (Table 6b). In our study, the great need percentage resulted in 83.2 per cent in referred population. As it is observed the great need in referred population lies between 74 per cent and 83.2 per cent in different populations.

When the aesthetic component of IOTN was assessed, 4.8 per cent of school population showed great need for treatment. However, great need was found to be 36.8 per cent in referred population. These great need values are satisfactorily in line with those values found by British professionals (Brook and Shaw, 1989; Richmond *et al.*, 1994; Table 6a,b). The individual percentages of AC for no need treatment and moderate treatment found by Brook and Shaw (1989) and Richmond *et al.* (1994) were not close to our findings (Table 6a,b).

The most difficult decision about treatment are those that have to be made for borderline malocclusion with aesthetic implications. Therefore, it might happen that the cut off point for no need and moderate grades (Grades 4

and 5) might sometimes be chosen differently in our study. In a similar manner, Stenvik *et al.*, (1997) determined that the cut-off points for aesthetic treatment need in moderate-borderline grade was used differently.

When DHC of IOTN in school population was considered 38.8 per cent great need which includes grade 4–5 (severe overjet, anterior and posterior crossbite, lateral open bite, etc.) was observed. However, the no need treatment percentage value was 90.4 per cent including grade from 1 to 4 in the AC in the same group. Therefore, the individuals didn't consider to apply for treatment.

On the other hand, when the DHC of IOTN in referred population was assessed, 83.2 per cent great need was observed. In this group, it was interesting to note that the AC component values were 28.0 per cent grade 3 and 28.8 per cent grade 8, which consisted the highest two values (Figure 3). If the scale of the AC was investigated, it could be noted that the canines in both grade 3 and grade 8 are not aesthetic. Brook and Shaw (1989) evaluated AC of IOTN in referred population. The results was 31.4 per cent great need which included 23.6 per cent grade 8. Therefore, it could be concluded that the ectopic canines were the driving factors for the patients to apply for treatment.

The decision to treat or not for referred population depends on many factors in addition to appearance (i.e., health, motivation, cost, risk, duration, prognosis) and cannot to be made therefore solely on the basis of indices of treatment need.

Conclusions

In our study, the Turkish school population under study showed 37.2 per cent no need treatment, 24.0 per cent moderate need and the great need treatment was 38.8 per cent when DHC of IOTN was used.

It is interesting to note that the need for orthodontic treatment in Turkish school population is a high percentage, 62.8 per cent when the moderate need and the great need for treatment is also taken into account, which is almost equal to the percentage values found by Brook and Shaw (1989). This high percentage of orthodontic treatment need also indicates the importance of preventive orthodontic treatment.

On the other hand, the referred Turkish population represented 4.8 per cent no need treatment, 12 per cent moderate need treatment, and 83.2 per cent great need treatment. When compared with the other studies, it is seen that the great need in referred population lies between 74 and 83.2 per cent.

Furthermore, the aesthetic component in the school population resulted in 4.8 per cent great need for treatment. Whereas the same component represented 36.8 per cent great need for treatment in referred population where Grade 8 consisted of 29.2 per cent out of 36.8 per cent great need percentage. Therefore, the ectopic canines (in Grade 8 of AC) are the main motivating factor for the patient to demand for orthodontic treatment.

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