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Prevalence of malocclusion and orthodontic treatment need in children and adolescents in Bogota, Colombia. An epidemiological study related to different stages of dental development

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SUMMARY The aim of the study was to assess the prevalence of malocclusion in a population of Bogotanian children and adolescents in terms of different degrees of severity in relation to sex and specific stages of dental development, in order to evaluate the need for orthodontic treatment in this part of Colombia. A sample of 4724 children (5–17 years of age) was randomly selected from a population that attended the Dental Health Service; none had been orthodontically treated. Based on their dental stages the subjects were grouped into deciduous, early mixed, late mixed and permanent dentition. The registrations were performed according to a method by Björk *et al.* (1964). The need for orthodontic treatment was evaluated according to an index used by the Swedish National Board of Health.

The results showed that 88 per cent of the subjects had some type of anomly, from mild to severe, half of them recorded as occlusal anomalies, one-third as space discrepancies, and one-fifth as dental anomalies. No clear sex differences were noted, except for maxillary overjet, spacing, tooth size (all more frequent in boys), and crowding (more frequent in girls). Occlusal anomalies and space discrepancies varied in the different dental developmental periods, as did tipped and rotated teeth.

Little need for orthodontic treatment was found in 35 per cent and moderate need in 30 per cent. A great need was estimated in 20 per cent, comprising children with prenormal occlusion, maxillary overjet, or overbite (>6 mm), posterior unilateral crossbite with midline deviation (>2 mm), severe crowding or spacing, congenitally missing maxillary incisors, impacted maxillary canines or anterior open bite (>3 mm in the permanent dentition). Urgent need for treatment was estimated to be 3 per cent, comprising subjects with extreme post- and pre-normal occlusion, impacted maxillary incisors or extensive aplasia.

Introduction

The demand for orthodontic treatment is increasing in most countries. Therefore, rational planning of orthodontic measures on a population basis is essential in assessing the resources required for such a service. This stresses the importance of epidemiological studies in order to obtain knowledge about the prevalence of different types of malocclusions and the need for orthodontic treatment.

A large number of studies on the prevalence of malocclusion in different populations have been published (Table 1a). The reported incidences vary from 39 to 93 per cent, making it clear that the majority of children have irregular teeth and an occlusal relationship that differs from the ideal. This divergence in prevalence figures may

Table 1a Prevalence (per cent) of malocclusion in children and adolescents in different ethnic groups.

Authors	Population	Subjects		Registration	%
		No.	Age		
Massler and Fränkel (1951)	Am. Caucasian	2758	14–18	Angle, modified	78.9
Altemus (1959)	Am. Negroes	3289	12–16	Angle, modified	83.5
Mills (1966)	Am. Caucasian	1455	8–17	Angle, modified	82.5
Grewe *et al.* (1968)	Am. Indians	651	9–14	Angle, modified	65.4
Helm (1968)	Danish	1700	9–18	Björk *et al.*	78.5
Helm (1970)	Danish	3848	7–18	Björk *et al.* DS	
Myllärniemi (1970)	Finnish	1531	3–19	Angle, subgroups	38.9
Wood (1971)	Eskimo	100	11–20	Angle, modified	82.0
Thilander and Myrberg (1973)	Swedish	5459	7–13	Björk *et al.*	73.8
Foster and Day (1974)	British	1000	11–12	Angle, modified	59.9
Ingervall and Hedegård (1975)	Skolt-Lapps	200	8–16	Angle, modified	76.5
Infante (1975)	Am. white/black	735	2–6	Angle, modified	31/21
	Apache indian				48
Magnússon (1976)	Icelandic	1641	6–18	Björk *et al.* DS	
Lavelle (1976)	British	1000	15–20	Björk *et al.*, occl. space	
Garner and Butt (1985)	Am. Negroes	445	13–15	Angle, modified	73.0
	Kenyans	505	13–14	Angle, modified	83.2
Kerosuo *et al.* (1988)	Tanzanian	642	11–18	Björk *et al.*	45.0
Kerosuo *et al.* (1991)	Finnish	458	12–18	Björk *et al.*	88.0
Hensel (1991)	German	408	3–10	Angle, modified	77
Lew *et al.* (1993)	Chinese	1050	12–14	Foster and Day	92.9
Otuyemi and Abidoye (1993)	Nigerian	574	12	Björk *et al.*	
Harrison and Davis (1996)	Native Canadian	1438	7–15	Tooth relationship	61.0
Ng' ang' a *et al.* (1996)	Kenyan	919	13–15	Björk *et al.*	72.0
Trottman and Elsbach (1996)	Am. black, white	238	3–5	Angle, modified	56/61
Tschill *et al.* (1997)	French	789	4–6	FDI 1973	57.6
Johannsdottir *et al.* (1997)	Icelandic	396	6	Björk *et al.*	69

depend on differences for specific ethnic groups, but also on wide ranges in number, as well as in age among the subjects examined. However, differences in registration methods, i.e. the criteria for the recorded items, are probably the most important factor explaining these differences.

As will be seen from Table 1a, the methods used may be classified into the following categories:

1. Estimates of the *total frequency* of malocclusion. This is the simplest form of registration, based on a subjective judgement whether or not any specific malocclusion is present.
2. Methods based on *typological classification*, usually that by Angle (1907). Several investigators have emphasized that this classification is not sufficiently differentiated for epidemiological purposes and have therefore supplemented Angle's classification by adding further classes (listed as Angle, modified in Table 1a).
3. Methods in which *single traits of malocclusion* are recorded on the basis of an evaluation of individual morphological variables, comprising *metric* and *qualitative* indices, e.g. the epidemiological registration of malocclusion developed by Björk *et al.* (1964).
4. Methods by which a *malocclusion index* is determined for each individual. Most such indices are intended for establishing the need of orthodontic treatment rather than affording information concerning the prevalence of given manifestations of malocclusion (Table 1b).

As will be seen from Table 1b, no fewer than eight different indices have been used to classify the need for orthodontic treatment. Furthermore, an

Table 1b Orthodontic treatment need (per cent) in children and adolescents in different populations.

Authors	Population	Subjects		Registration	Need
		No.	Age		
Ingervall *et al.* (1972)	Swedish	324	10	Swe NBH	75 40 great
Myrberg and Thilander (1973)	Swedish	5459	7–13	Swe NBH	73.8 34 moderate 11 great
Hannuksela (1977)	Finnish	1200	9	Swe NBH	60.2 18 moderate 25.6 great
Hill (1992)	Scottish	765	9–15	MSI	72
Holmes (1992)	British	955	12	IOTN	33 moderate 32 great
Steigman *et al.* (1983)	Israeli Arab	803	13–15	HMAR	80 30 moderate 12 great
Al-Emran *et al.* (1990)	Saudi Arab	500	13–14	Nor HS	75.5
Diagne *et al.* (1993)	Senegalese	1708	11–19	WHO	32.6 7.6 urgent
Burden and Holmes (1994)	British	1920	11–12	IOTN	33
Wheeler *et al.* (1994)	American	3696	9–10	Exam.	47 white 35 black 40 others
Estioko *et al.* (1994)	Australian	268	12–16	DAI	63.4 18 severe
Shaw *et al.* (1995)	British	333	11–12	IOTN	33 great
Bäßler-Zeltman *et al.* (1998)	German	1020	9	Swe NBH	88 32 moderate 32 great

Swe NBH, Swedish National Board of Health (1967). MSI, Malocclusion Severity Index (Hill, 1992). IOTN, Index of Orthodontic Treatment Need (Brook and Shaw, 1989). HMAR, Handicapping Malocclusion Assessment Record (Salzmann, 1968). Nor HS, Norwegian Health Service (1986). WHO, World Health Organization (1989). Exam., based on orthodontic evaluation of need/no need. DAI, Dental Aesthetic Index (Cons *et al.*, 1986).

index of treatment outcome, the PAR Index (Richmond *et al.*, 1992), has been developed to evaluate treatment success.

An objective registration method is not sufficient to obtain reliable data on the prevalence of malocclusion. Orthodontic treatment, for instance, will have eliminated some types of malocclusions. It is therefore no longer possible to determine the prevalence of malocclusion in some populations, unaffected by orthodontic treatment.

Malocclusion studies have usually been based on grouping of the material by chronological age. Malocclusion, however, is a manifestation of morphological variations that are related to the development of the dentition, rather than to chronological age as such. As there are great individual variations in dental maturation, it seems logical to determine the prevalence of malocclusion for groups of different stages of dental development, rather than for different age groups.

In Colombia, South America, only one study of prevalence of oral health has been published (Moncada and Herazo, 1984). The whole country was divided into five areas for screening 10,968 subjects of both sexes and all ages. A few parameters regarding malocclussion (overjet, overbite, crossbite, diastema, and crowding) were included, but these data gave insufficient information for effective planning of orthodontic treatment.

The aim of the present study was therefore to assess the prevalence of malocclusion in a population of Bogotanian children and adolescents in terms of different degrees of severity in relation to sex, age, and different stages of dental development, in order to evaluate the need for orthodontic treatment in this part of Colombia.

Subjects and methods

Subjects

A sample of 4724 children (2353 girls and 2371 boys) (5 –17 years of age) was randomly selected from a population that attended the Dental Health Service of the Paediatric Clinic of Colsubsidio in the centre of Bogota (Table 2). This Clinic is a new institution, organized for medical and dental health service for children (0–19 years of age) of different social background. Family origin, registered in order to determine the Colombian racial composition of the sample, was found representative of Bogotanians with an ancestry from the central part of the country (Figure 1).

The initial sample was designed to contain 5000 subjects with 384 children (192 girls and 192 boys) in each chronological age from 5 to 17 years of age. Difficulties arose, however, in reaching all adolescents in the age groups 15–17 years, due to their schoolwork. Furthermore,

Figure 1 Map showing the area studied.

Table 2 Distribution of the 4724 subjects (N) related to chronological age. Number of children (n) and percentage ($n/N \times 100\%$).

Age (years)	Girls		Boys		Total	
	n	%	*n*	%	*n*	%
5	217	4.6	197	4.2	414	8.8
6	192	4.1	177	3.8	369	7.9
7	213	4.5	208	4.4	421	8.9
8	199	4.2	204	4.3	403	8.5
9	202	4.3	196	4.2	398	8.5
10	206	4.4	221	4.6	427	9.0
11	224	4.7	226	4.8	450	9.5
12	191	4.0	195	4.1	386	8.1
13	207	4.4	213	4.5	420	8.9
14	173	3.7	183	3.9	356	7.6
15	129	2.7	155	3.3	284	6.0
16	109	2.3	115	2.4	224	4.7
17	91	1.9	81	1.7	172	3.6
Total	2353	49.8	2371	50.2	4724	100

children who had previously had any kind of orthodontic treatment were excluded from the examination. Thus, the final sample was reduced to 4724 subjects. Children with clefts, syndromes, and systemic health disease were not included in this study, as those children are treated in special hospitals.

The subjects were also grouped by stage of dental development (DS), described by Björk *et al.* (1964), according to the variation in tooth eruption:

- deciduous teeth fully erupted (DS02);
- incisors erupting (DS1) and fully erupted (DS2);
- canines and premolars erupting (DS3) and fully erupted (DS4);
- first molars not fully erupted (DSM0) and fully erupted (DSM1);
- second molars fully erupted (DSM2).

Based on their dental stages the subjects were grouped into the following four developmental periods (Table 3):

(1) deciduous dentition (DS02);
(2) early mixed dentition (DS02M1, DS1M0, DS1M1, DS2M0, DS2M1);
(3) late mixed dentition (DS3M1, DS3M2, DS4M1);
(4) permanent dentition (DS4M2).

Clinical examination

For each child, a registration chart related to malocclusions was designed, including all variables with their criteria, described in detail in a manual. Panoramic radiographs (not older than 1 month) were available for all children.

Before clinical registration, the examiners (four orthodontists) took part in a 3-day course on methods of clinical research and orthodontic diagnosis. They then had to pass an inter- and intra-observer calibration test on 15 plaster models with different types of malocclusion, in order to ensure accuracy and consistency of diagnosis. Finally, a pilot study on 50 children of different ages was performed before commencing the present investigation. The differences in the inter- and intra-observer tests were found not statistically significant ($P < 0.01$).

Registration criteria

The registrations were performed according to a method evolved by Björk *et al.* (1964), i.e. a qualitative registration of occlusal, space and dental anomalies, which, by themselves or in combination, characterize malocclusions. The variables, with their criteria, were as follows:

Occlusal anomalies
1. Sagittal anomalies

1. Post-normal occlusion (distocclusion, Angle Class II).
2. Pre-normal occlusion (mesiocclusion, Angle Class III); >1/2 cusp width at the first molar. Migration due to extraction of deciduous molars was taken into account. In the case of extraction of first molars, the registration was

Table 3 Grouping of the 4724 subjects according to specified stages of dental development. Number of children (n) and percentage ($n/N \times 100\%$).

Dentition	Girls		Boys		Total	
	n	%	*n*	%	*n*	%
Deciduous	182	3.9	191	4.0	373	7.9
Early mixed	748	15.9	791	16.7	1539	32.6
Late mixed	667	14.1	704	14.9	1371	29.0
Permanent	756	16.0	685	14.5	1441	30.5

Deciduous: DS02; Early mixed: DS02M1, DS1M0, DS1M1, DS2M0, DS2M1; Late mixed: DS3M1, DS3M2, DS4M1; Permanent: DS4M2. DS according to Björk *et al.* (1964).

made on the second deciduous molars or canines.
3. Maxillary overjet (0 mm = edge-to-edge; 4–6 mm = moderate; >6 mm = severe).
4. Mandibular overjet (all four upper incisors in crossbite).
5. Bimaxillary protrusion (Angle Class I with lip strain over protruded teeth).

2. Vertical anomalies

1. Overbite (0 mm = edge-to-edge; 4–6 mm = moderate; >6 mm = severe).
2. Open bite, anterior (<3 mm = moderate; >3 mm = severe).
3. Open bite, lateral (lack of contact between at least two pairs of antagonists).

3. Transversal anomalies

1. Posterior crossbite (right, left, bilateral, occurrence of guidance was registered).
2. Scissors bite (right, left, bilateral).
3. Midline displacement (registered when >2 mm).

Space discrepancies

1. Crowding and spacing (anterior, posterior) recorded for the incisor segment and the canine-premolar segments of each jaw (1–3 mm = mild; 4–6 mm = moderate; >6 mm = severe).
2. Maxillary median diastema (recorded when >2 mm).

Single tooth anomalies

1. Ectopic eruption, impaction, supernumerary and congenitally missing teeth recorded from the panoramic radiographs.
2. Inverted incisors, canines.
3. Infra-occlusion (recorded for deciduous molars and first permanent molars).
4. Tipped teeth (>30 degrees) and rotated teeth (>45 degrees).
5. Variation in tooth size (microdontia, macrodontia).

Orthodontic treatment need

An effective organization and planning of orthodontic service within the dental health system at the Colsubsidio Paediatric Clinic requires not only prevalence figures of malocclusion, but, above all, data on the orthodontic treatment need. Therefore, a rough grouping of the treatment need was evaluated by one of the authors (BT) according to an index, used by the Swedish National Board of Health (1967) with some modifications as follows:

Grade 1 (little need): Minor deviations from normal occlusion of little cosmetic and/or functional significance, e.g. open bite with little anterior opening, mild crowding or spacing, mild rotations and tippings.

Grade 2 (moderate need): e.g. cosmetic and/or functionally disturbing proclined or retroclined incisors, deep bite without gingival irritation, moderate crowding or spacing, moderate anterior rotations or tippings.

Grade 3 (great need): e.g. anterior crossbite, deep bite with gingival irritation, extreme overjet or open bite, posterior crossbite and scissors bite with functional deviation, severe anterior crowding or spacing, impacted canines, cosmetically and/or functionally disturbing rotations or tippings.

Grade 4 (urgent need): cosmetic and/or functionally handicapping anomalies, e.g. extreme post- and pre-normal occlusion, extensive aplasia.

Statistical analysis

The ratio of the sample, as a maximum estimate of the proportion of occlusal, space, and single dental anomalies in the whole population, was calculated for the total sample and for girls and boys separately. For each of the different stages of dental development the number of children with the diagnosed anomaly (n) and its prevalence ($n/N \times 100$, where N is the number of children examined) is given. Furthermore, the number of diagnoses per individual was calculated, and

some variables were defined in terms of mild, moderate, and severe so that assessment of their ratios in the sample could give rise to an estimate of the degree of severity and, hence, treatment need.

Results

Prevalence of malocclusion

Overall findings

As will be seen from Table 4, dentitions without any irregularity were found in 11.9 per cent. Thus, 88.1 per cent of the children had some type of anomaly, from mild to severe discrepancies. One or two anomalies were registered in 47 per cent, while 8.8 per cent of the children had five or more occlusal traits. In the children with some kind of anomaly, altogether 11,149 diagnoses were recorded (Table 5), half of them as occlusal anomalies, one-third as space discrepancies, and one-fifth as dental anomalies. No clear sex differences were noted, except for maxillary overjet, overbite, spacing, tooth size (all more frequent in boys), and crowding (more frequent in girls) (Table 6). Furthermore, occlusal anomalies and space discrepancies varied in the different dental developmental periods (Table 7), as did tipped and rotated teeth.

Table 4 Number and percentage of subjects according to number of anomalies.

Number of malocclusions	Subjects	
	n	%
0	560	11.9
1	1096	23.2
2	1125	23.8
3	932	19.7
4	594	12.6
5	265	5.6
>5	152	3.2
Total	4724	100

Table 5 Distribution and diagnoses, number (*n*) and percentage.

Diagnoses	*n*	%
Occlusal anomalies	5500	49.3
Space discrepancies	3686	33.1
Dental anomalies	1963	17.6
Total	11,149	100

Occlusal anomalies

Post-normal occlusion (distocclusion), registered as Angle Class II, was recorded in 20.8 per cent (Class II division 1 in 14.9 per cent and Class II division 2 in 5.9 per cent). The prevalence increased with age until the late mixed dentition (up to 24.9 per cent) and then decreased in the permanent dentition (18.5 per cent). Class II division 1 was associated with maxillary overjet, which was the most common sagittal anomaly (25.8 per cent). A marked overjet (>6 mm), however, was recorded in only 3.4 per cent, most commonly in boys. Like post-normal occlusion, maxillary overjet increased in prevalence during the mixed dentition, but decreased in the permanent dentition.

Pre-normal occlusion (mesiocclusion), registered as Angle Class III, was recorded in 3.7 per cent, and, contrary to post-normal occlusion, showed increasing prevalence with age. It was associated with mandibular overjet (5.8 per cent), diagnosed as anterior crossbite and in approximately half of the subjects was caused by anterior guidance of the mandible by an acquired muscular reflex.

Bimaxillary protrusion also increased in prevalence with age, from 5.4 per cent in the early mixed dentition to 15.3 per cent in the permanent dentition.

Deep bite (21.6 per cent) was more common in boys, with the highest prevalence in the late mixed dentition. An extreme overbite (>6 mm) was recorded in only 1.8 per cent, also most frequently in boys. A deep bite was often associated with a Class II malocclusion.

An *anterior open bite* (9.0 per cent) was most frequent in the deciduous and early mixed dentitions (about 11 per cent), decreased in the late mixed dentition (6.2 per cent) and increased again in the permanent dentition (8.7 per cent). An open bite exceeding 3 mm in the adolescent period was registered in 4.2 per cent.

Table 6 Prevalence of occlusal, space, and dental anomalies in the subjects (2353 girls and 2371 boys). Number of children with diagnosed anomaly (*n*) and prevalence given in per cent.

Anomaly	Girls		Boys		Total	
	n	%	*n*	%	*n*	%
Occlusal anomalies						
Sagittal						
Post-normal (distocclusion)	465	19.8	516	21.7	981	20.8
Pre-normal (mesiocclusion)	91	3.8	84	3.5	175	3.7
Bimaxillary protrusion	241	10.2	228	9.6	469	9.9
Maxillary overjet >4 mm	567	24.1	650	27.4	1217	25.8
Mandibular overjet <0 mm	135	5.7	137	5.8	272	5.8
Vertical						
Overbite >4 mm	446	18.9	575	24.3	1021	21.6
Anterior open bite	220	9.3	205	8.6	425	9.0
Transversal						
Posterior crossbite	117	5.0	99	4.2	216	4.6
Scissors bite	33	1.4	28	1.2	61	1.3
Midline deviation >2 mm	311	13.2	313	13.2	624	13.2
Space anomalies						
Crowding	1296	55.1	1167	49.2	2463	52.1
Spacing	537	22.8	686	28.9	1223	25.9
Median diastema >2 mm	141	6.0	190	8.0	331	7.0
Dental anomalies						
Congenitally missing	83	3.5	70	3.0	153	3.2
Supernumerary	35	1.5	52	2.2	87	1.8
Inverted incisors, canines	180	7.6	161	6.8	341	7.2
Infra-occluded	62	2.6	49	2.1	111	2.3
Ectopic	38	1.6	31	1.3	69	1.5
Impacted	82	3.5	64	2.7	146	3.1
Tipped >30°	176	7.5	153	6.5	329	7.0
Rotated >45°	218	9.3	202	8.5	420	8.9
Tooth size (macro/microdontia)	139	5.9	168	7.1	307	6.5

Of the *transverse anomalies*, a midline deviation (>2 mm) was registered in 13.2 per cent, increasing with age and being more frequent in the lower arch. It was often associated with space discrepancies and a posterior crossbite (unilateral in 3.5 per cent and bilateral in 1.1 per cent). Posterior crossbite was most frequent in the deciduous dentition (7.2 per cent).

Space discrepancies

As shown in Table 6, crowding in one or more segments was the most frequent of all anomalies recorded (52.1 per cent) and was more common in girls. As regards the different dental developmental stages, the crowding gradually increased from the early mixed to the young permanent dentition (Table 7). In most cases, it was bimaxillary, i.e. generalized crowding. In cases of local crowding, it was observed in the anterior regions, more frequently in the lower arch, or in the posterior segments, associated with mesial migration of the first permanent molars. Migration of permanent molars (23.9 per cent) was due to carious defects or early extraction of deciduous molars. In most of the subjects the crowding was mild (1–3 mm, 35 per cent), while moderate and severe crowding (>4 mm in the anterior region or in the right or left posterior segments) was recorded in 17.1 per cent of the children (Table 8).

The prevalence of spacing was 25.9 per cent, i.e. it was half as common as crowding. Maxillary median diastema (2 mm or more; 7 per cent) is included in this figure. A median diastema was most common in the early mixed dentition (13.5 per cent), then decreased during dental development to 3.7 per cent in adolescents. Irrespective

Table 7 Prevalence of different types of anomalies in the deciduous, early mixed, late mixed, and permanent dentitions, given in per cent of the different dentition samples (*N*).

Anomaly	Deciduous (*N* = 373, %)	Early mixed (*N* = 1539, %)	Late mixed (*N* = 1371, %)	Permanent (*N* = 1441, %)
Occlusal anomalies				
Sagittal				
Post-normal (distocclusion)	15.5	20.4	24.9	18.5
Pre-normal (mesiocclusion)	2.9	3.9	3.5	4.9
Bimaxillary protrusion	1.3	5.4	11.7	15.3
Maxillary overjet >4 mm	14.7	23.1	31.7	25.9
Mandibular overjet <0 mm	15.0	4.9	6.2	6.9
Vertical				
Overbite >4 mm	18.0	17.4	29.7	19.2
Anterior open bite	10.7	11.4	6.2	8.7
Transveral				
Posterior crossbite	7.2	4.0	3.7	3.9
Midline deviation >2 mm	6.7	8.8	16.4	16.6
Space discrepancies				
Crowding	17.4	50.6	55.7	59.3
Spacing	19.5	15.1	18.5	23.0
Median diastema >2 mm	4.0	13.5	4.0	3.7
Dental anomalies				
Inverted incisors, canines	5.9	6.1	8.8	7.3
Tipped >30°	3.0	3.2	6.5	12.4
Rotated >45°	2.4	4.2	9.2	15.3

Deciduous: DS02; Early mixed: DS02M1, DS1M0, DS1M1, DS2M0, DS2M1; Late mixed: DS3M1, DS3M2, DS4M1; Permanent: DS4M2. DS according to Björk *et al.* (1964).

Table 8 Prevalence of crowding (mild, moderate, severe) in the different dental development stages. Number of children (*n*) and prevalence ($n/N \times 100\%$).

Degree	Deciduous *N* = 373		Early mixed *N* = 1539		Late mixed *N* = 1371		Permanent *N* = 1441		Total *N* = 4724	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%
Mild (1–3 mm)	51	13.7	511	33.2	493	36.0	598	41.5	1653	35
Moderate (4–6 mm)	11	2.9	230	14.9	223	16.3	197	13.7	661	14
Severe (>6 mm)	3	0.8	38	2.5	47	3.4	61	4.2	149	3.1
Total	65	17.4	779	50.6	763	55.7	856	59.4	2463	52.1

of median diastema, local spacing was associated with congenitally missing teeth. Spacing in the posterior segments increased with age, due to extraction of permanent premolars and/or molars, as a result of caries.

Dental anomalies

The prevalences of the different dental anomalies demonstrated, as a whole, close agreement between the sexes (Table 6). The children often showed more than one dental discrepancy.

Tipped (>30 degrees) and rotated teeth (>45 degrees) were the most common dental anomalies (7.0 and 8.9 per cent, respectively). The prevalences increased during occlusal development and reached their highest figures in the permanent dentition (Table 7). Tipped teeth were usually

observed in the posterior segments, associated with early extraction of deciduous molars, while rotated teeth were as frequent in the anterior as in the posterior regions, also associated with crowding.

Inversion of all four maxillary incisors was recorded as mandibular overjet (anterior crossbite) in 5.8 per cent, while single inverted incisors and canines were found in 7.2 per cent, with no difference between the dental stages. The lateral incisors were most often involved (5.8 per cent), followed by the central incisors and canines (0.7 per cent each).

Congenitally missing teeth (third molars excluded) were recorded in 3.2 per cent. The mandibular second premolar was the most affected tooth (0.9 per cent), followed by the lower incisor (0.7 per cent), the maxillary lateral incisor (0.6 per cent), the second maxillary premolar (0.5 per cent), and others (0.5 per cent). In 11 of the children (mainly boys), congenitally missing deciduous teeth were also recorded, all of them lateral incisors. In these subjects, the permanent successor was also congenitally missing.

Almost all supernumerary teeth were recorded as mesiodens (1.8 per cent), only a few as para- and disto-molars in the lower jaw.

Impacted teeth (third molars excluded) were recorded in 3.1 per cent. The maxillary canine was the most affected tooth (1.7 per cent), followed by premolars in both jaws (1.2 per cent), maxillary incisors and mandibular canines (0.1 per cent each). Of the ectopically erupted teeth (1.5 per cent), almost half were maxillary canines with a disturbed path of eruption, but not diagnosed as impaction.

Infra-occlusion of the first and second deciduous molars was recorded in 2 per cent in the early mixed dentition. Only 0.3 per cent of permanent molars were infra-occluded.

Deviation from normal dental morphology (6.5 per cent) was more frequent in boys. Microdontia was four times as common as macrodontia and consisted of peg-shaped teeth, in almost 90 per cent involving the maxillary lateral incisor. Macrodontia, on the other hand, usually affected the maxillary central incisors as shovel-shaped teeth.

Orthodontic treatment need

It will be seen from Table 4 that no malocclusion traits were observed in 11.9 per cent of the subjects, and these children were registered as 'ideal' or 'normal' cases, i.e. children showing dentitions without any irregularity. Thus, 88.1 per cent of the subjects were considered to be in need of orthodontic treatment, from little to urgent need.

A rough grouping of the children in the four different grades of treatment need, used by the Swedish National Board of Health (Swe NBH) (Figure 2) showed that little need (Grade 1) was found among 35 per cent of the children. This category comprised subjects with minimal deviations from 'normality', i.e. children with overjet/overbite (<3 mm), mild crowding/spacing, infra-occlusion, supernumerary, or ectopic teeth.

The prevalence of moderate need (Grade 2) was estimated at 30 per cent and this was recorded for subjects with moderate crowding or spacing, maxillary overjet or overbite (4–6 mm), aesthetically disturbing bimaxillary protrusion, rotated and tipped maxillary incisors, or single inverted incisors/canines.

A great need (Grade 3) was estimated to be present in 20 per cent. This group consisted of subjects with mesiocclusion, inversion (two or three incisors), maxillary overjet or overbite (>6 mm), posterior unilateral crossbite with a

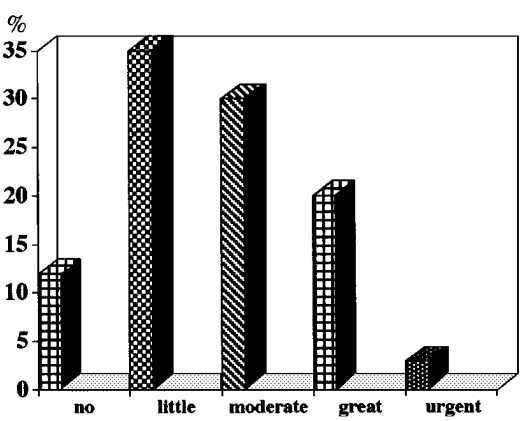

Figure 2 Orthodontic treatment need in the Bogotanian children and adolescents.

midline deviation (>2 mm), severe crowding or spacing, congenitally missing maxillary incisors, impacted maxillary canines, or anterior open bite (>3 mm in the permanent dentition).

The prevalence of urgent need (Grade 4) was estimated to be 3 per cent, comprising subjects with extreme distocclusion and mesiocclusion, impacted maxillary incisors, or extensive aplasia.

Discussion

In this study, specific criteria for random subject selection were used and the racial composition of the sample was representative of Bogotanians with an ancestry from the central part of the country. The sample consisted of children and adolescents of different ages; none had been orthodontically treated, either by interceptive or by corrective measures. In studies of prevalences of malocclusion, the material should be obtained from a well-defined population, be large enough, and cover non-orthodontically treated children and adolescents of different ages. Thus, the present sample satisfies these requirements well.

The clinical registrations were based on the method evolved by Björk *et al.* (1964), a method that has been used in many studies during recent years (Table 1a) and, hence, allows objective comparisons of the presence of malocclusion in different populations. The examiners had to pass an inter- and intra-observer calibration test before the start of the study, which resulted in satisfactory conformity, and the risk of methodological misjudgements is consequently considered to be small.

The results showed that 88 per cent of the subjects had some type of anomaly, from mild to severe. Such a high prevalence is in agreement with most previous published studies using the same classification system (Table 1a). Many papers have used Angle's classificaton (1907) or various modifications of his system, which will jeopardize comparison of the total prevalence of malocclusion traits. However, as Table 1a clearly shows, racial differences do exist. It can also be seen that differences exist between chronological ages.

A few studies on prevalence of malocclusions in preschool children have been published (Table 1a), based on various classification systems. The numbers of children examined in the different studies are of about the same magnitude as for children in the deciduous group in the present investigation, so comparisons of some malocclusion traits may be made. Generally, the present study shows a lower prevalence of anterior open bite (10.7 per cent) and especially posterior crossbite (7.2 per cent), but a higher prevalence of crowding (17.4 per cent) than in Europeans and white Americans. The prevalences in Bogotanian preschool children are, however, closer to those of Indians and black Americans.

Sex differences in some malocclusion prevalences were demonstrated in the different dental stages. It is well known that there are developmental differences in tooth eruption time between boys and girls, as well as between individual children; some are 'early' and some 'late' throughout their occlusal development. This is also valid for the present sample, as the various dental stage groups comprised children of different ages. Due to these great individual variations, grouping by dental stage, rather than by chronological age would seem to increase the probability of detecting sex differences in malocclusion prevalence during the development of the dentition.

When comparing the prevalences of malocclusion in the three developmental stages (early mixed, late mixed, and permanent dentition), it must be taken into account that the present study is cross-sectional. Although the sample was sufficiently large to demonstrate changes in the prevalence of the anomalies from one dental stage to another, individual changes in the morphological variables could not be assessed. This would have required longitudinal collection of the material. Longitudinal follow-up of the present sample seems, however, to be impossible to perform due to social conditions in this region. However, the classification according to dental stage resulted in three groups of rather equal size, i.e. those of special interest from developmental aspects (early mixed, late mixed and young permanent dentition). It was clearly shown that changes in prevalences in the different dental periods occurred. Despite being cross-sectional in nature, the present study may thus

justify recommending the orthodontist to use this knowledge in orthodontic treatment planning.

Crowding was the most common anomaly and was recorded in 52.1 per cent, which is a higher figure than reported in other publications. In one-third of these subjects, the crowding was mild, but moderate or severe in 17 per cent. The prevalence increased from the early mixed to the permanent dentition. Plaque, caries lesions and extracted deciduous molars were of frequent occurrence. The occlusal development became negatively influenced due to mesial migration of the first permanent molars (25 per cent), which in turn caused deviation of the midline, tipped (>30 degrees) and rotated (>45 degrees) teeth. Thus, it cannot be excluded that poor dental health partly explains the high prevalence of crowding. A prophylactic oral hygiene programme is of greatest importance for this population and such a programme was commenced during this study. It would be of interest to find out if this decreases the prevalence of malocclusion, especially crowding.

The prevalences of occlusal anomalies agree on the whole with figures given in the literature for Europeans and white Americans. No marked sex difference was observed in the prevalence of Angle Classes II and III. However, differences between the developmental periods were observed, e.g. decreasing prevalences of Class II, but increasing prevalences of Class III, especially from the late mixed to the permanent dentition, a period of average mandibular growth spurt. Knowledge of the relationship between the growth patterns of the jaws and the development of the occlusion is essential for an understanding of the occurrence of sagittal malocclusions in different ages. It is well known from longitudinal cephalometric studies that mandibular prognathism increases in relation to the maxilla with age (Björk and Skieller, 1983). This explains why the prevalence of maxillary overjet decreased, but the prevalence of mandibular overjet increased during these periods.

Differences in the prevalences between Class III and mandibular overjet (3.7 and 5.8 per cent, respectively) indicate a functional anterior crossbite in 2.1 per cent, i.e. an anterior guidance of the mandible due to a muscular reflex. A functional anterior crossbite generally shows a Class III molar relationship in the centric position, but a Class I relationship in the retruded position and should therefore be diagnosed as a Class I malocclusion according to Angle. Negligence of such a differential diagnostic principle may explain variations in Class III prevalences given in the literature. However, a high incidence of anterior crossbite in Class I, as well as in Class III malocclusions has been reported in Chinese and Indian schoolchildren, in the Chinese sample combined with crowding in the upper anterior region (50 per cent), as a result of retrognathic maxillary growth.

Of the vertical anomalies, deep bite (overbite >4 mm) was more than twice as frequent as anterior open bite. The prevalence of deep bite increased up to the late mixed dentition, which may be explained by the common use of extraction of deciduous molars, a procedure that will usually result in a collapsed dentition. Full eruption of the premolars and second molars aims to stabilize the occlusion, which may explain the decrease in the prevalence of deep bite in the permanent dentition. Another explanation is that during craniofacial growth the mandible will rotate in a backward direction (posterior according to Björk and Skieller, 1983), while the overjet will decrease. This hypothesis on mandibular backward rotation was confirmed by the fact that the anterior open bite increased from the late mixed to the permanent dentition. This is in agreement with cephalometric data from Inuit adolescents (showing open bite in 14 per cent), demonstrating a long lower face and high mandibular plane, characteristics that are associated with an open bite configuration. Anterior open bite is also frequent in black American adolescents; an overall prevalence of 10 per cent has been reported, compared with about 1 per cent in white American adolescents.

Bimaxillary protrusion is a characteristic finding in black populations, but prevalences from those and other populations are missing. Clinical experience, however, tells us that a subjective need and demand for orthodontic treatment exists in some populations, which also is true for the Bogotanian children. Bimaxillary protrusion, therefore, had to be one of the

malocclusion traits included in the present study. It was, however, difficult to distinguish between mild, moderate, and pronounced cases without cephalometric analysis. Therefore, only clinically observable traits of protrusion were noted, which, according to the Bogotanian orthodontic examiners, were not difficult to classify.

Posterior crossbite was registered in only 4.6 per cent, which is close to findings in rural Nigerian, Indian, and Chinese children, but much lower than in other populations, for which prevalences varying between 8 and 16 per cent have been reported. The great majority are unilateral, and often associated with forced guidance and mandibular midline deviation, which was also observed in the present study. It is generally considered that the influence of finger- and dummy-sucking is one aetiological factor of unilateral crossbite in the early dentition. One explanation for the low prevalence in the present sample might be that oral habits are rather rare among small Bogotanian children, who are usually breast-fed for at least the first year of life.

For the dental anomalies, no differences in frequencies were observed between boys and girls. Irrespective of congenitally missing teeth, the figures were of about the same magnitude as those given in previous publications. The congenital absence of 3.2 per cent of teeth in the present material is very low compared with the 6.0–8.5 per cent given in the literature. In the present study, only panoramic radiographs from subjects in the late mixed and permanent groups were used, to ensure that the lateral incisors and the premolars had reached such a maturation that they could be observed on the radiographs. A reduction in tooth form is a common sign in patients with congenitally missing teeth, and in the present sample conical or peg-shaped upper lateral incisors were seen in 4.8 per cent. Heredity is one of the most important aetiological factors in congenitally missing teeth as in reduction of tooth material. No extraction of permanent upper laterals or premolars had been carried out according to the dental examination charts of each child. Thus, heredity must explain the low prevalence of hypodontia in the Bogotanian population.

Some other occlusal traits also vary in frequency between the Bogotanian children and other populations. A mixture of races live in Colombia; Indians in the south, black people in the west and Caribbeans in the northern part of the country (Figure 1). Thus, it would be of great interest to repeat the present study in those areas, which might reveal racial differences.

The need for orthodontic treatment has been presented in the literature by means of different indices (Table 1b). In the present study, the classification by SweNBH was used as one of the authors is familiar with this index. This classification is a method of defining the severity or degree of traits, which are divided into four grades intended to define the urgency of treatment need. However, the dividing lines between the grades are somewhat vague, which may result in loss of reproducibility, especially among untrained examiners. Due to that fact, only a rough estimate by one of the authors was made from the registration charts at the end of the examination. Despite this, the overall objective need for orthodontic treatment in the Bogotanian sample seems to be of the same magnitude as has been described for other populations. However, differences exist between great, severe and urgent need in various populations, which cannot be attributed solely to the populations studied, but are also due to differences in the interpretation of the criteria when grading treatment need.

The number and severity of malocclusal traits may reflect the need and demand for orthodontic treatment in the individual case. However, an evaluation of the subjective need is not included in the SweNBH classification. Such information would require the use of other methods, e.g. the aesthetic component of IOTN according to a 10-point scale. The demand for treatment could be assessed by interviewing the children and their parents. The use of special methods to obtain information on subjective need for treatment and demand for such orthodontic care was, however, not realistic in the present study.

As for the need of treatment in different populations and cultures, there are usually several levels of treatment need based on socio-economic

and/or ethnic differences. Thus, orthodontic treatment need should be understood as a relative concept and, when expressed as a single figure, is not easily comparable between different cultures. However, as regards facial appearance, cultural factors have a strong effect, i.e. an anomaly judged as aesthetically unacceptable in one population may be acceptable and even a sign of beauty in another.

The need for orthodontic treatment seems to be great in the Bogotanian sample. Most of the major occlusal trends characterizing the young permanent dentition were detectable at early developmental stages, which suggests that development of the occlusion is a continuum. Consequently, the question will arise: When to start treatment? Prevention and early treatment in orthodontics are still controversial with respect to cost effectiveness analysis, and functional and psychological benefit. Although the present study has demonstrated a great and urgent need for orthodontic treatment (close to 25 per cent), oral hygiene aspects must be taken into consideration. Preventive programmes and early treatment of caries are still the best means of reducing the high prevalences of malocclusion traits, especially crowding. The question of the orthodontic treatment need therefore remains irrelevant as long as dental health care is neglected.

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