Preventive and Interceptive Orthodontic Treatment Needs of an Inner-City Group of 6- and 9-Year-Old Canadian Children

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ABSTRACT

Objective: Early recognition of developing malocclusions and the potential for uncomplicated orthodontic treatment procedures can minimize or eliminate future costly treatment. This study was designed to assess the potential for this approach in children living in a limited-income environment. A modified index for preventive and interceptive orthodontic needs (IPION) was used to determine the need for such treatment in schoolchildren aged 6 and 9 years.

Methods: Two calibrated examiners examined each child independently and assessed several components of his or her occlusion, including molar relationship, crossbite, open bite, overbite and overjet. Dental variables such as presence of caries and early loss of teeth were also noted. Informed consent was obtained and all children present at school on the day of the field study were included. A total of 395 children were divided into 2 groups, aged 6 and 9 years.

Results: A high prevalence of caries in the deciduous dentition (30.4% for 6 year olds; 20.6% for 9 year olds) and early loss of primary teeth (11.9% for 6 year olds; 29.4% for 9 year olds) was observed. A large percentage of children had crossbite in the anterior or posterior segments, or both. Open bites were also a common finding. Future orthodontic problems were identified in 28% of this population by using the modified IPION. No statistically significant differences ($p > 0.05$) were found between sexes or age groups using the χ^2 test.

Conclusions: Most of the developing malocclusions identified in this study would be amenable to interceptive orthodontics, consisting of space maintenance, crossbite correction and arch expansion.

MeSH Key Words: Canada; malocclusion/prevention & control; orthodontics, interceptive; orthodontics, preventive

Preventive orthodontics are procedures to promote the development of a normal occlusion and aid in preventing malocclusion from developing.[1] Interceptive orthodontics are procedures to restore a normal occlusion once a malocclusion has started to develop.[1] Genetic and environmental factors can contribute to the development of malocclusion and can span several years, rendering it difficult to determine specific causative factors.[2] Malocclusions are not life threatening, but are important public health issues[3] as most can be prevented or intercepted.[1]

Intercepting a developing malocclusion in a public health program requires a simple, reliable method for identifying or measuring the degree of malocclusion. Several indices have been described in the literature, the most

Table 1 Occlusal traits and criteria measured by IPION

6 year olds	9 year olds
Caries	Caries
Early loss	Early loss
Molar relationship	Molar relationship
Rotation/tipping of molars	Rotation/tipping of molars
Overjet	Overjet
Overbite	Overbite
Anterior crossbite	Anterior crossbite
Posterior crossbite	Posterior crossbite
Open bite	Open bite
Lip incompetency	Lip incompetency
	Submerged teeth
	Active frenum
	Absent incisors

prominent being the treatment priority index,[4] although it is of limited use in screening for preventive or interceptive orthodontic needs. A more recent tool is the index for orthodontic treatment need,[1] which has 5 categories from "no need for treatment" to "treatment needed." It also has both a dental health component and an esthetic component.[5]

Recently, the index for preventive and interceptive orthodontic needs (IPION) was described and is currently the only such reported index.[6] The goal of IPION is to allow early detection of developing malocclusions, so that simple interceptive treatment can be undertaken to minimize or eliminate the need for more extensive and costly orthodontic treatment later.[6] IPION measures various occlusal traits (**Table 1**) and assigns a value depending on their severity. The trait scores are then added, yielding a total score that indicates the need for preventive or interceptive orthodontic treatment. Different factors have an influence on the development of malocclusion in 6 and 9 year olds, which is why slightly different indices exist for the 2 age groups.

Although the index is a valuable tool for planning prevention or interception of potential malocclusions, it does not indicate the true prevalence of malocclusion. Severe malocclusions may be placed in a low treatment category due to the impracticality or inadvisability of rendering either preventive or interceptive treatment at the time of assessment.

In terms of cost-effectiveness of orthodontic screenings, the cost of screening 1,837 children was less than that of 7 courses of treatment undertaken in general practice to correct overcrowding of a fully developed Class I malocclusion.[7] In light of this finding, we deemed it useful to conduct research on IPION in Canada.

This study was designed to determine the prevalence of malocclusion that is amenable to interceptive orthodontic intervention in 6- and 9-year-old schoolchildren from socioeconomically challenged communities in Winnipeg. Because of the socioeconomic environment in this area where parental unemployment rates are high,[8–10] these children may not have had adequate previous access to necessary preventive and interceptive dental care.

Table 2 Number of teeth affected by caries

No. of teeth	No. (and %) of 6 year olds affected	No. (and %) of 9 year olds affected
0	140 (69.7)	154 (79.4)
1	27 (13.4)	18 (9.3)
2	17 (8.5)	8 (4.1)
3	6 (3.0)	4 (2.1)
4+	11 (5.5)	10 (5.1)

Methods

Study Population

Schools were chosen within the inner-city area of Winnipeg, based on the 1996–1999 Winnipeg School Division No.1 demographics reports.[8–10] Twenty schools were selected, in which at least 30% of all parents were unemployed. Ten schools participated resulting in a total of 1,807 eligible children — 818 in the 6-year-old group and 989 in the 9-year-old group. Consent was obtained for 413 (22.9%) children: 216 (26.4%) in the 6-year-old group and 197 (18.9%) in the 9-year-old group. Inclusion criteria were age as close as possible to 6 or 9 years, consent, present the day of screening and no previous orthodontic treatment.

Clinical Examinations

A fourth-year dental student and a supervising instructor, working blind to each other's findings, examined every child. Infection control procedures as outlined by the Centers for Disease Control and Prevention were used.[11] Children were examined in a chair in an upright position using mouth mirrors and plastic rulers. No radiographs were taken due to ethical concerns. Modified IPION criteria were applied.[4] Partial cusp Class II molar relationships (i.e., quarter-cusp or half-cusp Class II) were recorded as a Class II molar relationship. The child's age at the last birthday was considered the child's age at examination.

Examiner Calibration

Examiner training and calibration was performed using sample study models and inter-examiner agreement was assessed for those components of the IPION that the study models allowed.

Two calibrated examiners, working blind to each other's findings, carried out all parts of the examination. Intra-examiner agreement was set at 10%.

Table 3 Teeth most commonly affected by caries

Tooth type	No. (and %) of 6 year olds affected	No. (and %) of 9 year olds affected
Primary first molars	27 (3.4)	36 (4.6)
Primary second molars	60 (7.5)	43 (5.5)
Permanent first molars	33 (4.1)	31 (4.0)
Primary canines	8 (1.0)	5 (0.6)

Table 4 Premature loss of primary teeth

No. of teeth	No. (and %) of 6 year olds affected	No. (and %) of 9 year olds affected
0	177 (88.1)	137 (70.6)
1	14 (7.0)	22 (11.3)
2	6 (3.0)	23 (11.9)
3	3 (1.5)	4 (2.1)
4+	1 (0.5)	8 (4.1)

Table 5 Teeth most commonly affected by early loss

Tooth Type	No. (and %) of 6 year olds affected	No. (and %) of 9 year olds affected
Primary second molar	5 (0.6)	25 (3.2)
Primary first molar	23 (2.9)	34 (4.4)
Primary canine	11 (1.4)	65 (8.4)

Table 6 Number of children with molar occlusion according to Angle's classification

Classification	No. (and %) of 6 year olds affected (n = 201)	No. (and %) of 9 year olds affected (n = 194)
Not measurable	42 (20.9)	5 (2.6)
Class I	99 (49.3)	98 (50.5)
Class II	51 (25.4)	86 (44.3)
Class III	9 (4.5)	5 (2.6)

Ethical Consideration

The study was approved by the Winnipeg School Division as well as the University of Manitoba's ethics committee. Informed consent was obtained from parents or guardians.

Statistical Analysis

All results were tested for statistically significant differences between age groups and genders using the χ^2 test.[12] Inter- and intra-examiner agreement were evaluated using the weighted kappa statistic.

Results

Of the 413 children for whom consent was obtained, only 395 were present in school and examined on the day of the study. In the 6-year-old group, 201 children were examined (79 boys and 122 girls); their ages ranged from 5 years 9 months to 7 years 5 months. In the 9-year-old group, 194 children were examined (83 boys and 111 girls); their ages ranged from 8 years 6 months to 10 years 4 months.

Caries

In the 6-year-old group, 13.4% of children had caries affecting 1 tooth and 17% had caries affecting more than 1 tooth; in the 9-year-old group, 9.3% had caries affecting 1 tooth and 11.3% had caries affecting more than 1 tooth (**Table 2**). For the 6 year olds, caries were most common in primary second molars (7.5%), followed by the permanent first molars (4.1%); in the 9 year olds, primary second molars (5.5%), followed by primary first molars (4.6%) were most commonly affected (**Table 3**).

Premature Loss of Teeth

Premature loss of primary teeth was recorded when a tooth was absent, regardless of the reason for its loss. The majority of children examined did not exhibit any premature loss of teeth (**Table 4**). The most commonly missing teeth were the primary first molars (2.9%), followed by the primary canines (1.4%) for the 6 year olds; in the 9 year olds, the primary canines (8.4%) were most commonly missing, followed by the primary first molars (4.4%) (**Table 5**).

Molar Relationship

As is common in 6-year-old children, 20.9% of those examined did not have occlusions that could be classified because the permanent molars had not yet erupted (**Table 6**). Of the 159 children in the 6-year-old group who did have measurable occlusions, 62.3% presented as Class I, 32.1% as Class II and 5.7% as Class III, according to Angle's classification. Only 2.6% of children in the 9-year-old age group had occlusions that could not be classified due to noneruption. Of the 189 children who did have measurable occlusions, 51.9% presented as Class I, 45.5% as Class II and 2.6% as Class III.

Occlusion

Of the children with measurable occlusions, 11.2% of the 6-year-old children had an overjet > 5.0 mm compared with 17.5% of the 9-year-old children (**Fig. 1**). As well, 24.1% of the 6-year-old group and 23.2% of the 9-year-old group presented with a deep overbite (≥ 2/3 of lower incisor covered) (**Fig. 2**). Crossbites were found to be more common in the anterior segment (**Fig. 3**) than the

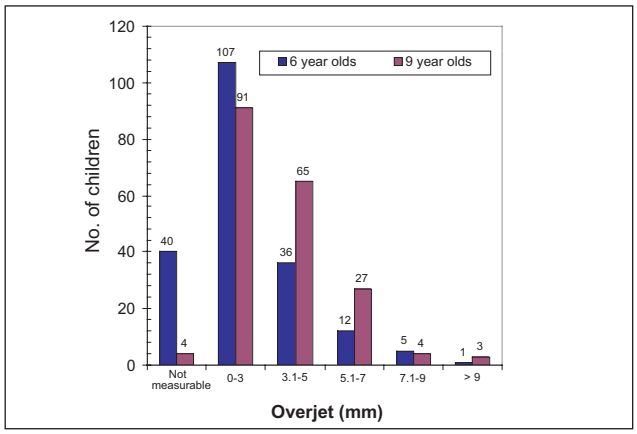

Figure 1: Number of children with overjet

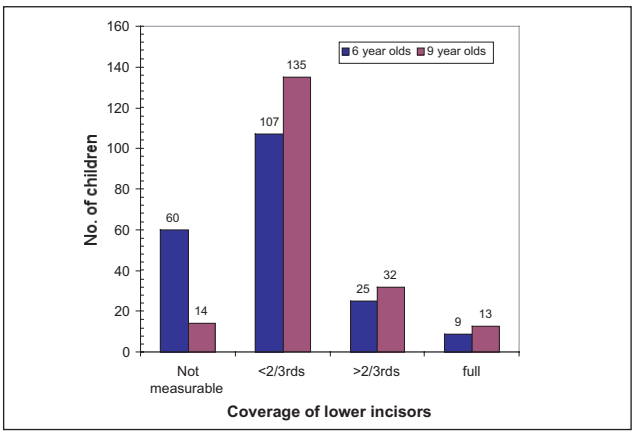

Figure 2: Number of children with overbite

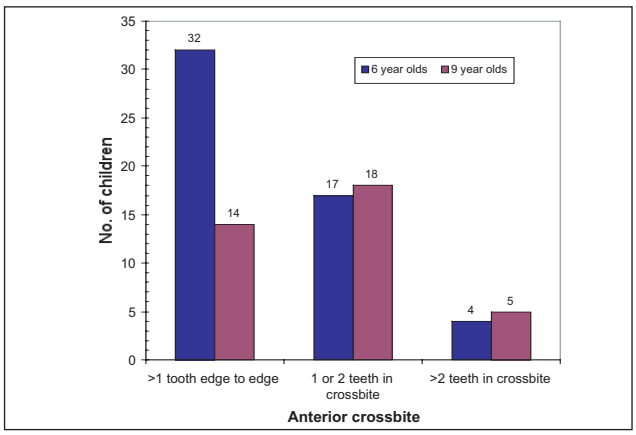

Figure 3: Number of children with anterior crossbite

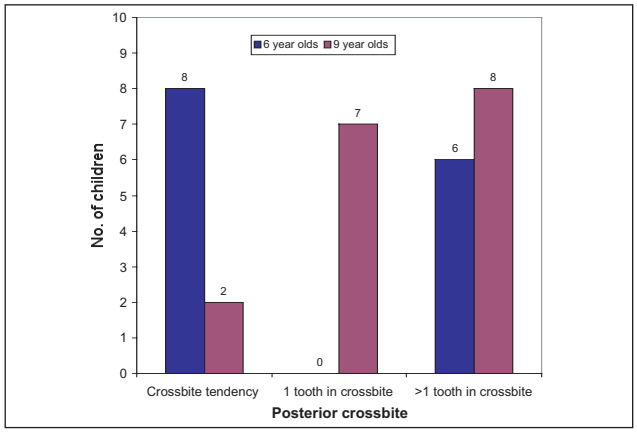

Figure 4: Number of children with posterior crossbite

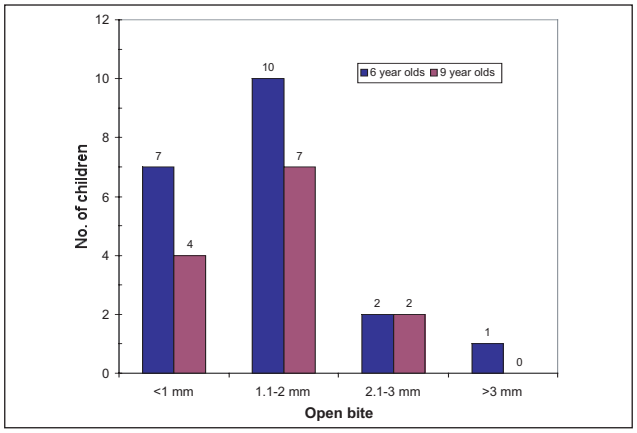

Figure 5: Number of children with open bite

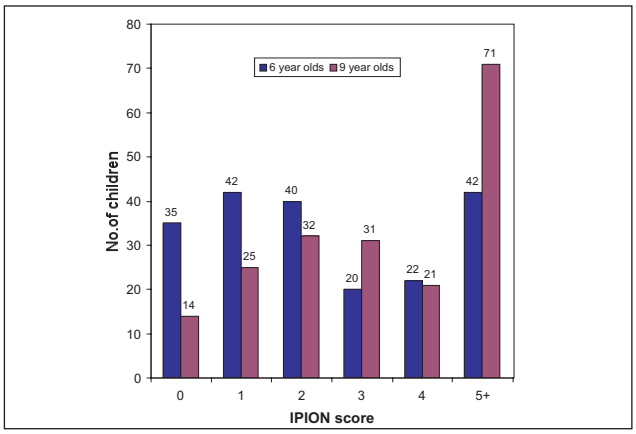

Figure 6: IPION scores for all children

posterior segment (**Fig. 4**) for both groups. In the 6-year-old group, 10.5% exhibited some form of anterior crossbite compared with 11.9% in the 9-year-old group. Posterior crossbites occurred in 3.0% of the 6-year-old children, while another 4.0% displayed a crossbite tendency; this finding was almost double in the 9-year-old group at 7.8% of children with crossbite and 1.0% displaying a crossbite tendency (**Fig. 4**). An anterior open bite was found in 10.0% of the 6 year olds and 6.7% of the 9 year olds (**Fig. 5**).

IPION Scores

IPION scoring for both groups is shown in **Fig. 6**. A score of 5 was determined to be a reasonable indicator of the need for preventive and interceptive orthodontic

treatment. Of the 6-year-old children, 17.4% scored 0 on the IPION compared with 7.3% of the 9-year-old group. Most children scored between 1 and 4; the proportion was higher among the 6 year olds (61.7%) than the 9 year olds (55.7%). Overall, a considerable proportion of children scored 5 or higher: 42 children in the 6-year-old group (20.9%) and 72 in the 9-year-old group (37.1%).

No statistically significant differences were found between sexes or age groups, using χ^2 analysis. A weighted kappa value of 0.95 indicated almost perfect inter-examiner agreement, and a value of 0.91 indicated almost perfect intra-examiner agreement.

Discussion

Only a few studies have dealt with preventive and interceptive orthodontics. Two studies were conducted in the United States,[13,14] in which patients were treated to determine the success of preventive and interceptive orthodontics. In the first,[14] interceptive treatment benefited 27.3% of all treated cases. In the second,[13] 15% of potential patients were judged to be good candidates for preventive and interceptive orthodontics, but it was concluded that despite the potential benefit to these patients, it may not be cost-effective to emphasize a relatively expensive treatment modality on a population basis. Two studies in Finland,[15,16] found that 25.8% and 20.4% of children were in need of some kind of preventive or interceptive orthodontic treatment.

Caries was a common finding in the present study. Untreated carious primary teeth create a risk for malocclusion by shortening the dental arch either through breakdown of interproximal surfaces or loss of these teeth.[17] Premature loss of primary teeth is regarded as the most common local factor leading to a malocclusion.[18] Premature loss of primary teeth was more common in our 9-year-old group (29.4%) than in the 6-year-old group (11.9%). This could be attributed to the normal sequence of eruption in 9 year olds, as many deciduous teeth exfoliate at this age. Similar to our study, research in South Africa reported a high prevalence of both premature loss of primary teeth and unrestored dental caries.[19] Early tooth loss could eventually create a space shortage if the remaining teeth drift into the leeway space. Preservation of this space could be achieved with space maintenance appliances.[20]

It is disturbing to note that no children with premature loss of teeth examined in our study presented with any form of space maintenance device. Parents may ignore space shortage in their children for several reasons. They may believe that the permanent successor will erupt soon. Alternatively, the economic status of the families may not allow for the provision of treatment or, of greater concern, the parents may not have been made aware of the importance of space maintenance by health care workers (school nurse, hygienist, dentist).

Crossbites should be treated as soon as they are detected, because a purely dental malocclusion may lead to growth problems and skeletal deviations if left untreated.[21] This is especially true in posterior crossbites caused by a functional shift. These crossbites should be corrected as soon as they are discovered, even in the deciduous dentition.[20] Anterior crossbites are best treated at an early age, because the upper incisor may traumatically occlude with the lower incisor, potentially giving rise to adverse periodontal problems, mobility and fracture.[22] Anterior crossbites were found to be more common in both age groups compared with posterior crossbites. Anterior crossbites were found in 10.5% of the 6 year olds and 11.9% of the 9 year olds. These findings were similar to those reported by Coetzee and Wiltshire,[19] who found a 13.1% prevalence of anterior crossbite among 3- to 8-year-old children in South Africa. In our study, posterior crossbites among the 9 year olds were more than twice as frequent as in the 6-year-old group (7.8% vs. 3.0%). Spontaneous correction of posterior crossbite has been reported in the literature[21] but is rare at best. Many of these crossbites, especially single-tooth crossbites, could be successfully intercepted with removable appliances (z-spring appliance).

Coetzee and Wiltshire[19] reported a prevalence of a deep anterior overbite of 18.7% among 3- to 8-year-old children. In contrast, this was found in 13% of children examined by Kabue and others.[23] These results were much lower than those in our study (24.1% of the 6-year-old and 23.2% of the 9-year-old children).

The prevalence of anterior open bites was found to be quite similar between age groups; 10.0% of the 6-year-old and 6.7% of the 9-year-old children displayed open bites. We were not able to establish with certainty the cause of the open bites in the children participating in our study. Although a strong indication exists in the literature that habits such as thumb-sucking may cause anterior open bites,[24] this could not be concluded from our study as few of the parents of children with anterior open bites reported the existence of any habits.

Addressing problems in the mixed dentition offers several benefits. First, children at this age are often more attentive and cooperative than adolescent patients.[25] Second, early treatment of deleterious habits, such as digit sucking and tongue thrusting, is recommended after 8 years of age as it can simultaneously improve speech impediments due to the open bite, which often develops as a result of oral habits.[26] Also, at 8 years, the first permanent molars are fully erupted, facilitating removable appliance therapy, which is also better tolerated at this age.

Although the IPION is a very useful tool, it lacks the sensitivity necessary for deciding which cases to accept for preventive or interceptive orthodontic treatment. No defined value has been established as a reasonable marker for treatment. In our study, an IPION value of 5 or higher

was chosen, resulting in inclusion of 42 6-year-old children and 72 9-year-old children in this group. This amounts to over 28% of all children examined.

Modifications to make the IPION more effective could include allocating higher scores for criteria such as crossbites and premature loss or caries of specific teeth. Preventive and interceptive orthodontics by a general dentist as opposed to a specialist orthodontist can potentially eliminate the need for, or reduce the cost of, future extensive orthodontic treatment. Patient education, fluoride, sealants, regular screenings and basic restorative work can enhance the preventive orthodontic approach. Also, important interceptive orthodontic work can be accomplished with relatively inexpensive removable appliances, such as expansion appliances, habit-breaking appliances, space maintainers and crossbite correction appliances.

Conclusions

The prevalence in our study group of certain variables (caries, early tooth loss, crossbites) that could lead to malocclusions was unacceptably high for a developed country such as Canada. It is thus evident that planning aimed at providing necessary and more affordable dental care to children in urban and rural communities is necessary. Our study demonstrates the need for the implementation of a primary dental health care program for children in underserviced communities in Canada.

THE AUTHORS

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