

# Malocclusions in children at 3 and 7 years of age: a longitudinal study

Lillemor Dimberg\*, Bertil Lennartsson\*, Björn Söderfeldt\*\* and Lars Bondemark\*\*\*

\*Department of Orthodontics, Postgraduate Dental Education Center, Örebro and Departments of \*\*Oral Public Health and \*\*\*Orthodontics, Faculty of Odontology, Malmö University, Sweden

Correspondence to: Lillemor Dimberg, Department of Orthodontics, Postgraduate Dental Education Center, SE-701 11 Örebro, Sweden. E-mail: lillemor.dimberg@orebroll.se

**SUMMARY** The aim of this longitudinal study was to compare the prevalence of malocclusion at ages 3 and 7 years in a sample of children, exploring the hypothesis that prevalence of malocclusion is higher at 3 than at 7 years of age and may be influenced by sucking habits. The study sample comprised 386 children (199 girls and 187 boys), aged 3 years at study start, sourced from three Public Dental Service clinics in Sweden. Malocclusion was diagnosed by clinical examination, using a specific protocol. Data on allergy, traumatic injuries, sucking habits, and breathing pattern including nocturnal breathing disturbances were obtained by means of a questionnaire answered by child and parent in conjunction with the initial and final clinical examination. The overall prevalence of malocclusion decreased significantly, from 70 to 58% ( $P < 0.0001$ ): predominantly anterior open bite, excessive overjet, and Class III malocclusion. Although high rates of spontaneous correction were also noted for deep bite, Class II malocclusion and posterior and anterior crossbites, new cases developed at almost the same rate; thus, the prevalence was unchanged at the end of the observation period. Anterior open bite and posterior crossbite were the only conditions showing significant associations with sucking habits. The results confirm the hypothesis of higher prevalence of malocclusion at 3 years of age and clearly support the strategy of deferring orthodontic correction of malocclusion until the mixed dentition stage.

## Introduction

At 3 years of age, the prevalence of malocclusion is as high as 66–70 per cent (Kohler and Holst, 1973; Dimberg *et al.*, 2010). Among pre-school children, the most common conditions are anterior open bite, excessive overjet, Class II malocclusions, and posterior crossbite (Kohler and Holst, 1973; Thilander and Myrberg, 1973; Ravn, 1976; Holm, 1978; Svedmyr, 1979; Warren *et al.*, 2005; Dimberg *et al.*, 2010).

Some malocclusions are more prone than others to persist during the development of the occlusion, and it is claimed that a full Class II malocclusion in the primary dentition is never self-correcting in growing children (Holm, 1978; Bishara *et al.*, 1988). Moreover, maxillary protrusion is established early in the primary dentition and remains unmodified in the transition to the mixed dentition (Antonini *et al.*, 2005). Other conditions undergo spontaneous correction: the prevalence of anterior open bite decreases from 51 per cent in the primary dentition to 4 per cent in the mixed and early permanent dentitions (Holm, 1978; Duncan *et al.*, 2008). Klocke *et al.* (2002) also reported spontaneous correction of most cases of anterior open bite between the ages of 5 and 12 years. With respect to posterior crossbite, the results of studies to date are contradictory, with reports of spontaneous correction ranging from 17 to 45 per cent (Thilander *et al.*, 1984; Lindner, 1989; Kurol and Berglund, 1992; Tscill *et al.*, 1997).

The prevalence of sucking habits in 3-year olds ranges from 66 to 88 per cent (Kohler and Holst, 1973; Holm, 1978; Svedmyr, 1979; Modeer *et al.*, 1982; Dimberg *et al.*, 2010) and is implicated in the development of anterior open bite, Class II malocclusion, and posterior crossbite (Kohler and Holst, 1973; Ravn, 1976; Holm, 1978; Svedmyr, 1979; Warren *et al.*, 2005; Dimberg *et al.*, 2010). Persistence of the condition in the mixed dentition may be determined by the age at which the sucking habit is discontinued. Allergy, mouth breathing, snoring, and nocturnal breathing disturbances also have potentially negative effects on the developing dentition (Vázquez-Nava *et al.*, 2006; Góis *et al.*, 2008; Souki *et al.*, 2009; Zicari *et al.*, 2009).

It is obvious that determining the factors involved in the development of the occlusion during the transitional period from the primary to the permanent dentition requires knowledge and experience on the part of the clinician. Early treatment of a malocclusion might be unnecessary, if spontaneous correction occurs during the transition from the primary to the mixed dentition.

The prevalence of malocclusion and spontaneous correction has been studied with inconsistent results, which are difficult to interpret (Thilander *et al.*, 1984; Kurol and Berglund, 1992; Tscill *et al.*, 1997). Longitudinal studies covering the period of transition from the primary to the early mixed dentition would contribute to our understanding of

occlusal development over time and how and if early malocclusions self-correct.

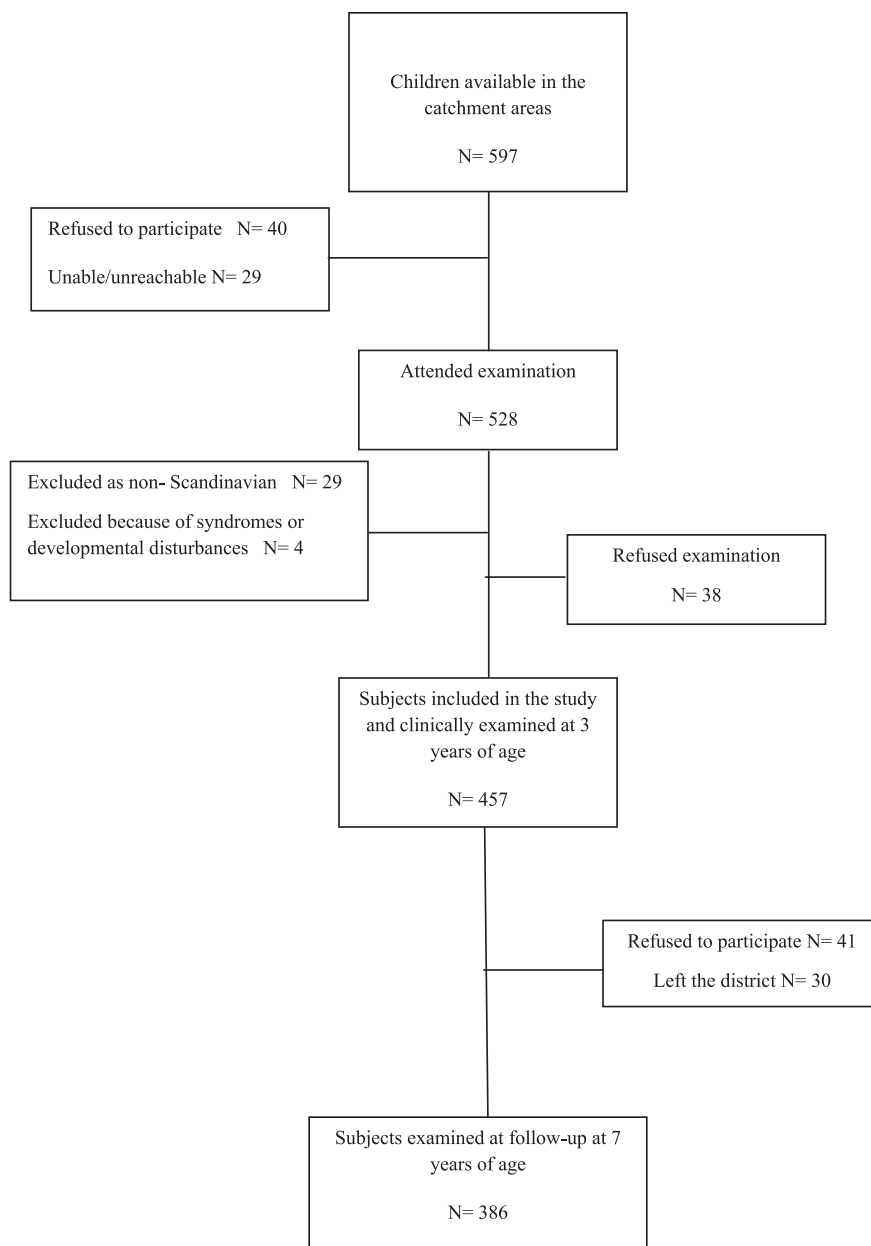
The aim of the present study was threefold: to follow a group of children and record occlusal status at ages 3 and 7 years in a cohort of Swedish children, with special reference to prevalence of malocclusion; to determine the frequency of spontaneous correction of malocclusion during the transition from the primary to the early mixed dentition, and thirdly to analyse the possible influence of sucking habits on the prevalence of malocclusion.

The hypothesis was that the prevalence of malocclusions is higher at age 3 than at age 7 and may be influenced by sucking habits.

## Materials and methods

### Subjects

The study sample was sourced from three Swedish Public Dental Service clinics, each located in a small rural community of about 22 000 inhabitants. In 2003, these clinics had an enrolment of 597 three-year-old children. Forty subjects refused to participate in the study and 29 could not be contacted. Thus, 528 children presented for initial clinical examination in conjunction with the routine dental examination offered to every child in Sweden at 3 years of age. In order to reduce potential confounding factors such as ethnic differences and environmental



**Figure 1** Flowchart of the children in the study.

conditions, 29 non-Scandinavian children were excluded. Four children with syndromes or developmental disorders were also excluded. Every child was given at least 2 opportunities to attend the examination, but 38 children refused, resulting in a final sample comprising 457 three-year-old subjects (223 boys and 234 girls; Figure 1).

At the clinical examination at 3 years of age, uncooperative behaviour in a number of children precluded registration of sagittal occlusion or vertical relationships in five and four cases, respectively. Moreover, the overjet could not be measured in 18 children.

At the clinical examination at 7 years of age, 386 children (187 boys and 199 girls) participated. Thus, 71 (15 per cent) subjects were lost to the study: 30 children had left the district and 41 refused to participate (Figure 1). Because of erupting permanent incisors, measurement of overjet was precluded in 14 children and measurement of overbite in 61.

No orthodontic treatment was undertaken in the interval between the two examinations.

The Ethics committee of the Örebro Health Care region, Sweden, approved the study protocol and informed consent form (2003-87/03).

#### *Clinical examination*

The examinations were undertaken by one experienced clinician (LD) between 2003 and 2009. The examinations, using a mouth mirror and probe, followed a specific protocol. The methods of Björk *et al.* (1964) and Foster and Hamilton (1969) served as guidelines for registration of malocclusion in centric occlusion. Radiographic examination was not included.

Data on allergy, traumatic injuries, sucking habits, and breathing pattern, including nocturnal breathing disturbances, were collected by means of a questionnaire which the children, together with their parents, were asked to answer at the time of the 3- and 7-year examinations.

*Measures.* At 3 years of age, the sagittal occlusion was determined by the relationship between the maxillary and mandibular primary canines and at 7 years of age, at the maxillary and mandibular primary canines and also at the first maxillary and mandibular permanent molars.

#### *Primary canines.*

##### -Class I (normal occlusion)

The tip of the upper primary canine tooth is in the same vertical plane as the distal surface of the lower primary canine tooth.

##### -Class II (post-normal occlusion)

The tip of the upper primary canine tooth is in anterior relationship to the distal surface of the lower primary canine tooth.

##### -Class III (pre-normal occlusion)

The tip of the upper primary canine tooth is in posterior relationship to the distal surface of the lower primary canine tooth.

#### *First permanent molars.*

##### -Class I (normal occlusion)

Normal, up to or equal to one-half cusp post-normal or pre-normal relation.

##### -Class II (post-normal occlusion)

More than one-half cusp post-normal relation.

##### -Class III (pre-normal occlusion)

More than one-half cusp pre-normal relation.

-Overjet was measured at the most protruding maxillary incisor and was classified as normal in the range of 0–4 mm.

-Anterior crossbite was registered if one or more maxillary incisors occluded lingually to the mandibular incisors and checked for anterior shift in the retruded position.

-A deep bite was registered when more than two-third of the heights of the mandibular incisors were covered by the maxillary incisors on full closure.

-A negative overlap in the vertical plane was recorded as an anterior open bite. Incisors in edge-to-edge relationship neither were considered to be in open bite nor were lack of overlap due to incomplete eruption of the incisors.

-Posterior crossbite and scissorsbite were recorded if at least two teeth were involved.

They were also stratified as unilateral or bilateral and checked for lateral shift in the retruded position.

A stainless steel ruler was used to measure overbite and overjet to an accuracy of 0.5 mm.

*Questionnaire.* The questionnaire comprised the following questions:

1. Has your child ever had a sucking habit?  
Response options: Yes No
2. Is the habit on going?  
Response options: Yes No
3. Has the habit ceased?  
Response options: Yes No  
If yes, at what age did the sucking habit cease?
4. What kind of sucking habit did your child have?  
Response options: Dummy, finger/thumb, other objects.
5. Estimate the duration rate of sucking habit during a day!  
Response options: Night + day (>16 hours), night (8–16 hours), part of night + day (<8 hours).
6. Does your child normally breathe with an open mouth?  
Response options: Yes No

7. Does your child snore while sleeping?  
Response options: Yes No  
If yes: every night, sometimes
8. Does your child have nocturnal breathing interruptions during sleep?  
Response options: Yes No
9. Does your child have any allergy?  
Response options: Yes No  
If yes, has the allergy been confirmed by tests?  
Response options: Yes No
10. Has your child suffered any dental trauma?  
Response options: Yes No  
If yes,  
a. When did the injury occur?  
b. Which tooth/teeth were involved?  
c. Has there been more than one incident of dental trauma?  
d. How was the dental trauma treated?  
Response options: Expectancy, grinding of the tooth/teeth, extraction of the tooth/teeth

### Statistical analysis

All data were analysed using the SPSS version 17.0. When analysing dependent data, i.e. comparison of the same children at two different times, the McNemar's test was used.

Chi-square analysis was used for analysis of binary variables and odds ratio (OR) with a 95 per cent confidence interval was calculated to measure the strength of associations for binary variables. Each sagittal, vertical, and transverse malocclusion was dichotomized in contrast with others and correlated with sucking habits.

Differences in probabilities of less than 5 per cent ( $P < 0.05$ ) were considered to be statistically significant.

### Results

The sample was tested for homogeneity by analysis of participants and non-participants with respect to gender, sucking habits, breathing disturbances, or types of malocclusion. At 3 years of age, more boys than girls were found with sucking habits ( $P = 0.015$ , OR = 1.7) or nocturnal breathing disturbances in the non-participant group ( $P = 0.040$ , OR = 3.6). At 7 years of age, posterior crossbite was more prevalent in girls than in boys ( $P = 0.023$ , OR = 1.87). Deep bite was more prevalent in boys than in girls ( $P = 0.006$ , OR = 10.7). At age 7 years, no other significant gender-related differences in the study variables were disclosed. The data for both genders were therefore pooled for analysis.

### Prevalence

**Malocclusions.** One or more malocclusions were diagnosed in 70 per cent of the children at 3 years of age, compared with 58 per cent at age 7 ( $P < 0.0001$ ). Two or more malocclusions were diagnosed in 18 per cent at age 3 and in 8 per cent at age 7 ( $P < 0.0001$ ).

The prevalence of anterior open bite, excessive overjet, and Class III malocclusions decreased significantly from age 3 to 7 years (Table 1). For other specific malocclusions, the prevalence remained relatively constant throughout the observation period (Table 1).

Among the cases of anterior crossbite, 30 per cent had an anterior shift and 71 per cent of posterior crossbites showed lateral shift at 7 years of age.

**Spontaneous correction.** During the observation period, spontaneous correction was observed in all types of

**Table 1** Prevalence of different types of malocclusion, overjet, and overbite at 3 and 7 years of age.

Variables	Three years of age			Seven Years of age			<i>P</i> for difference between ages
	Sample size	Prevalence	<i>n</i>	Sample size	Prevalence	<i>n</i>	
	<i>n</i>	%		<i>n</i>	%		
Sagittal relationship	452			386			
Class I		66	296		67	258	0.478
Class II		26	116		28	107	0.614
Class III		9	40		5	21	0.024
Overjet	439			372			
Excessive overjet (>4 mm)		23	99		17	63	0.037
Anterior crossbite (<0 mm)		1	5		1	6	0.687
Vertical relationship							
Overbite	453			325			
Anterior open bite (<0)		50	226		10	32	0.0001
Deep bite (>2/3)		6	29		3	11	0.152
Transverse relationship	457			386			
Unilateral crossbite		13	60		14	56	0.551
Bilateral crossbite		6	29		3	11	0.003
Scissors bite		0	0		0	0	—

**Table 2** Spontaneous correction and occurrence of new malocclusions from 3 to 7 years of age.

	Sample size	Spontaneous correction of those with malocclusion at 3 years of age	Spontaneous correction of total	New cases with malocclusion of those without respective malocclusion at 3 years of age	New cases of total	<i>P</i> for difference
Type of malocclusion	<i>n</i>	%	%	%	%	
Class II	100	46	—	—	—	—
No Class II (Class I + Class III)	284	—	12	18	14	0.614
Class III	36	75	—	—	—	—
No Class III (Class I + Class II)	348	—	7	3	3	0.024
Excessive overjet	81	58	—	—	—	—
No excessive overjet	279	—	13	10	8	0.037
Anterior crossbite	4	50	—	—	—	—
No anterior crossbite	356	—	1	1	1	0.687
Anterior open bite	164	87	—	—	—	—
No anterior open bite	159	—	44	6	3	0.0001
Deep bite	19	84	—	—	—	—
No deep bite	304	—	5	3	3	0.152
Posterior crossbite	76	37	—	—	—	—
No posterior crossbite	310	—	7	6	5	0.243

McNemars test was used. *P*-value with the null hypothesis indicates that there is no difference between spontaneous correction and new cases of malocclusions among children between 3 and 7 years of age.

**Table 3** Association between malocclusion and sucking habit at 3 and 7 years of age.

Type of malocclusion	Three years of age						Seven years of age					
	Sample size	Sucking habit	No sucking habit	OR	95% CI	<i>P</i>	Sample size	Sucking habit	No sucking habit	OR	95% CI	<i>P</i>
	<i>n</i>	%	%				<i>n</i>	%	%			
Class II	116	32	2	21.5	5.2–88.8	0.0001	107	29	22	1.4	0.8–2.6	0.214
No Class II (Class I + Class III)	336	68	98				279	71	78			
Excessive overjet	99	27	4	8.5	3.1–23.9	0.0001	63	17	15	1.2	0.6–2.3	0.641
No excessive overjet	340	73	96				309	83	85			
Anterior open bite	226	63	1	156.2	21.5–1133.3	0.0001	32	12	3	4.6	1.1–19.8	0.025
No anterior open bite	227	37	99				293	88	97			
Posterior crossbite	89	24	1	29.8	4.1–216.6	0.0001	67	20	7	3.1	1.3–7.5	0.008
No posterior crossbite	368	76	99				319	80	93			

Chi-square was used. *P*-value with the null hypothesis indicates that there is no difference in associations between malocclusions and children with a sucking habit or children who never had had a sucking habit. Odds ratio (OR) was calculated to measure the strength of associations. CI, confidence interval.

malocclusion and also new malocclusions developed (Table 2). In cases of Class III malocclusion, excessive overjet, and anterior open bite, the rate of spontaneous correction was significantly greater than the development of new malocclusions (Table 2). However, with respect to Class II malocclusion, anterior crossbite, deep bite, and posterior crossbite, the rates of spontaneous correction and the development of new malocclusions were similar.

**Sucking habits.** The prevalence of sucking habits decreased from 66 to 4 per cent ( $P < 0.0001$ ) between 3 and 7 years of age. Almost all those reporting a persistent sucking habit at age 7 years were thumb or finger suckers.

**The influence of sucking habits.** During the observation period, the ORs for developing anterior open bite or posterior crossbite were significantly higher for those children who had or had had a sucking habit than for those who had never had a sucking habit (Table 3).

Compared with finger or thumb suckers, children with a dummy sucking habit and anterior open bite ( $P < 0.0001$ ) or excessive overjet ( $P = 0.002$ ) had a spontaneous correction rate, significantly higher than the rate of development of new malocclusions.

**Breathing disturbances and allergy.** During the observation period, the prevalence of mouth breathing decreased from 19 to 8 per cent ( $P < 0.0001$ ).



The reported prevalence of snoring was relatively constant at age 3 and 7 years: 9 and 10 per cent, respectively.

At 3 years of age, 6 per cent were experiencing nightly nocturnal breathing disturbances; at 7 years of age, the prevalence had decreased to 2 per cent ( $P = 0.007$ ). Most (16 out of 25) had undergone abrasio/tonsillectomy between the ages of 3 and 7 years and post-operatively; nocturnal breathing disturbances had ceased in 15.

The prevalence of allergy at 7 years of age was 12 per cent.

*The influence of breathing disturbances and allergy.* Associations were found between snoring and posterior crossbite (OR = 2.28,  $P = 0.003$ ) as well as between allergy and Class II malocclusion (OR = 3.19,  $P = 0.001$ ). In addition, an interdependence was found between mouth breathing and allergy (OR = 1.78,  $P = 0.045$ ) and finally between mouth breathing and snoring (OR = 4.56,  $P < 0.0001$ ).

*Traumatic injury.* Thirty-four per cent (132 of 386) of the 7-year-old children had experienced dental trauma, while 4 per cent (6 of 386) reported injury to a permanent incisor. The mean age for the first incident of dental trauma was 4.1 years. For those who had experienced a second incident, the average age was 5.4 years. The prevalence was no higher among children with excessive overjet than those with normal overjet ( $P = 0.101$ ).

In cases of traumatic injury to the teeth, most common was expectancy (no treatment), 87 per cent. In 8 per cent of the children, traumatized primary incisors were extracted and in 5 per cent the primary incisors were ground.

## Discussion

The results of this study clearly support the hypothesis that the prevalence of malocclusion is higher at 3 than at 7 years of age. Moreover, despite the relatively constant prevalence of some types of malocclusion from 3 to 7 years of age, changes occurred at the individual level, not only because of spontaneous correction but also because of the development of new malocclusions at a similar rate.

Similar findings have been reported earlier with respect to posterior crossbite (Thilander *et al.*, 1984; Kurol and Berglund, 1992), stimulating debate about the question of early treatment, i.e. in the primary dentition, with claims that early treatment should be avoided because of the high rate of spontaneous correction and the poor success rate for grinding therapy. The present results are in accordance with previous findings and support the strategy of deferring orthodontic intervention until the mixed dentition stage. Instead, the focus at age 3 should be on observation of occlusal development, growth and tooth eruption, and information to parents about the undesirable consequences of persistent sucking habits or functional disturbances.

It was noteworthy that the influence of sucking habits on the occlusion was significant at 3 years of age, while at 7 years of age, sucking habits were associated with anterior

open bite and posterior crossbite. Anterior open bite may also be caused by tongue thrust; if persistent, these habits may prevent spontaneous correction of the open bite. With respect to posterior crossbite, normalization of tongue position is usually a prerequisite for spontaneous correction. A sucking habit may change the swallowing pattern that has been found as an important factor in the aetiology for posterior crossbite development (Ovsenik *et al.*, 2007; Ovsenik, 2009). Thus, even if the sucking habit ceased several years ago, persistence of abnormal tongue position or pressure will prevent spontaneous correction of the malocclusion. Unfortunately, tongue pressure, tongue position, or swallowing pattern was not evaluated in this study.

The results also showed that in children with anterior open bite or excessive overjet, spontaneous correction was less frequent among thumb or finger suckers than among dummy suckers. This can probably be explained by the fact that as children get older, periods of dummy sucking decrease, whereas in thumb or finger suckers the habit is often prolonged, even during waking hours. Moreover, finger suckers tend to cease the habit later in life than dummy suckers (Larsson, 1986, 1987; Bishara *et al.*, 2006; Duncan *et al.*, 2008; Dimberg *et al.*, 2010).

It was noteworthy that the results also disclosed that allergy, mouth breathing, or snoring had a potential effect on occlusion as early as in the primary or early mixed dentition stages, supporting earlier studies (Vázquez-Nava *et al.*, 2006; Góis *et al.*, 2008; Souki *et al.*, 2009). However, it should be borne in mind that the reported associations are bivariate and may not be confirmed by multivariate analysis. Therefore, further studies are warranted on even larger populations, in order to allow multivariate analysis and thereby disclosure of any such associations.

The 34 per cent prevalence of dental trauma in the 7-year-old children is within the reported range of 18–39 per cent for children aged 7–15 years (Forsberg and Tedestam, 1990; Carvalho *et al.*, 1998; Robson *et al.*, 2009).

Two important advantages of the present study are the longitudinal design and the fact that none of the subjects underwent orthodontic treatment during the study period. However, a drawback inherent in the longitudinal study design is the unavoidable loss of some subjects over time. In the present study, attrition was relatively low and within acceptable limits (15 per cent). Analysis disclosed only minor differences between the study sample and subjects who failed to complete the study. Finally, it can always be questioned if results from self-reported data are valid, but it has been shown that such data have good validity on population level (Kronstrom *et al.*, 1997).

## Conclusions

In this study, comparing dental occlusal conditions of children observed longitudinally at 3 and 7 years, the following conclusions were reached.

1. Between the ages of 3 and 7 years, the overall prevalence of malocclusion decreased significantly, from 70 to 58 per cent. This decrease in overall prevalence was attributable primarily to spontaneous correction of anterior open bite, excessive overjet, and Class III malocclusion.
2. Although high rates of spontaneous correction were also recorded for deep bite, Class II malocclusion, and posterior and anterior crossbite, new malocclusions developed at almost the same rates, resulting in unchanged prevalence at the end of the observation period.
3. There was a significant association between sucking habits and anterior open bite and posterior crossbite.
4. Spontaneous correction of anterior open bite and excessive overjet was less frequent among thumb or finger suckers than among dummy suckers.
5. Allergy, mouth breathing and snoring had potentially negative effects on the occlusion.
6. The results clearly support clinical guidelines recommending deferral of orthodontic treatment of malocclusion diagnosed in the primary dentition until transition to the mixed dentition stage.

### Funding

This study was supported by grants from Örebro County Council and from the Swedish Dental Society.

### Acknowledgements

The authors would like to thank the staff at the three public dental service clinics for all help in completing this study.

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