

Association between snoring and primary dental development and soft tissue profile in 3-year-old children

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Description of each author's contribution to the submission

All authors have actively participated in planning and preparing the manuscript, and more in detail in the following way:

PN: made all dental and facial photo measurements

SM: made otorhinolaryngological examinations

MH: assisted in statistical analyses

MR: supervisor of PN's PhD project (present paper is 1/3 of the needed publications)

MKK: made data collection on feeding pattern

OS-H: principal investigator in the Child-Sleep Birth Cohort research project

TP: collected clinical data, supervisor of PN's PhD project (present paper is 1/3 of the needed publications)

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Introduction: The aim was to study the association between snoring and development of occlusion, maxillary dental arch, and soft tissue profile in children with newly completed primary dentition.

Methods: 32 (18 female, 14 male) parent-reported snorers (snoring ≥ 3 nights/week) and 19 (14 female, 6 male) non-snorers were recruited. Breathing preference (nose/mouth) was assessed at the mean age of 27 months by otorhinolaryngologist. At the mean age of 33 months, an orthodontic examination was performed, including sagittal relationship of 2nd primary molars, overjet, overbite, and occurrence of crowding and lateral crossbite. Bite index was obtained to measure upper dental arch dimensions (inter-canine and inter-molar width, arch length). A profile photograph was obtained to measure facial convexity.

Results: No significant differences were found between non-snorers and snorers in any of the studied occlusal characteristics or in measurements of upper dental arch dimensions. Snorers were found to have a more convex profile than non-snorers. Occurrence of mouth breathing was more common among snorers.

Conclusions: Parent-reported snoring (≥ 3 nights/week) does not seem to be associated with an adverse effect on the early development of primary dentition, but snoring children seem to have more convex profile than non-snorers. Snoring is mild sign of sleep disordered breathing (SDB), and in the present study its short time lapse may not have had adequate functional impact on occlusion.

Introduction

Sleep disordered breathing (SDB) describes a spectrum of conditions with increasing upper airway resistance. In its mildest form, patients exhibit a snoring habit without daytime symptoms. With the increase in airway resistance, this may gradually lead to a more severe disorder, i.e., obstructive sleep apnea.¹ Snoring prevalence in the pediatric population has been found to vary greatly depending on the criteria used to judge snoring. In a Finnish study of 1-6-year-old children, the prevalence of snoring “always” or “often” was 6.3% and of snoring “sometimes,” 12.4%.² In a systematic review and meta-analysis by Lumeng and Chervin,³ the prevalence of parental reports that their child snored “always” is in the range of 1.5 to 6.2%. But if including children who snored “often,” the range is much greater: 3.2-14.8%. Since occasional snoring is common in children, snoring during three nights per week or more frequently is generally considered a sign of SDB.⁴

Snoring is caused by obstruction in airways, which in small children is commonly due to increased adenoids and/or palatine tonsils, allergic rhinitis, respiratory infections, and parental snoring and smoking.² Furthermore an association has been reported between body mass index and the severity of SDB in children.⁵ Interestingly breastfeeding has been found to be a protective factor in pediatric snoring.⁶ Due to increasing obstruction mode of breathing may change from normal nose breathing to partial or total mouth breathing. Since unrestricted breathing particularly during sleep is considered important for normal craniofacial and occlusal development,⁷⁻¹⁰ snoring and mouth breathing may lead to deviation from normal growth pattern. Maxillary transversal growth can be adversely affected, and mandibular forward displacement directed predominantly downwards, leading to increased lower facial height.¹¹⁻¹⁷ Most of the studies have, however, included subjects with significant variation in age, which also means significant variation in occlusal status.

The aim of the present study was to evaluate the association between snoring and development of occlusion, maxillary dental arch, and soft tissue profile in 3-year-old children with newly completed primary dentition. It was hypothesized that non-snoring children would have more optimal development of primary dentition and a less convex soft tissue profile than snoring children.

Material and methods

The present study is part of the Child-Sleep Birth Cohort research project, which is a longitudinal birth cohort study consisting of 1,673 children born between April 2011 and February 2013 at Tampere University Hospital. The inclusion criteria were a Finnish-speaking family and residing in the Pirkanmaa Hospital District. The families were recruited to take part of the project prenatally at the 32nd week of pregnancy in local maternity clinics. Questionnaires, which concentrate on sleep, behavior, temperament, somatic and mental health, and family relations, were filled out prenatally at week 32, at the birth of the child, and at 3, 8, 18, and 24 months following birth. The study protocol was approved by the Ethics Committee of the Pirkanmaa Hospital District and the City of Tampere in March 2011.

Questions based on the Sleep Disturbance Scale for Children questionnaire¹⁸ were used to assess snoring frequency. The question was: "Does the child snore?" and the answer options were "always (daily)", "often (3–5 times per week)", "sometimes (once or twice per week)", "occasionally (once or twice per month or less)", and "never." This study focuses on children whose parents have reported their child to snore minimum of three nights per week at the age of 8 or 24 months. A child was excluded if snoring was detected only during respiratory infections. Controls were recruited among non-snoring children. Patients' and controls' families were personally asked to participate in this sub-study and were interviewed by phone to verify the occurrence of snoring. Duration of exclusive breastfeeding was also questioned at 24-month questionnaire. Written informed consent was obtained from the parents.

Based on the 8-months-questionnaire, 22 snoring and 13 non-snoring children were recruited to participate in the study. Seven snorers and nine non-snorers dropped out before the age of 24 months. Based on the 24-months-questionnaire, 17 new snorers and 16 new non-snorers were recruited, making a total of 32 (18 female, 14 male) snorers and 20 (14 female, 6 male) non-snorers. At the mean age of 27 months (range 23-34), an otorhinolaryngological examination was performed, in all cases by the same researcher (SM). As a part of the examination child's breathing preference was assessed. A child was labelled to be mouth or nose breather according to the principal breathing preference noticed by close observation during the examination.

One non-snorers dropped out the study before dental examinations. At the mean age of 33 months (range 28–42 months), when primary dentition is on average fully formed, orthodontic

examination was performed. Examination included sagittal relationship of 2nd primary molars (mesial step/distal step/flush), overjet (increased $\geq 3\text{mm}$), overbite (open bite $\leq 0\text{mm}$, deep bite $\geq 3\text{mm}$), crowding (yes/no), and lateral crossbite (yes/no). In addition, occlusal bite index (Yellow Bite Wax Sheets, 0.18–0.22 cm thick, Modern Materials) was obtained to measure upper dental arch dimensions. Measurements were made with a digital sliding caliper (Sommet PM 160 digital sliding 1.6 Typ:14016458KS) and included inter-canine width measured between upper primary canine cups tips (dd. 53–63), intermolar width measured between mesiopalatal cups of upper second primary molars (dd. 55–65), and arch length measured from the labial surfaces of the first primary incisors perpendicular to the line connecting the distal surfaces of the right and left upper second primary molars (Figure 1).

A profile photograph of the face was taken with a digital camera (Canon EOS 60D, DS126281 Canon Inc.). Children were standing at rest and asked to bite their teeth together at the moment of taking the photo. The photographs were printed, and soft tissue landmarks Glabella (G), Subnasale (Sn), and Pogonion (Pg) were identified to measure facial convexity (Figure 2).

Upper dental arch and soft tissue profile angle measurements were made twice by one operator (PN) and mean values used in the statistical analysis. Statistical analysis was performed using IBM SPSS Statistics (version 22 or newer). Crosstabulation was used to compare occlusal characteristics between the groups and the strength of the association was evaluated with Fisher's exact test. Differences in arch dimensions and soft tissue profile measurements between the groups were tested with Mann-Whitney test. P-value < 0.05 was considered statistically significant.

Results

At the time of otorhinolaryngological examination all control children were still non-snoring. Snoring status of the snoring children varied: 56% (n=18) still snored minimum of three nights per week. A statistically significant difference was found between the groups in soft tissue profile in that snorers had a more convex profile than non-snorers ($167^\circ \pm 4.5^\circ$ vs. $170^\circ \pm 4.8^\circ$, $p=0.044$, Mann-Whitney test). Occurrence of mouth breathing was also statistically more common among snorers (10/31.3% vs. 1/5.0%, $p=0.035$, Fisher's exact test, Table 1).

Statistical analysis did not reveal significant differences between non-snorers and snorers in any of the studied occlusal characteristics ($p > 0.05$, Fisher's exact test, Table 2). No statistically significant differences were found between the groups in the measurements of upper dental arch dimensions. Inter-canine width (dd. 53–63) was 27.8 mm and 28.1 mm, intermolar width (dd. 55–65) 32.9 mm and 33.8 mm, and arch length 28.8 mm and 28.6 mm in snorers and non-snorers, respectively ($p > 0.05$, Mann Whitney test). Duration of exclusive breastfeeding was 3.8 and 3.9 months in the snoring and non-snoring groups, respectively, i.e. no statistically significant difference.

The same parameters were compared between the children whose parents reported them to snore minimum of 3 nights per week at the age of 24 months ($n=18$) and the controls ($n=19$). Snoring children were found to have mouth breathing preference statistically more frequently than the controls ($p=0.04$). No other statistically significant differences were found ($p > 0.05$, Fisher's exact test, data not shown). The same parameters were also compared inside the snorer group ($n=32$) to distinguish differences between mainly mouth breathing snoring children ($n=10$) and mainly nose breathing snoring children ($n=22$). No statistically significant differences were found ($p > 0.05$, Fisher's exact test, data not shown).

Discussion

The strength of the present study is that the children were studied at a younger age than in earlier studies and thus formed a homogenous group in terms of occlusal development. The examination time point was planned in children who had just completed primary dentition, which normally occurs by 30 months.¹⁹ In six subjects, upper and/or lower second deciduous molars had not yet erupted, while all others had fully formed primary dentition. The age range of those without fully erupted dentition was 32–42 months. Gender difference has been found in dental arch measurements in that boys tend to have larger values.²⁰ In the present study, however, no meaningful difference in the gender breakdown is noticed between the groups. Facial profile photographs, instead of radiological imaging (lateral radiographs), were used. This is an evident, but ethically acceptable, limitation, and prevents direct comparison to most previous studies. Young age was also a challenge and because of lack of co-operation not all planned information and measurements could be collected.

Habitual snoring status has been demonstrated to fluctuate naturally in the early childhood years.²¹ In our study all controls were still non-snoring and 56.59% of the snoring children were snoring minimum of three nights per week at the time of examination. The groups can be interpreted to represent never snoring children (control group) and children who have had remarkable snoring between ages 8 to 24 months (snorer group).

Snoring children were found to have a more convex profile than non-snorers, a finding that is in line with previous studies.^{17,22} Systematic review and meta-analysis by Katyal et al.¹⁷ concluded that children with primary snoring have a statistically significantly increased ANB angle compared with non-snorers, a difference that is mainly due to a more retrognathic mandible in snorers (1.4° decrease in SNB angle). The age range of the children included in the systematic review was, however, large: from 0 to 18 years. In a study of 6–8-year-old children by Ikävalko et al.²² a comparable profile photography method was used as in the present study. In SDB children, facial convexity was more remarkable than in healthy children. Unfortunately, as the authors indicated, use of facial convexity assessment is clinically challenging, since facial convexity is a normal characteristic of every healthy child. Minor difference, i.e., 2-3° is probably of marginal clinical significance. The tendency for increased facial height and a vertical growth pattern of the mandible have also been found in 4–8-year-old snoring children, using lateral cephalometry.^{17,23-24} Our study methodology precluded assessment of these facial characteristics.

The present findings seem to contradict previous studies on dental arch measurements and occlusal characteristics. Löfstrand-Tideström et al.¹² studied 4-year-old children and found that the upper dental arch width was smaller and lateral crossbite more frequent in snoring children compared to non-snorers. Pirilä-Parkkinen et al.¹⁵ reported that snoring children (mean age 7.2 years, range 3.8–10.8) had a larger overjet and narrower upper dental arch than the control children. They furthermore reported an increase in malocclusion prevalence with increased severity of the breathing disorder, from snoring to obstructive sleep apnea.¹⁵ In our study, no statistically significant differences were found in dental arch measurements or in any occlusal characteristics. Mouth breathing, as found in 30% of the snoring children, has been considered to have an impact on the muscular balance between the tongue and cheek muscles, and when long-lasting, on the occlusal relationships.²⁵ In the present study, this adverse effect may have not yet been at work sufficiently long to have an adverse effect on the

upper dental arch or the occurrence of malocclusion, since no statistically significant difference was found between nose vs. mouth breathing children in the snoring group. Souki et al.²⁶ studied the association between mouth breathing and occlusal characteristics at different developmental stages (primary, mixed, and permanent dentition) and concluded that older children with mouth breathing tended to have increasing prevalence of malocclusions with great individual variation. They even stated that “using a young sample may explain the lack of association between the tested variables” as evidenced in our study. On the other hand, in our previous study, occlusal/dentoalveolar dimensions and features of snoring 5-year-old children did not differ compared to non-snorers. In this study, the dichotomous question (yes or no snoring) may not have differentiated the groups adequately.²⁷

The impact of breathing function on occlusal and craniofacial growth has been a controversial issue among orthodontists for longer than a century.²⁸ In many studies, the age range of the included subjects has been wide, meaning variable duration of the functional factor on the studied parameter(s). This has probably led to substantial variation in the response and unfounded conclusions on the association. During the first months after birth feeding pattern seems to be an important factor: exclusive breastfeeding up to three months has been reported to be associated with lower SDB probability in later life. In our study this factor could not be properly studied, since duration of exclusive breastfeeding was equal in both groups. Carlson²⁹ has pointed out another probable confounding factor: normal variation in the individual genome, which means a different response to the same environmental factor; in this case, breathing function.

Conclusions

Within the limitation of the present small sample size, it can be concluded that parent-reported snoring (≥ 3 nights/week) does not seem to be associated with an adverse effect on the early development of primary dentition at the age of 2 to 3 years. Therefore, the hypothesis of the study has to be refuted concerning occlusion, but it cautiously supporting the facial profile assumption. Snoring as the first and mild sign of SDB may not have adequate functional, environmental impact on the occlusion. Another explanation for the lack of association could lie in the short time lapse between completion of primary dentition and the

snoring/mouth breathing. An on-going, long-term study with the same study population will hopefully shed light on this issue.

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Figure Legends

Figure 1. Primary dental arch measurements: a-b inter-canine width (dd.53–63), c-d intermolar width (dd.55–65) and e-f arch length.

Figure 2. Soft tissue landmarks on lateral facial photographs. Soft tissue Glabella (G), Subnasale (Sn), and Soft tissue Pogonion (Pg).

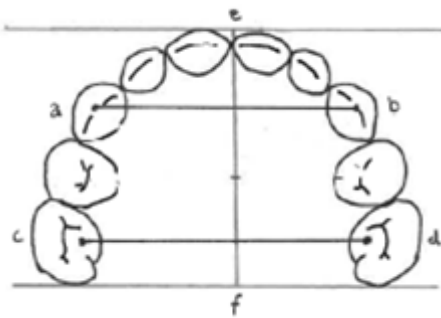


Figure 1

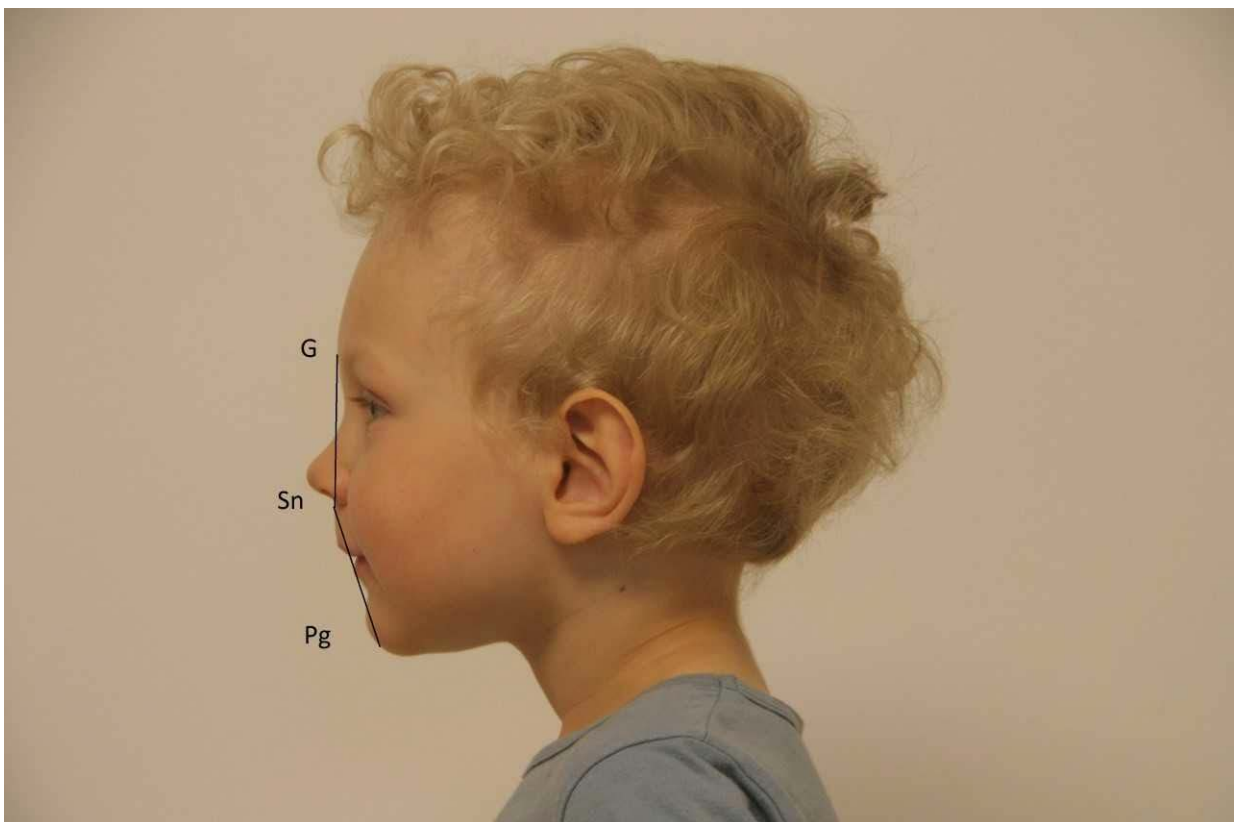


Figure 2

Table 1. Soft tissue profile measurements (mean, in degrees), occurrence of mouth breathing (n/%), and missing values in snorer and non-snorer groups.

	Snorers (n=32)	Snorer missing values	Non-snorers (n=19)	Non-snorer missing values	<i>p</i> -value
Soft tissue profile (degrees)	167±4.5	4	170±4.8	7	0.044
Mouth breathing	10 / 31.3%	-	1 / 5.3%	-	0.035

Table 2. Frequencies of occlusal morphological characteristics (n/%), and missing values in snorer and non-snorer groups.

	Snorer (n=32)	Snorer missing values	Non-snorer (n=19)	Non-snorer missing values	<i>p</i> -value
Overjet ≥ 3mm	14 / 46.7%	2	7 / 38.9%	1	0.77
Open bite ≤ 0mm	4 / 12.5%	-	1 / 5.6%	1	0.77
Normal	15 / 46.9%		10 / 55.6%		
Deep bite ≥ 3mm	13 / 40.6%		7 / 38.9%		
Crowding	8 / 25.0%	-	2 / 11.1%	1	0.30
Crossbite, lateral	2 / 6.3%	-	2 / 10.5%	-	0.62
Molar relationship		-		1	0.36
- mesial step	21 / 65.6%		9 / 50.0%		
- flush	5 / 15.6%		6 / 33.3%		
- distal step	6 / 18.8%		3 / 16.7%		