Orthodontic Risk Factors For Obstructive Sleep Apnea In Childhood: A Pilot Study (ORFOS Project)

Inaugural-Dissertation

zur Erlangung des Doktorgrades

der Medizin

der Medizinischen Fakultät

der Eberhard Karls Universität

zu Tübingen

vorgelegt von

Ring, Carmen Maria

2016

Dekan:	Professor Dr. I. B. Autenrieth
1. Berichterstatter:	Professor Dr. Ch. F. Poets
2. Berichterstatter:	Privatdozent Dr. T. Schott

To

Annette,

Lisa and Bernhard

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1 Abstract

Background: Orthodontic risk factors have mainly been discussed as *consequences* of, rather than as a *reason* for obstructive sleep apnea (OSA) in childhood. Although they have gained importance concerning OSA treatment options, they scarcely attract attention in screening or diagnosis. The ORFOS pilot study aims to test feasibility of an OSA screening method in the setting of an orthodontic clinic in order to confirm known risk factors and identify new orthodontic conspicuous parameters. In the long term, we plan to establish a nationwide pediatric OSA screening to see if the identified OSA risk factors are transferable to the ethnic background of Germany, with the objective to define OSA risk profiles.

Methods: The study comprised 162 minor orthodontic patients between 6 and 16 years of age (median 13 years). To evaluate a comprehensive medical (sleep) history, 6 questionnaires were applied and a non-invasive, self-developed ear-nose and throat (ENT) examination was performed. Orthodontic parameters covering clinical history, intra- and extraoral examination, dental and cephalometric analysis were recorded. Using the PSQ, we divided the study sample into a sleep disordered breathing/OSA (42 children) and an unaffected control group (120 children). We tested the feasibility of examination and screening methods, as well as performed a statistical group comparison.

Results: Of 188 children approached, 167 (88,8 %) participated with a drop-out rate of 0 %, 5 met exclusion criteria. Concerning time factor of our study model, probands and their parents had to consider approximately 20 minutes for questionnaires and the ENT examination in addition to their routine orthodontic appointment. 7 variables showed a missing n rate greater than 10 % concerning clinical history, 3 in ENT examination (missing data rate over 5 %). The group comparison revealed 8 intergroup differences ($p < 0.1$) in both, orthodontic clinical history plus examination, and dental cast models: The test group "snorers" had less often sucking habits (9.5 %) than controls "non-snorers" (24.2 %, risk ratio (RR) = 0.39). Concerning lip configuration, a lower median of lip configuration lower third of 15 mm/ 67 % was detected in

the test group by contrast with a median of 18 mm/ 69 % in the reference group. Another difference was seen in asymmetries of the face: "snorers" were over three times less likely to display asymmetries of the mandible to the right (n = 2, 4.9 %) than "non-snorers" (n = 21, 17.8 %, RR = 0.28). An asymmetry of the mandible to the left was less common in "snorers", too (n = 4, 9.8 % versus (vs.) n = 15, 12.7 %, RR = 0.77). The median overbite in "snorers" (4 mm) was relevantly larger than in "non-snorers" (3 mm). A frontal crossbite was diagnosed half as frequently in "snorers" (9.8 %) than in "non-snorers" (23.7 %, RR = 0.41). An edge-to-edge occlusion was seen in 33.3 % of the test and in 24.6 % of the reference group (RR = 1.35). A lateral open bite was less frequent in "snorers" (7.5 %) compared to "non-snorers" (18.6 %, RR = 0.40). Relevant differences were also found in the transversal width maxilla anterior (median of 19.5 mm in "snorers" and 18 mm in "non-snorers") and posterior (median of 28.5 mm vs. 24 mm). Also the transversal width mandible anterior differed between the groups: a median of 31.5 mm in "snorers" and 18 mm in "non-snorers". The transversal width of the posterior mandible was increased in the test group (41 mm vs. 25 mm).

Conclusion: The tested OSA screening and examination methods demonstrated practicability in the setting of an orthodontic practice regarding acceptance, adherence and feasibility. The PSQ serves as a suitable screening tool. ORFOS could not clearly identify orthodontic risk factors for OSA in childhood. We found differences relating to edge-to-edge bite, frontal facial asymmetries, overbite, crossbite, transversal widths, sucking habits and open bite between potential pediatric OSA patients and controls.

2 Abstract (German)

Kieferorthopädische Risikofaktoren (KRF) wurden bisher weitestgehend als Folge einer obstruktiven Schlafapnoe (OSA) im Kindesalter angesehen, weniger als eine ihrer Gründe. Obwohl KRF mittlerweile einen hohen Stellenwert in der OSA Therapie erlangt haben, spielen sie im Screening sowie in der Diagnosefindung noch keine entscheidene Rolle. Die ORFOS Pilotstudie verfolgte daher das Ziel, eine OSA Screeningmethode im Alltag einer kieferorthopädischen Praxis zu testen. Zudem sollen bekannte Risikofaktoren bestätigt und neue kieferorthopädische Auffälligkeiten bei Kindern mit OSA aufgezeigt werden.

Eingeschlossen wurden 162 kieferorthopädische Patienten im Alter von 6 bis 16 Jahren (Medianalter 13 Jahre). Um eine umfassende (Schlaf-) Anamnese zu erheben, wurden sechs Fragebögen angewandt und darüberhinaus eine nicht-invasive Hals-Nasen-Ohren Untersuchung (HNO) durchgeführt. Kieferorthopädische Daten aus Anamnese, Untersuchung, Kieferabdrücken und kephalometrischer Analyse wurden erfasst. Mit Hilfe des PSQ teilte man das Studienkollektiv in eine OSA- (42 Kinder) und eine Kontrollgruppe (120 Kinder). Wir untersuchten zum einen die Machbarkeit unserer Screening- und Untersuchungsmethoden und stellten zum anderen einen statistischen Gruppenvergleich auf Basis der erhobenen Daten an.

Von 188 befragten Kindern nahmen 167 (88,8 %) teil, 5 wurden ausgeschlossen. Die Abbruchquote betrug 0 %. Die Zeitinanspruchnahme für die Probanden und deren Eltern zur Fragebogenbeantwortung und HNO Untersuchung belief sich auf circa 20 Minuten zusätzlich zum eigentlichen kieferorthopädischen Therapietermin. 7 Variablen zeigten eine „Missing n" Rate über 10 % bei der Anamnese, 5 eine „Missing n" Rate über 5 % bei der HNO Untersuchung. Der Gruppenvergleich der orthopädischen Parameter ergab acht relevante Unterschiede ($p < 0,1$): Die Testgruppe „Schnarcher" zeigte relevant weniger Lutschgewohnheiten (9,5 %) im Vergleich zur Kontrollgruppe „Nicht-schnarcher" (24,2 %, relatives Risiko (RR) = 0,39). Bei der Lippenkonfiguration stellt man bei der Testgruppe einen geringeren

Median der Höhe des unteren Lippendrittels im Vergleich zur Kontrollgruppe fest (15 mm/ 67 % versus (vs.) 18 mm/ 69 %). Relevante Unterschiede zeigten sich auch bezüglich Gesichtsasymmetrien: „Schnarcher" hatten über dreimal weniger Asymmetrien des Unterkiefers nach rechts als „Nicht-schnarcher" (n = 2, 4,9 % vs. n = 21, 17,8 %, RR = 0,28). Ähnlich verhielt es sich mit Asymmetrien des Unterkiefers nach links (n = 4, 9,8 % vs. n = 15, 12,7 %, RR = 0.77). Der mediane Überbiss war bei „Schnarchern" größer (4 mm vs. 3 mm). Ein frontaler Kreuzbiss wurde annähernd halb so oft bei „Schnarchern" (9,8 %) diagnostiziert, als bei „Nicht-schnarchern" (23,7 %, RR = 0,41). Einen Kopfbiss sah man bei 33,3 % der Testgruppe und bei 24,6 % der Kontrollgruppe (RR = 1.35). Ein seitlich offener Biss war bei „Schnarchern" weniger häufig (7,5 % vs. 18,6 %, RR = 0.40). Relevante Unterschiede bestanden bei den transversalen Breiten des vorderen (Median von 19,5 mm bei „Schnarchern" und 18 mm bei „Nicht-schnarchern") und hinteren Oberkiefers (Median von 28,5 mm vs. 24 mm). Auch die transversalen Breiten des vorderen Unterkiefers unterschieden sich in den Gruppen: ein Median von 31,5 mm bei „Schnarchern" und 18 mm in der Kontrollgruppe. Die transversale Breite des hinteren Unterkiefers war in der OSA Testgruppe vergrößert (Median von 41 mm vs. 25 mm).

Die getesteten Screening- und Untersuchungsmethoden demonstrierten hohe Praktikabilität im Setting einer kieferorthopädischen Praxis bezüglich der Akzeptanz, Compliance und Durchführbarkeit. Der PSQ ist ein geeignetes Screeningtool. ORFOS konnte keine kieferorthopädischen Risikofaktoren für OSA im Kindesalter identifizieren. Im Hinblick auf Kopf-, Über-, Kreuz- und den offenen Biss, sowie die frontalen Gesichtsasymmetrien, transversale Breiten und Lutschgewohnheiten, gibt es relevante Unterschiede zwischen potentiellen OSA Patienten und Kindern der Kontrollgruppe.

3 Abbreviations

AHI	apnea-hypopnea index
approx.	approximately
AT	adenotonsillectomy
BMI	body mass index
CPAP	continuous positive airway pressure
DA	disorder of arousal
DIMS	disorder of initiating and maintaing sleep
DOES	disorder of excessive somnolence
ENT	ear, nose and throat
ESS	Epworth Sleepiness Scale
KiGGS	German Health Interview and Examination Survey for children and adolescents
LCR	lateral cephalometric radiographs
ORFOS	orthodontic risk factors for obstructive sleep apnea in childhood
OSA	obstructive sleep apnea
PDSS	Pediatric Daytime Sleepiness Scale
POB	posterior open bite
pro.	professional
PSG	polysomnography
PSQ	Pediatric Sleep Questionnaire
PT	partial tonsillectomy
resp.	respectively
RME	rapid maxillary expansion
RR	risk ratio
SD	standard deviation
SDS	standard deviation score

SDSC	Sleep Disturbance Scale for Children
SHY	nocturnal hyperhidrosis
SDB	sleep disordered breahting
SRBD	sleep-related breathing disorders
SWTD	sleep-wake transition disorder
TMJ	teeth, mouth and jaw
UKT	University Hospital of Tuebingen
vs.	versus

4 Introduction

4.1 Clinical presentation of childhood obstructive sleep apnea

Obstructive sleep apnea (OSA) "is defined as a disorder of breathing during sleep characterised by prolonged periods of increased upper airway resistance and recurrent episodes of partial and/or complete upper airway obstruction. Such impairments subsequently lead to disruption of normal ventilation and oxygenation during sleep as well as disruption of normal sleep patterns" (1). Furthermore, it has been shown that OSA is also common in childhood (2, 3), with prevalence rates in the general pediatric population ranging from approximately 1 % to 5 % (4). Consequently, OSA is listed among frequent children's diseases, whilst younger children are usually more often and more severely affected than their older counterparts (5). OSA ranks among the spectrum of sleep disorderd breathing (SDB) which refer to a wide variety of nocturnal breathing disorders. (6)

The pathophysiology is broadly based on two pillars: "anatomical factors that effectively reduce airway calibre and those that promote increased upper airway collapsibility" (7), both implying numerous risk factors. One stated reason among sleep induced loss of tonicity is obesity (4). Moreover, altered upper airway reflexes, hypotonia and upper airway inflammation support collapsibility (4). Accordingly, adenotonsillar hyperplasia, nasal obstruction, macroglossia, rhinitis and septal deviation are considered risk factors for upper airway narrowing in general (5, 8, 9). Craniofacial abnormalities such as mandibular deficiency, an inferiorly positioned hyoid bone, lateral crossbite or elongation of the soft palate also promote the occurence of OSA (7, 10). Additionally, abnormalities in jaw or tongue position or a dysfunctional open mouth posture also increase the likelihood of sleep-related breathing disorders (SRBD) (11).

Nighttime symptoms range from habitual snoring, sleep-wake transition disorders (SWTD) and sleep hyperhidrosis to arousal reactions. The main consequences comprise daytime sleepiness, attention deficit disorders or

even failure to thrive (2, 12, 13). Furthermore, affected children are likely to develop hyperactive behaviour and enuresis (14). If left untreated, sequelae of OSA as deficits in neuropsychological function and cognition, behavioural abnormalities, nocturnal enuresis, cardiovascular and metabolic morbidity may result (4, 7). Thus, these patients suffer from reduced overall life quality (15).

Nocturnal polysomnography (PSG) in a sleep laboratory is still the gold standard for diagnosing OSA (4, 12), even though further diagnostic methods such as audiotaping, videotaping, questionnaires, home monitoring device, overnight pulse oximetry, tracheal sound signals or sleep endoscopy have been established (13, 16-21). In the future, polygraphy, urinary biomarkers and rhinomanometry, which all show a high diagnostic test accuracy, might be alternatives to PSG (22). Although PSG is a long-standing and well-established diagnostic tool, there is still no exact agreement on a apnea-hypopnea index (AHI) cut-off justifying treatment or non-treatment (7). Nonetheless, therapeutic indication should not only be based on PSG outcomes, but also account for the variety of symptoms and risk factors (7). To keep abreast of changes, different algorithms for individualized diagnostic and therapeutic approaches have been proposed (23, 24).

OSA first line therapy is still adenotonsillectomy (AT). Thus, adenotonsillar hyperplasia is considered the main cause for OSA in childhood (4, 12). Beneficial effects of early AT comprise an improvement in quality of life, in PSG findings and behaviour as well as reduced symptoms (25). Another surgical method of treatment is tonsillotomy or partial tonsillectomy (PT), claiming similar outcomes combined with lower risk (26, 27). However, data is insufficient for recommending PT over AT, especially in terms of tonsillar regrowth (4). For patients with poor response to invasive therapy methods or children for whom surgery may not be a treatment option, continuous positive airway pressure (CPAP) is useful (4, 28). Alternatively, high flow nasal cannula oxygen therapy is possible, showing equal effects as CPAP (29). An additional, non-invasive current approach is anti-inflammatory medication. Under certain circumstances, nasal fluticason and oral montelukast may be

used as an initial therapy or a solution for mild OSA residual symptoms (29-37). For obese pediatric OSA patients, weight loss has been discussed as a treatment option although evidence lending support to this hypothesis is still limited (38). Interestingly, therapy innovations in the field of orthodontics and dentistry are promising, with rapid maxillary expansion (RME) found to be an effective procedure (39, 40). In the literature, oral devices have been described as "potentially" "improving even curing" OSA (41-45). All orthodontic methods aim to expand the nasal and/or oropharyngeal airway.

4.2 Study basis

Despite AT being established as the most selected therapy option, this surgical treatment is attended by a certain risk of failure: 17 % on average and 79 % in overweight children treated (46, 47). The recurrence of OSA in teenagers after AT plus orthodontia has been reported (48). While following CPAP application seems to improve OSA residuals, adherence is poor (49). In fact, none of the OSA pediatric patients with narrow jaws benefited from AT (50). These findings point to other risk factors playing a role in the aetiology and pathogenesis of OSA. Although ear-nose-and-throat (ENT) aspects of this illness are mainly taken into account separately, relations between ENT and orthodontic parameters have been repeatedly declared (5, 51). Accordingly, an association between facial disharmony and OSA has been observed in recent years (52): common cephalometric variables in children suffering from OSA include a retrusive chin, steep mandibular plane, vertical direction of growth, and a tendency towards Class II malocclusion (53-56). Characteristics among pediatric OSA patients also are an increased total and inferior anterior height of the face as well as a more anterior and inferior position of the hyoid bone (57).

However, orthodontic distinctive features have mainly been interpreted as *consequences* of ENT abnormalities (58) while orthodontic risk factors as *causes* for ENT abnormalities (and therefore OSA) have been barely examined to date. For example, Huang et al. state that OSA is "a disorder of oral-facial growth" (59). The fact that dento-facial development does not

change after performing AT in snoring children supports this assumption (60). Above all, a solid base of evidence points to the fact that OSA in children with a narrow jaw becomes better after RME, even without ENT intervention (43, 50). This would put the chain of causation into a reverse order with narrow jaw being a *reason for* OSA, rather than *a consequence* of it. One conclusion could be that orthodontic abnormalities along with ENT risk factors can also cause OSA. With reference to these observations, individual orthodontic treatment as a first line therapy (besides AT) seems intuitive and has indeed been shown for RME (61). However, it has also been reviewed that data are insufficient to recommend RME at present (4).

4.3 Study objectives

Taking these considerations into account, the idea to screen children for OSA directly in an orthodontic practice and examine them with respect to orthodontic in addition to other known pediatric OSA risk factors, seems a promising approach.

Plainly speaking, which objectives do we pursue?
On the one hand, we want to find out if detected OSA risk factors in the literature involving other ethnic groups (e.g. Scandinavian or Asian) also apply

to the ethnic environment of Germany. Are OSA risk factors transferable regardless of ethnic background?
Moreover, we aim for a wide coverage of OSA risk factors in childhood in order to create risk profiles which may faciliate diagnosing OSA.
Finally, we plan to establish an OSA screening with the help of the PSQ questionnaire (20).

To implement the above long-term objectives, we initiated the ORFOS pilot study to pave the way for a large-scale research project with a higher number of cases including orthodontic practices nationwide.

ORFOS aims to answer the following questions beforehand:
1. On which orthodontic risk factors should we focus?
2. How could an OSA screening be performed?
3. How is the acceptance of our chosen screening methods?
4. Is the screening process feasible?
5. What about adherence?
6. Are we able to confirm known OSA risk factors?
7. Can we state new orthodontic risk factors?

Hence, we hypothezise that we are able to confirm orthodontic along with general risk factors by means of our OSA childhood screening. Also, we believe to reveal which orthodontic parameters are eligible and relevant for further testing.

5 Methods and material

5.1 Design and study population

The ORFOS project involved a cooperation between the Interdisciplinary Centre for Sleep Medicine, University Children's Hospital, Tuebingen and the Orthodontic Department, University Centre of Dentistry, Oral Medicine and Maxillofacial Surgery, University Hospital Tuebingen (UKT), Germany. Data acquisition was carried out together, yet in the competence of each specialty. The clinical study was based on a case series of children and adolescents receiving orthodontic treatment at the University Centre of Dentistry, Oral Medicine and Maxillofacial Surgery, UKT. The Ethics Committee of the Medical Faculty of the University of Tuebingen approved the study in 2010. Within the study, subjects were interviewed and extensively examined regarding risk factors and symptoms of OSA, supplementary to routine treatment during 2010 and 2011. However, study-related interventions were not performed. The source population comprised 162 orthodontic patients between 6 and 16 years of age, with their parent having given prior written consent. Children with cognitive developmental disorder or disability were excluded. Parents' insufficient German language knowledge to complete the questionnaires was an exclusion criterion as well. The examination could be terminated early in the case of poor compliance or upon the participant's request. Furthermore, information regarding medical confidentiality and the handling of collected personal data (data protection) were explained and written informed consent was obtained.

5.2 Study process

As previously mentioned, the general routine part of orthodontic care covers a clinical history, intra- and extraoral photographic documentation, 3D photo scan, dental casts, and cephalometric radiographs. With an average duration of therapy of up to 4 years, the patients had 4 to 12 orthodontic appointments

per year, whereas additional measures arising from the study were one-off investigations. For our purpose we used 6 questionnaires, taking a detailed medical (sleep) history. We further performed a basic non-invasive ENT check-up (without endoscopy). Moreover, orthodontic findings covering clinical history, intra- and extraoral examination, dental cast and cephalometric analysis, were recorded separately. To summarize, we gathered all items pseudonymised in a database.

5.3 Preparatory measures

5.3.1 Information about clinical study "ORFOS"

Each parent received a comprehensive information sheet, providing the most important facts about OSA and the examination methods: how OSA is defined, what are known causes and consequences, what aim is to achieve with this study and how clinical history and medical inspection are performed. In addition, it was made clear that participation was voluntarily and did not pose any known risks. Participants were free to withdraw from the study at any time upon request.

Every study participant was also given a child-friendly version of the OSA study information sheet, with a linguistic style suitable for children. The reasons behind this were to gain also the child’s informed consent, to attract participants, and to increase the children’s compliance. All children evaluated were awarded with certificates of participation as an incentive.

Subsequently, a statement of agreement for the parents followed, including the full name, birth date and gender of their child taking part in the ORFOS pilot study.

To ensure its correct completion, a short explanation with examples to introduce the questionnaires was added. Parents could decide if they wanted to receive further information regarding OSA by providing their contact details.

5.3.2 Data protection

The legal guardian's informed written consent and the agreement of the study participants concerning data protection were a prerequisite to take part in this clinical study. Individual-related data were collected either in written form or digitally. Only project supervisors and principal investigators could access the data, which were kept in safe custody and were not disclosed to third parties. Written data were pseudonymised so that the proband's identity will remain confidential if the results or data are published.

5.4 Examination methods

5.4.1 Questionnaires - structured medical sleep history

Overall, the parents were asked to fill out five OSA questionnaires in German with different emphases in order to detect symptoms and likely effects of a potential OSA. A further questionnaire was to be answered by the children themselves. The questionnaires included both pre-defined possible answers (to be ticked) and self-formulated ones. In the event that the guardian or proband selected more than one answer, the one in favour of the child's health was utilised or intermediate values were calculated.

5.4.1.1 Clinical history

Firstly, we referred to relevant pediatric sectors in general, covering topics such as birth, neonatal nutrition, basic and childhood diseases, allergies, medication, surgical intervention, as well as misalignment of teeth or jaw and ENT symptoms or abnormalities. This self-developed clinical history sheet consisted of 65 items and most questions were answerable on a 3-point rating scale ("yes", "no", "I don't know"). The questionnaire's purpose was to gain an overview of the child's general health status. Like the child's dental chart combined with subsequently performed orthodontic therapy, it was designed to demonstrate OSA symptoms (such as sore throat, for instance). This provided initial indications of possible OSA.

5.4.1.2 Pediatric Sleep Questionnaire (PSQ)

Second, guardians completed the SRBD scale as part of the Pediatric Sleep Questionnaire (PSQ), which checks for the following symptom complexes: snoring, daytime sleepiness and behaviour (22 items, 3-point rating scale with "yes", "no", "I don’t know") (20, 62). On this basis, a calculated PSQ (sub)score > 0.33 was regarded as conspicuous, pointing out to a SDB. In our study model, the PSQ served as a "filtering tool" for potential OSA patients who presented with "snoring" as one of the main symptoms of OSA.

5.4.1.3 Sleep Disturbance Scale for Children (SDSC)

Third, the Sleep Disturbance Scale for Children (SDSC) inquires hints at existing insomnia, including six subscales: disorders of initiating and maintaining sleep, sleep breathing disorders, disorders of arousal, SWTD, disorders of excessive somnolence and sleep hyperhidrosis (26 items, 5-point rating scale chiefly with "never", "rarely", "occasionally", "frequently", "always ") (63).

5.4.1.4 Epworth Sleepiness Scale (ESS)

To detect daytime sleepiness, parents were asked to complete the Epworth Sleepiness Scale (ESS), which provided an external assessment of their child’s likelihood of dozing in various common situations (8 items, 4-point rating scale with "would never doze off", "low probability of dozing off", "mean probability of dozing off", "high probability of dozing off ") (64). An ESS score > 10 indicates excessive daytime sleepiness as a possible symptom of SDB such as OSA.

5.4.1.5 Demographic information

A 23-items questionnaire concerning the subject’s demographic characteristics followed. It was derived from "KiGGS - the German Health Interview and Examination Survey for children and adolescents" (65, 66) to obtain information about the child’s social and demographic background.

5.4.1.6 Pediatric Daytime Sleepiness Scale (PDSS)

Finally, the participants themselves completed the "Pediatric Daytime Sleepiness Scale" (PDSS) questionnaire with 8 items (5-point rating scale with chiefly "never", "rarely", "occasionally", "frequently", "always") (67). This was done in order to evaluate how the children rated their possible propensity for daytime sleepiness and sleep-related behaviour from their point of view in comparison to that of their parents.

SDSC, ESS and PDSS helped to describe the study population, but were not directly included in our feasibility study as such.

5.4.1.7 ENT history and clinical findings

An orientational ENT examination with anamnestic elements was designed especially for this study (49 items) (68-74). Therefore, the main investigator acquired the necessary knowledge and clinical skills during a voluntary internship at the ENT University Clinic Tuebingen, Germany. The focus particulary lay on clinical evidence of upper airway obstruction and related symptoms. This examination method was especially targeted at children, being risk-free and non-invasive. The examination took place in the Department of Orthodontics in the Center of Dentistry, Oral Medicine and Maxillofacial Surgery Tuebingen, Germany, in 2010/11. During the waiting period at the subjects' orthodontic appointment, the children and their parents were asked to complete the questionnaires and the study-related examination

(5 to 10 minutes) was performed in the same setting, under the circumstances as outlined above.

The following materials were used:

a. diagnostic otoscope with reusable tips (HEINE Beta NT 100® Diagnostic Otoscope; HEINE Unispec Disposable® Ear Specula)
b. disposable wooden tongue depressors (HARTMANN® wooden tongue depressors, sterile)
c. diagnostic pen light (AMPri Med Comfort® Diagnostic Lamp)
d. stainless steel ruler 15 cm
e. hand disinfectant (BODE Sterillium® med 500ml)

At the outset, the proband was interviewed about OSA symptoms. If the subject affirmed the occurrence of any clinical signs, the examiner questioned in further detail to specify the conspicuousness. The clinical history referred to impaired nasal breathing, dysphagia, halitosis, salivation, height and weight. Younger participants received help from a parent in answering the questions if necessary. Starting with the questioning tended to gain the children's confidence and consequently promote their adherence. Besides, one could ascertain where to pay close attention when examining.

The next step was a clinical evaluation. The purpose was to find out whether cervical lymph nodes were enlarged, if the child suffered from tympanic membrane retraction or tympanic effusion and if ENT/teeth, mouth and jaw (TMJ) external malformations were visible. Afterwards, the child's nose, mouth and throat were examined and the Mallampati Score (71) was obtained. All findings were recorded on the ENT investigation form (see appendix).

5.4.2 Orthodontic analysis

5.4.2.1 Clinical history and examination

A clinical history of each child was taken during the course of orthodontic care, with a focus on sigmatism, sucking-habits, bruxism or previously performed orthodontic therapy (16 items). A clinical examination followed, assessing

extra- and intraoral findings (27 items). A detailed list of the individual variables is attached in Table 4 (75, 76).

The following materials were used:

a. outside caliper
b. diagnostic pen light (AMPri Med Comfort® Diagnostic Lamp)
c. stainless steel ruler 15 cm
d. hand disinfectant (BODE Sterillium® med 500ml)

5.4.2.2 Dental cast analysis

The objective was to detect dental misalignments and malocclusions that may occur in sagittal, transverse and vertical plane. This included the following components:

a. metric analysis of the dental arch form
b. analysis of the support zones
c. analysis of dental space requirement
d. discrepancy measurement
e. analysis of the vertical plane
f. Bolton analysis (77)
g. analysis of the apical base
h. occlusion findings (see also Figure 7)

The children's available dental casts were analysed according to Nötzel and Schultz (78) in line with the standards of the Clinical Manual of Orthodontic Treatment, Orthodontic Department, University Centre of Dentistry, Oral Medicine and Maxillofacial Surgery, University Hospital Tuebingen (UKT), Germany (76). The materials comprised a bow divider, ruler, and a measuring grid, according to Schmuth. The measured parameters (28 items) are listed in Table 5 (79-82).

5.4.2.3 Cephalometric analysis

Cephalometry is a diagnostic tool in orthodontics to measure the inner and outer structures of the head with x-rays (83). The use of lateral cephalometric radiographs (LCR) possibly rendered a metric analysis of cranial and facial structures (84). LCRs enabled us to draw conclusions on:

a. the relation between the jaw bases,
b. the relation between the incisor axes,
c. the size of the jaws and their integration in the skull,
d. analysis of the soft tissue morphology,
e. analysis of the face's profile and
f. localisation of dysgnathia (76, 83).

The LCRs of the patients were taken in the Orthodontic Department, University Centre of Dentistry, Oral Medicine and Maxillofacial Surgery, University Hospital Tuebingen (UKT), Germany (Cephalostat Wehmer Company, Serie 3 RSt 35; X-Ray tube Siemens, Model No. 03072456, Series Nr. 4152, Siemens AG Munich; distance: 4 m; 9 mA for children). All LCRs were recorded digitally and analysed with the help of a computer-based cephalometry analysis program "fr-win®" (computer konkret AG). Therefore, the subject needed to stand up, the head being fixed in the cephalostat with ear rods and a forehead support. Lips and the head should be kept in a natural position, the teeth in a maximum intercuspal position (85). A modified analysis method was used according to the Orthodontic Department, University Centre of Dentistry, Oral Medicine and Maxillofacial Surgery, University Hospital Tuebingen (UKT), Germany, based on Rakosi (86). Accordingly, the examiner marked cephalometric reference points that represent the base of the skull, maxilla, mandible, as well as the dentition. With these measuring points, cephalometric reference lines and angles were constructed to reveal sagittal and vertical structural features with their deviation from norm values (83) (43 items). A cephalometric measurement example is listed in the appendix (Figures 5-6). The results of cephalometic analyses were in the responsibility of the doctoral candidate of Orthodontics. Thus they will be discussed in a separate thesis.

5.5 Group comparison

In oder to make a suspected diagnosis of OSA/SBD, we used the PSQ score. A calculated score > 0.33 points out an existing OSA/SBD. Consequently, children with a score of 0.33 or higer formed the "snorer" group and were compared to "non-snorers" (PSQ score < 0.33) with respect to collected data. The aim was to find out significant intergroup differences.

5.6 Statistics

IBM SPSS Statistics program Version 21.0 was used for all statistical analyses.

To test the data for normal distribution a Shapiro-Wilk's test ($p > 0.05$) (87) and a visual inspection of histograms, Q-Q and box plots showed whether or not metric variables were approximately normally distributed. This was enhanced by the values for skewness and kurtosis (as close to 0 as possible) and their calculated z-values (measures/standard error; -1.96 - +1.96) (88-90).

In order to describe the study sample, descriptive statistics and frequency analyses were carried out. The BMI, BMI percentiles and the standard deviation scores (SDS) were computed with the BMI calculator of the University Children's Hospital Tuebingen, Germany (91).

All questionnaires were analysed for "missing n" to see where the parent/participant or the examiner herself cumulatively left out questions, in order to discuss possible acceptance or feasibility issues and provide solutions.

The statistical group comparison was performed with the help of cross tables. Nominal data were analysed with Chi^2 (92) and Cramers V (93), dichotomic scaled variables with Phi. A p-value < 0.1 (*) was considered as relevant for further investigation. The group's means were compared with a t-test (94) for independent variables. If the data were not normally distributed, the non-parametric Wilcoxon - Mann - Whitney test (95) was used. Data were expressed with median and minimum/maximum or mean and standard deviation (SD) as appropriate. A risk ratio was calculated between the two groups compared. All statistical results are presented in tables, diagrams and figures.

6 Results

6.1 Description of the study population

The study population included 162 children between 6 and 16 years of age (median of 13 years). 92 (56.8 %) were female and 70 (43.2 %) male. The median BMI was 18.14, which corresponds to the 38th percentile with a SDS of -0.325. 32 children (21.3 %) were born prematurely (median of 36th week of gestation). Concerning demography, 93.8 % of the parents were German and approximately 30 % of the mothers and fathers had completed education up to A-Levels (Abitur).

73.6 % (n = 106) of the children had an initial orthodontic diagnosis and 88.9 % (n = 136) previously have had orthodontic therapy. Almost one fifth of the study population were on regular medication and nearly 30 % of the children suffered from allergies. 15.7 % had undergone an intervention, such as tonsillectomy. Four probands (2.6 %) had been diagnosed with a heart failure or a chronic heart disease. The median PSQ score was 0.05, whereby 7 subjects (4.3 %) had a pathological PSQ score > 0.33. Information on basic characteristics of the study sample are given in Table 1.

Table 1: Basic characteristics of the study sample

characteristic	statistical definition	valid n	category	probands
sex	n (%)	162	female	92 (56.8%)
			male	70 (43.2%)
age †	median (min - max)	162	years	13 (6 - 16)
BMI †	median (min - max)	158	kg/m^2	18.14 (11.5 - 28.6)
BMI percentile †	median (min - max)	158		38 (< 3 - 99)
SDS †	median (min - max)	158		-0.325 (-4.67 - 2.52)
premature baby	n (%)	150		32 (21.3%)

premature baby # week of gestation †	median (min - max)	15	weeks	36 (24 - 37)
Demographic characteristics				
nationality mother	n (%)	156	German	149 (95.5%)
			other	7 (4.9%)
nationality father	n (%)	149	German	137 (91.9%)
			other	12 (8.1%)
education mother	n (%)	155	A-Levels (German Abitur)	47 (30.3%)
			lesser degree of education/graduation	108 (69.7%)
education father	n (%)	150	A-Levels (German Abitur)	44 (29.3%)
			lesser degree of education/graduation	106 (70.7%)
native language at home	n (%)	155	German	152 (98.1%)
			(and) other	3 (1.9%)
household smoking	n (%)	155		29 (18.7%)

Sleep history				
favourite sleeping position	n (%)	137	supine	32 (23.4%)
		137	prone	29 (21.2%)
		137	right lateral	68 (49.6%)
		137	left lateral	51 (37.2%)
Childhood illnesses/infections/clinical findings				
heart failure/chronic heart disease	n (%)	151		4 (2.6%)
neurodermatitis	n (%)	148		18 (12.2%)
asthma	n (%)	148		12 (8.1%)
obstructive bronchitis	n (%)	146		16 (11%)
frequency of infections per year	n (%)	148	never	1 (0.7%)
			1-2 times	87 (53.7%)
			3-4 times	47 (29%)
			5-7 times	9 (5.6%)
			> 7 times	4 (2.5%)
nasal congestion/obstructed nasal breathing/mouth breathing per week	n (%)	146	never	52 (35.6%)
			< 1 times	71 (48.6%)
			1-2 times	10 (6.8%)
			3-5 times	5 (3.4%)
			6-7 times	8 (5.5%)
enlarged adenoids	n (%)	155		30 (19.4%)
enlarged tonsils	n (%)	151		29 (19.2%)

tympanic effusion	n (%)	147		17 (11.6%)
on regular medication	n (%)	149		27 (18.1%)
Allergies				
allergy overall	n (%)	157		43 (27.4%)
Interventions				
adenotomy	n (%)	162		23 (14.2%)
tonsillotomy	n (%)	154		2 (1.3%)
tonsillectomy	n (%)	160		7 (4.4%)
paracentesis	n (%)	158		5 (3.2%)
intervention overall	n (%)	159		25 (15.7%)
Orthodontic/dental information				
permanent sucking bottle	n (%)	155		44 (28.4%)
previous orthodontic therapy	n (%)	153		136 (88.9%)
initial orthodontic diagnosis	n (%)	144	yes	106 (73.6%)
			no	23 (16.0%)
			not examined yet	7 (4.9%)
			unknown	8 (5.5%)
Questionnaires				
PSQ score †	median (min - max)	162		0.0476 (0.0 - 0.5)
SDSC score †	median (min - max)	157		38 (26 - 71)
ESS score [a]	median (min - max)	162		3 (0 - 20)
PDSS score [a]	median (min - max)	160		9 (0 - 27)

† not normally distributed; [a] normally distributed

6.1.1 Feasibility of the study model

Of 188 children approached, 21 children or their parents refused participation (11.2 %). Stated reasons included a lack of time or a reluctance to fill out the questionnaires. 5 of 167 initially recruited children were outside the defined age limits and therefore were excluded (drop-out rate of 3 %). None of the probands desired to terminate the examinations prematurely or cancel study participation. Thus, 162 probands were enrolled in the ORFOS project.

Concerning the time factor, probands and parents had to consider approx. 10 - 15 minutes to complete all questionnaires. The perfomed ENT examination took 5 - 10 minutes, depending on compliance and clinical findings. The

orthodontic data collection was integrated in the routine diagnosis process of the clinic, so no extra time was required.

To asses feasibility, the percentages of missing values in "clinical history", "demographic information" and the individual examinations were reviewed. In summary, few variables showed a missing data rate ≥ 10 % (n ≥ 16). In "clinical history" this concretely involved 7 variables: how often does your child have nasal congestion/obstructed nasal breathing/mouth breathing, does your child have a dental or orthodontic malposition that has been diagnosed by a dentist or orthodontist, has your child been breast-fed, tonsilitis, pseudocroup, bronchitis and epiglottitis. Regarding the demography questionnaire, the father's education had the highest number of missings (n = 17). 3 variables in the ENT examination revealed missing data ≥ 5 % (n ≥ 8): external malformation of the nose, nasal breathing while the mouth remained closed and tonsils' side difference. Looking at the orthodontic data sample, missings in the transversal widths (n = 15) were apparent. Data sets of cephalometric analysis were missing in 8 participants.

6.2 Test results for normal distribution

Of all metric variables tested, nine showed a normal distribution ([a]). All others were not normally distributed (†) according to Shapiro-Wilk ($p < 0.05$) and/or skewness and kurtosis. However, looking at the histograms and/or Q-Q plots

one can assume that most data did not differ significantly from normality and were approximately normally distributed.

6.3 Statistical group comparison between "snorers" and "non-snorers"

6.3.1 Group classifications

Only seven children (4.3 %) represented the test group "snorers", by demonstrating a PSQ score > 0.33. Therefore, we changed our group classification criteria:

With the help of the PSQ, the study population was divided into two groups whereby all children who ticked at least one "yes" in the subscores for snoring (questions 1 to 5, 5 items) formed the test group labelled "*snorers*" (42 children [25.9 %], 25 females [59.5 %], 17 males [40.5 %], mean age 12.9 years). The other group consisted of probands who did not tick "yes" in the snoring subscores and served as the reference/control group "*non-snorers*" (120 children [74.1 %], 67 females [55.8 %], 53 males [44.2 %], mean age 12.7 years). Based upon the variables collected, these two groups were now compared.

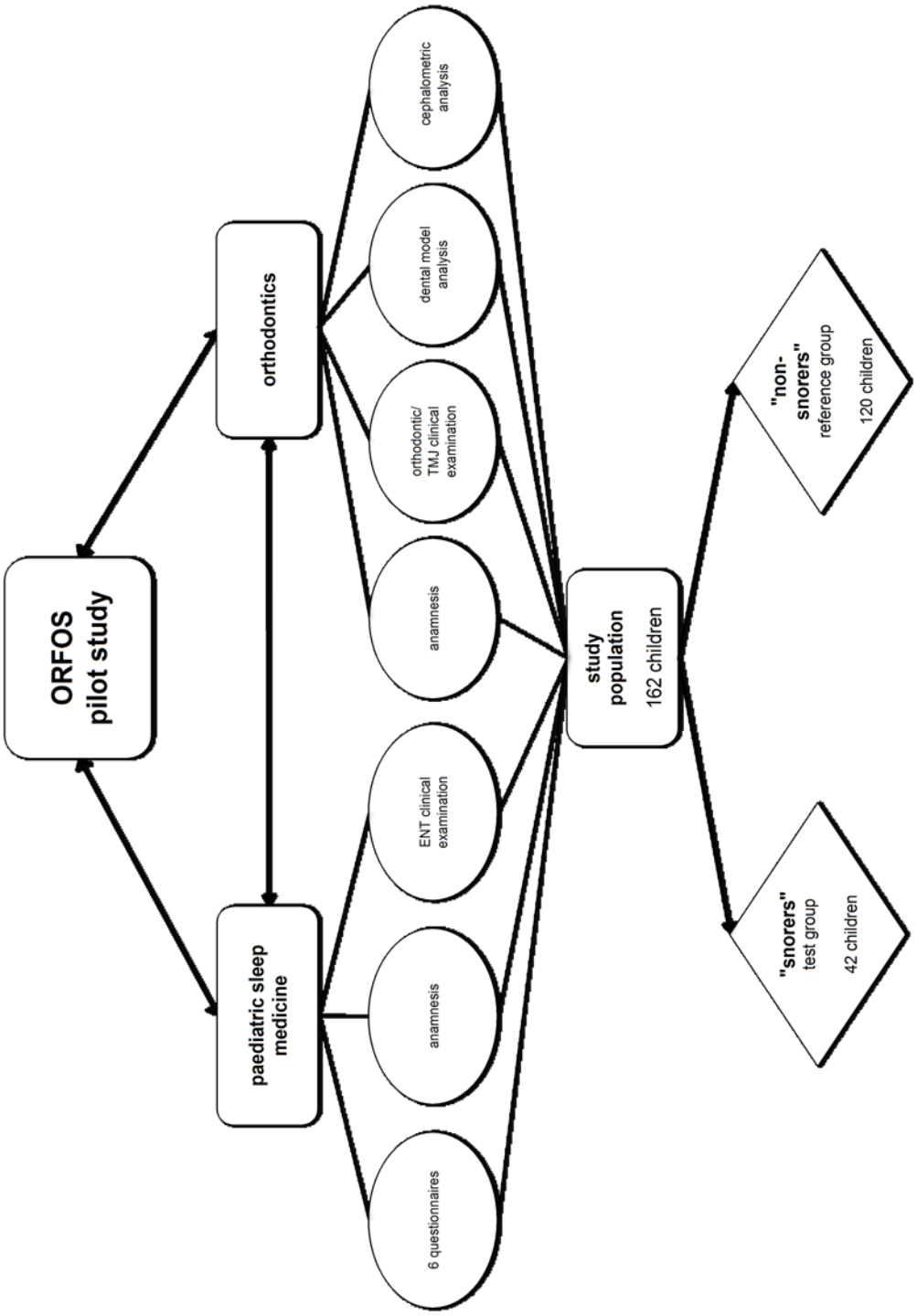

Figure 1: Flowchart ORFOS pilot study

6.3.2 Intergroup differences - relevant results

Table 2: Intergroup differences - relevant results

characteristic	statistical definition	valid n "snorer"	"snorer"	valid n "non-snorer"	"non-snorer"	risk ratio (RR)
Orthodontic anamnesis and clinical findings						
sucking habits	n (%)	42	4 (9.5 %)	120	29 (24.2 %)	0.39*
lip configuration lower third [mm] †	median (min - max)	41	15 (6 - 25)*	118	18 (6 - 37)*	
lip configuration lower third [%] †	median (min - max)	41	67 (26 - 129)*	118	69 (32 - 150)*	
asymmetries of the face (frontal) l # mandible to the right	n (%)	41	2 (4.9 %)	118	21 (17.8 %)	0.28*
asymmetries of the face (frontal) l # mandible to the left	n (%)		4 (9.8 %)		15 (12.7 %)	0.77*
Dental model analysis						
overbite [mm] †	median (min - max)	42	4 (-5 - 7)*	117	3 (-5 - 9)*	
frontal crossbite	n (%)	41	4 (9.8 %)	118	28 (23.7 %)	0.41*
edge-to-edge occlusion	n (%)	39	13 (33.3 %)	118	29 (24.6 %)	1.35*
lateral open bite	n (%)	40	3 (7.5 %)	118	22 (18.6 %)	0.40*
transversal width maxilla ant. [mm] †	median (min - max)	38	19.5 (12 - 44)*	109	18 (9 - 40)*	
transversal width maxilla post. [mm] †	median (min - max)	38	28.5 (14 - 52)*	109	24 (10 - 49)*	
transversal width mandible ant. [mm] †	median (min - max)	38	31.5 (11 - 39)*	109	18 (9 - 39)*	
transversal width mandible post. [mm] †	median (min - max)	38	41 (19 - 52)*	109	25 (14 - 52)*	

* $p < 0.1$; † not normally distributed; [a] normally distributed

characteristic	statistical definition	valid n "snorer"	"snorer"	valid n "non-snorer"	"non-snorer"	risk ratio (RR)
Clinical history						
frequency of infections per year # 5 - 7 times	n (%)	39	5 (12.8 %)	106	4 (3.7 %)	3.46*
frequency of infections per year # > 7 times	n (%)		4 (10.3 %)		0	0*
tonsilitis	n (%)	34	21 (61.8 %)	106	34 (32.1 %)	1.93*
bronchitis	n (%)	35	20 (57.1 %)	107	44 (41.1 %)	1.39*
on regular medication	n (%)	36	12 (33.3 %)	113	15 (13.3 %)	2.5*
frequency of nasal congestion/obstructed nasal breathing/mouth breathing per week # 3 - 5 times	n (%)	38	4 (10.5 %)	108	1 (0.9 %)	11.67*
frequency of nasal congestion/obstructed nasal breathing/mouth breathing per week # 6 - 7 times	n (%)		5 (13.2 %)		3 (2.8 %)	4.71*
pollen allergy	n (%)	40	8 (20 %)	116	11 (9.5 %)	2.11*
animal hair allergy	n (%)	37	5 (13.5 %)	115	4 (3.5 %)	3.86*
enlarged polyps	n (%)	37	16 (43.2 %)	118	14 (11.9 %)	3.63*
enlarged tonsils	n (%)	37	16 (43.2 %)	114	13 (11.4 %)	3.79*
adenotomy	n (%)	42	12 (28.6 %)	120	11 (9.2 %)	3.11*
permanent sucking bottle	n (%)	40	15 (37.5 %)	115	29 (25.2 %)	1.49*

* $p < 0.1$; † not normally distributed; [a] normally distributed

characteristic	statistical definition	valid n "snorer"	"snorer"	valid n "non-snorer"	"non-snorer"	risk ratio (RR)
ENT anamnesis and clinical findings						
BMI †	median (min - max)	40	19.64 (12.09 - 28.57)*	118	17.85 (11.51 - 26.53)*	
percentile †	median (min - max)	40	56 (<3 - 99)*	118	32 (<3 - 96)*	
SDS †	median (min - max)	40	0.170 (-4.67 - 2.52)*	118	-0.475 (-4.43 - 1.82)*	
impaired nasal breathing	n (%)	42	14 (33.3 %)	120	22 (18.3 %)	1.82*
halitosis	n (%)	42	9 (21.4 %)	120	8 (6.7 %)	3.19*
tympanic membrane retraction	n (%)	41	1 (2.4 %)	114	0	0*
tympanic effusion	n (%)	42	2 (4.8 %)	114	0	0*
open spontaneous mouth posture	n (%)	42	21 (50 %)	119	32 (26.9 %)	1.86*
tonsils' size # reaching over post. velum	n (%)	40	13 (32.5 %)	120	29 (24.2 %)	1.34*
tonsils' size # "kissing tonsils"	n (%)		3 (7.5 %)		1 (0.8 %)	9.38*
tonsils' side difference	n (%)	40	7 (17.5 %)	113	8 (7.1 %)	2.46*
position of the uvula tip # upper third	n (%)	42	6 (14.3 %)	119	38 (31.9 %)	0.45*
position of the uvula tip # middle third	n (%)		23 (54.8 %)		55 (46.2 %)	1.19*
position of the uvula tip # lower third	n (%)		13 (31 %)		26 (21.8 %)	1.42*

* $p < 0.1$; † not normally distributed; [a] normally distributed

characteristic	statistical definition	valid n "snorer"	"snorer"	valid n "non-snorer"	"non-snorer"	risk ratio (RR)
Demography						
younger siblings # none	n (%)	33	12 (36.4 %)	100	57 (57 %)	0.64*
younger siblings # one	n (%)		15 (45.5 %)		37 (37 %)	1.23*
younger siblings # two	n (%)		6 (18.2 %)		6 (6 %)	3.03*
nationality mother # German	n (%)	40	34 (85 %)	116	115 (99.1 %)	0.86*
nationality mother # other	n (%)		6 (15 %)		1 (0.9 %)	16.67*
nationality father # German	n (%)	38	32 (84.2 %)	111	105 (94.6 %)	0.89*
nationality father # other	n (%)		6 (15.8 %)		6 (5.4 %)	2.93*
education mother # primary/lower secondary school	n (%)	40	10 (25 %)	115	22 (19.1 %)	1.31*
education mother # secondary school	n (%)		14 (35 %)		49 (42.6 %)	0.82*
education mother # A-Levels	n (%)		11 (27.5 %)		36 (31.3 %)	0.88*
education mother # other	n (%)		2 (5 %)		0	0*
education father # primary/lower secondary school	n (%)	38	21 (31.6 %)	112	27 (24.1 %)	1.31*
education father # secondary school	n (%)		5 (13.2 %)		42 (37.5 %)	0.35*
education father # A-Levels	n (%)		12 (31.6 %)		32 (28.6 %)	1.10*
education father # other	n (%)		3 (7.9 %)		1 (0.9 %)	8.78*
pro. education mother # apprenticeship	n (%)	37	10 (27 %)	111	45 (40.5 %)	0.67*
pro. education mother # business school	n (%)		6 (16.2 %)		26 (23.4 %)	0.69*
pro. education mother # technical college	n (%)		7 (18.9 %)		12 (10.8 %)	1.75*
pro. education mother # technical university	n (%)		1 (2.7 %)		7 (6.3 %)	0.43*
pro. education mother # university	n (%)		8 (21.6 %)		15 (13.5 %)	1.6*
pro. education mother # none	n (%)		5 (13.5 %)		3 (2.7 %)	5*

* $p < 0.1$; † not normally distributed; [a] normally distributed

6.3.3 Intergroup differences - further results

Regarding the following variables, there were differences between the groups, despite neither of them being significant ($p > 0.1$). In total, 8 variabels demonstrated a risk ratio > 2. Regarding the clinical history questionnaire, this referred to nasal septal deviation (RR = 3.34), heart failure (RR = 3), tonsillotomy (RR = 3), asthma (RR = 2.24), house dust allergy (RR = 2.2) and paracentesis (RR = 2). In demographic information, the professional education of the father showed a risk ratio of 6.33 in the option "none" and 2.29 in "technical university". With a risk ratio of 6, Mallampati IV was apparent in ENT clinical findings.

Results are given in Table 5 to 9.

7 Discussion

With the ORFOS pilot study, we aimed to determine if our OSA screening method in childhood combined with the elaborated examination is feasible and practicable in the setting of an orthodontic practice with a view towards a nationwide study project. The study also adressed the issue of collecting orthodontic OSA risk factors in children, in order to determine a suitable diagnostic focus for future examinations.

We were able to show promising everyday suitability for the tested OSA screening, so that our methods can be implemented considering suggested improvement opportunities.

A group comparison between children with suspected OSA/SDB and controls revealed eight relevant ($p < 0.1$) intergroup differences in orthodontic evaluation: On the one hand, we found that an edge-to-edge bite might be a risk factor for OSA in childhood, which has not been described before. On the other hand, the majority of our study results run counter to a review of current studies (concerning crossbite, open bite, transversal widths, sucking habits) as they A) do not confirm their role as OSA risk factors (overbite) or B) differ from our assumptions (frontal facial asymmetries). Explanatory approaches are discussed in the subsequent sections followed by conclusions and practical implications.

7.1 Feasibility of the procedures

In order to evaluate feasibility, the following discussion primarily focuses on three main issues:

1. Are framework conditions satisfying?
2. Is the PSQ a suitable screening/classification instrument?
3. Is an orthodontist/dentist able to perform an orientational ENT examination in daily routine practice?

7.1.1 Acceptance

A participation rate of 88.8 % seems rather acceptable, especially considering that parents and children will be asked to complete less than six questionnaires in our future project. To a large extent, they served the purpose of detecting risk factors and describing the study population. With less questionnaires to fill out, we assume an even higher number of participants with their parents to agree on completing one questionnaire as the initial screening tool for OSA. Furthermore, in our pilot study a doctoral candidate recruited the probands and obtained the parents' consent. With a practising orthodontist/dentist recruiting in the planned main study, an increase in participation is likely. Patients and their guardians may have built up a doctor-patient relationship or/and may therefore put greater confidence in the orthodontist's skills and competence compared to those of a medical student. Consequently, stated arguments for refusing participation could be refuted with these intended modifications. It hence appears realistic to recruit sufficient numbers of participants for the main study.

7.1.2 Adherence

With a drop out rate of 0 % the probands' adherence was excellent, pointing to a high acceptance of our study concept. Reasons that may account for this could be the risk free and non-invasive examination methods, a short time requirement, and the child-friendly approach in the study introduction.

7.1.3 Feasibility of framework conditions

The concrete study implementation is economically feasible as the performed survey with both questionnaires and the ENT examination involved minimal financial expenditure. Incurring costs from the orthodontic data collection will not charge the study budget extensively, since these are integral part of the orthodontic/dental routine care. Nonetheless, one has to be concerned about the financial compensation for time and personnel expenses.

No additional staff on-site in the orthodontic practices are needed as the study along with the declaration of agreement and the questionnaires can be introduced by a dentist assistant, for instance. However, clinical history and examination would be performed by the orthodontist/dentist.

The additional time required for our study on average was less than 20 minutes per participant. Parents completed the questionnaires during waiting time at their orthodontist's appointment. Only the ENT history and examination took once 5 to 10 minutes maximum of extra time. Thus, we conclude that study participation will not be time consuming for any of the parties involved.

7.1.4 Feasibility of the ENT examination

The conducted ENT examination including the questionnaires offered the advantages of low costs, few necessary personnel and a fast evaluation. With a preparatory internship in the pediatric ENT consultation, an ENT specialist taught the doctoral candidate the required skills in order to perform the examination properly. At the same time, the doctoral candidate gained experience in dealing with pediatric patients.

Whereas orthodontists are used to handling children in their practice, they would have to be trained in examining the ENT features outside of their specific field. This precondition is supported by the fact that a high degree of standardisation needs to be achieved in data collection. A uniform training of all participating orthodontists, certified as further training for instance, may help to keep detection bias low, increase time efficiancy, and faciliate the evaluation process.

The ENT examination itself contained some clinical features whose assessment depended on practical knowledge or a "trained eye" like

otoscopic examination and interpretation. The classification of nose malformations appeared difficult without sample images. Moreover, nasal septal deviation as well as nasal concha hyperplasia could only be inspected externally and it was a challenging task to attain clear statements without using invasive examination methods. On the other hand, illustrations of the Mallampati score, the pictogram for tonsil size interpretation or the pictoral description of the hyoid - mentum measurement helped the examiner. In summary, the doctoral candidate had no problems in performing a basic NT examination with the available assistance. We hence believe that orthodontists with their clinical experience combined with trained additional qualifications will be able to implement an ENT examination procedure.

7.1.5 "Missing n"

By reviewing the "missing n", we aimed to find out why the response rate in specific questions was low or why examination steps may have caused problems. Concerning the clinical history questionnaire, a non-comprehension of medical terms may have been the cause for a lower response rate on the queries referring to pseudocroup, bronchitis and epiglottitis. Looking at the demographical questionnaire, in total, information on the father was filled out less frequently. This might have been due to the fact that single mothers had no knowledge about the father's education for example, and the questionnaire did not provide the opportunity to answer by ticking an "I don't know" box. Missing values regarding the question about an orthodontic diagnosis might have been the result of unawareness and could be answered by the orthodontist him/herself in the future.

Overall, the ORFOS pilot study demonstrated favourable framework for our planned long-term project: Our methods were convincing concerning acceptance, adherence and feasibility so that the setting within an orthodontic practice is considered suitable.

7.2 The PSQ as a screening tool for OSA

In the clinical practice guideline for diagnosis and management of childhood OSA of 2012, Marcus et al. (96) recommended that all children should be screened for snoring. They could benefit from dentists being involved in an SDB screening process according to De Luca Canto et al. (97). Derived from these and other recommendations, Chervin's PSQ questionnaire (20) with its 22-item SRBD scale and, more specifically the snoring subscale, served us as a screening instrument to identify children at risk for OSA in orthodontic practice.

The childhood SDB prevalence of 4.3 % in this pilot study is in line with the literature which refers to a prevalence of 4 to 11 % (98), and does not considerably differ from Sauer C. et al.'s results of 3.3 % (85). The technical report of Marcus et al. (4) also states a reviewed prevalence of OSA in the range of 1 to 5 %. However, our average PSQ score of 0.09 was slightly higher than the one reported by Sauer C. et al. (0.071) (85). Like in the study by Archbold et al. (99), our study population comprised a noticeable number of probands having allergies, having had an ENT intervention or being on regular medication. On the other hand, OSA is reported to be more frequently seen in a younger age (5, 100, 101), yet our study sample excluded children under six years of age. Moreover, mainly the parents were surveyed concerning their child's sleep problems. According to Paavonen et al. (102), in this setting one third of sleep problems is not detected. Together, these facts may have led to our prevalence being in the lower range. Although studies reported either an equal (4, 103-105) gender-specific or an increased prevalence of OSA in boys (3, 106) our sample suggested quite the opposite. More females than males were in the "snorer" group, indicating SDB or even OSA. It is very plausible that these findings only reflect the dominance of the female gender in the study population or can be accounted for by a small number of cases. Taking into account that the group classification was based on the PSQ, a

significant intergroup difference is hardly surprising. This also explains the increased median in the "snorer" group.

An argument in favour of the use of the PSQ in our setting is its suitability for the age distribution in our study population (designed for children aged 2 - 18 years). Its completition requires considerable time for the parents (22 questions) and the three given response options ("yes", "no", "I don’t know") are clearly enunciated.
Moreover, Chervin and colleagues also confirmed validity of the SRBD scale, demonstrating a sensitivity of 78 % and a specificity of 72 % for PSG-defined OSA in 2007 (107), supporting its effectiveness as a screening tool. Spruyt et al.'s review about instruments used to investigate or evaluate sleep issues in children substantiates these statements, as the PSQ fulfills 10 of 11 listed methodological steps needed to develop and evaluate a sleep assessment tool (108). In a recently published review on the diagnostic capability of questionnaires and clinical examinations to assess sleep-disordered breathing in children, the PSQ turned out to be the only valid tool to screen for pediatric SDB (97). De Luca Canto et al.'s research also revealed that a physical examination combined with a questionnaire improved test performance, affirming our study approach.

In contrast, the PSQ lacks a measurement of "change", questions are restricted to a certain time-frame and may not focus on severity but solely on frequency of occurrence (108). Furthermore, our group classification to identify potential OSA patients was not based on the SRBD scale itself but on five "snoring" items. With a pathological SRBD/PSQ score > 0.33, we only could have included 7 children in the "snorer" group. With our classification criterion of at least one ticked "yes" in the PSQ questions on snoring, we were able to recruit 20 children. Considering snoring the cardinal symptom of OSA, this approach seems justified, especially if more clinically conspicuous children could be detected in this way who would otherwise go unnoticed. However, Brietzke (109) and Rembold (110) reported a weak association

between objective snoring characteristics and the actual presence of OSA to form a diagnosis (4). Nevertheless, screening on the basis of five selected snoring items resulted in a "snoring" test group that differed relevantly from the control group. For the most part, these differences are discussed in previous research and consequently point out qualification of our screening criteria. Yet, other OSA symptoms outlined in the introduction such as daytime sleepiness for instance, were not taken into account in our screening method resp. group classification. Accordingly, involving more OSA symptoms than just "snoring" should be considered.

To conclude, the group classification or rather the tested OSA screening method appeared reasonable for our individual purposes since hypotheses for OSA risk factors concurrently needed to be deduced. Assessing advantages and disadvantages, the total SRBD/PSQ score (20) might serve as a reliable screening but not as diagnostic tool for pediatric SDBs in our planned study project, particulary in combination with a clinical examination. The PSQ, however, offers potential for improvement and prior to its application as an OSA screening instrument a modification due to points of critisim should be dicussed.
Alternatively, a different screening questionnaire might be considered: Kadmon et al., for example, lately valided a 6-item screening questionnaire for pediatric OSA with "fair specificity and favorable sensitivity" (111) which has not been adressed in De Luca Canto et al.'s review.

Before further discussing the results of orthodontic risk factor evaluation, it seems important to accurately assess the high risk of bias and put our results into proper perspective.

7.3 Limitations

The ORFOS study is subject to limitations concerning study sample, study model and the collection of risk factors.

7.3.1 Limitations concerning the study sample

Our study population consisted of children and adolescents aged 6 to 16 years, undergoing orthodontic treatment at an university hospital. The fact that pre-schoolers were not included may raise limitations, as frequency of snoring as an OSA symptom is increased within 4 to 5 year olds (5). Moreover, descriptive statistics did not show a convincing representativeness of our study group because of higher frequencies compared to the general population of this age group. 21.3 % of our study probands were born prematurely (on average 9.2 % in Germany), 8.1 % had asthma (lifetime prevalence of 4.7 % in Germany), 27.4 % had allergies (16.7 % due to KiGGS), and 18.1 % were on regular medication (109, 110). A reason for our study population appearing "sicker" may be that parents whose children are or have been in the care of a university hospital (preterm babies, for instance) tend to choose orthodontic care at the university hospital as well. Another limiting factor might be that almost 90 % of study subjects have had previous orthodontic therapy and over 70 % have already been orthodontically diagnosed at the time of investigation, so that possible symptoms vanished. An evaluation at the patient's admission to orthodontic care is promoted by the fact that parents often mentioned that they would have completed the questionnaires differently before treatment or as their child was younger.

These findings may have led to under-estimated results, but with an adaption for age limits and investigation time, their occurrence is preventable.

7.3.2 Limitations concerning the study model

It cannot be ruled out that some of our study findings are based on misclassifications. Group classification with the help of PSQ items, BMI and a great part of clinical history results relied on parental report and were not ascertained with objective measures. Furthermore, we did not focus on severity degrees but instead on the presence of OSA facilitating factors, since we aimed to test a screening method.

7.3.3 Limitations concerning the evaluation of risk factors

The ENT examination was intentionally not performed by a specialist in ENT medicine but by a medical student instead, in order to test its feasibility for orthodontists. Nevertheless, this might have influenced data collection. Although having positive effects on adherence, a non-invasive method (without endoscopy) may limit interpretation of ENT findings.

7.4 Suggestions for improvement

For a better understanding, all medical terms occurring in the questionnaires should be translated in future. Lowering the age limit and including 4 to 6 year olds in early orthodontic care could have a positive effect on the screening process. Thereby the first peak of frequency distribution for snoring (preschool children with growing adenoids/tonsils) would be taken into account (5).

Opportunities for improvement are also seen for the ENT history and clinical examination. As previously mentioned, a training for orthodontists involved would ensure a correct performance and promote a standardised collection of study data. Furthermore, example images of possible clinical findings would faciliate their interpretation. To avoid inaccurate data for BMI calculations, height and weight could be objectively measured. Consideration should also be recorded at point of investigation. Children preferably ought to be screened

routinely at their initial consultation before orthodontically treated as possible symptoms then might have vanished or data might lose significance.

7.5 Orthodontic OSA risk factors

In the last decades, multiple research groups made effort in evaluating differences between pediatric OSA/SDB patients and normal controls in order to work out risk factors. Especially in the field of dentistry and orthodontics, diagnostic tools like clinical history and examination, dental cast models and cephalometry helped to identify changes in OSA/SDB children: retrusive chin, steep mandibular plane, reduced mandibular length, vertical direction of growth, tendency towards Class II malocclusion, increased total and inferior heights of the face, inferior position of the hyoid bone, narrow maxillary widths, and associations to cross and open bites, etc. (7, 41, 51-53, 55, 57, 58, 112). At the same time, literature also suggests that further investigation with a higher number of subjects is needed to clarify orthodontic risk factors for clinical diagnosis. To accomodate these recommendations, the ORFOS pilot study combined several orthodontic diagnosis tools to identify criteria which might help to determine children at risk for OSA/SDB. We aimed to present orthodontic parameters eligible and relevant for future testing in a sufficiently large group of pediatric probands.

Table 3: Potential orthodontic risk factors and their categorisation in literature

	orthodontic risk factor	conform to literature	contrary to literature	new	collection method
1	sucking habits		X		*clinical orthodontic history*
2	lip configuration			X	*orthodontic examination*
3	asymmetries of the face		X	X	*orthodontic examination*
4	overbite	x	X		*dental cast model*
5	frontal crossbite		X		*dental cast model*
6	edge-to-edge occlusion			X	*dental cast model*
7	lateral open bite		X		*dental cast model*
8	transversal widths maxilla/mandible		X		*dental cast model*

Overall, our study revealed eight relevant ($p < 0.1$) intergroup differences in orthodontic evaluation. Regarding history and clinical findings, the test group "snorers" was characterised by less sucking habits, a lower prevalence of frontal face asymmetries based on the mandible, as well as a reduction in the percentage of lower lip configuration. Analysis of the dental cast models showed that children in the test group demonstrated a higher occurrence of edge-to-edge occlusion, greater overbites and increased transversal width dimensions of maxilla and mandible. We also found that frontal crossbites and lateral open bites were not as frequent in "snorers" as in the control group. No other relevant intergroup differences in dental arch morphology could be detected.

Edge-to-edge bite

It was noticable that every third child in the snorer group presented with an edge-to-edge bite in contrast to every fourth child in the control group. To our knowledge, these findings are new since no association to OSA has been described in the literature before. An edge-to-edge bite exists when the incisal surfaces of the maxillary anterior teeth meet the incisal edges of the mandibular anterior teeth. It can be caused by a retrusion of the upper and/or protrusion of the lower incisors or if skeletal relation of maxilla and mandible does not meet physiological norm (113). A higher occurrence of edge-to-edge bite in the test group seems comprehensible as OSA patients tend to show malocclusions like Class II pattern or changes in maxilla or mandible position, length and widths. As orthodontic therapy had been initiated in a high number of study participants, an edge-to-edge bite might have been more common as an intermediate state in treatment towards normal occlusion. Up to the present, pediatric OSA study groups might not have focused on edge-to-edge bites, so that its incidence might be underrepresented. Based on our results we suggest that the edge-to-edge bite should be considered for future testing to see whether its classification as a orthodontic risk factor for OSA is justified.

Frontal facial asymmetries

Moreover, our study groups differed in the appearance of frontal facial asymmetries. Because OSA is known to be an accompanying condition in pediatric patients with craniofacial abnormalities (114, 115), we would have hypothesized that they are more common in the test group. In contrast to our assumption, children in the control group "non-snorers" were diagnosed more frequently with facial asymmetries. This affected relevantly both the mandibular deviation to the left and notably to the right. The same applied for asymmetries due to midface deviation. Remarkably, deviations to the right of the face were generally more prevalent. Facial asymmetries can be of genetic or nongenetic origin but are usually a combination of both (116). According to Bishara et al., there are three main causes for facial asymmetry and dental midline irregularities: muscoloskeletal, dental, and functional (117). On this

basis, our findings appear to be reasonable since we demonstrated higher incidences of sucking habits (assigned to dental asymmetries) and malocclusions (assigned to dental or muscoloskeletal asymmetries) or shorter transversal widths as a cause for functional asymmetries in the control group. Furthermore, the fact that craniomandibular dysfunction as a possible effect of mandibular deviation also occured more often in "non-snorers" supports our findings. Even though our results concerning facial asymmetries can be contextualised with other characteristics in the control group, they do not contribute their role towards OSA risk factors. As the causes for face asymmetries are multifactorial, future testing is to reveal their prognostic value in pediatric OSA.

Overbite

Children with OSA/SDB or tonsillary obstruction were found to have a reduced overbite unlike controls (7, 51, 58, 102, 118, 119). Explanatory approaches are scarcely provided. Pirila-Parkkinen et al. refers to Subtelny's opinion that overbite might be reduced by continued eruption of the posterior teeth due to an open mouth posture (120). Our measurements, on the contrary, agree with Cozza et al.'s findings (41): overbite was relevantly increased in our test group. Cozza's study does not discuss causes but his results were combined with a skeletal Class II pattern and a reduced mandibular length. Our methods did not include mandibular length measurements, but a Class II pattern was in fact more common. Although literature seems to be divided over the question if an increased or reduced overbite is significant for OSA in childhood, its role in diagnostic approach appears unquestionable.

Crossbite

In 1970, Linder-Aronson found a high incidence of crossbites in children with adenoids combined with nasal respiratory obstruction (121). Following, several authors reported similar observations of lateral and/or posterior crossbites in relation to airway obstruction (7, 85, 118, 122, 123). Hultcrantz et al. postulated a spontaneous correction of open bite and anterior crossbite

if tonsillectomy is performed before the age of six years in children with OSA (51). These results lead to the conclusion that crossbites seem to be a common sign for pediatric OSA/SDB, if not even an orthodontic risk factor. Contrary to stated literature, we diagnosed an equal percentage of lateral crossbites in the test ("snorers") and in the control group ("non-snorers"). Frontal crossbites were even relevantly more frequent in controls. Pirila-Parkkinen et al. could also not demonstrate a higher occurrence of crossbites in their study as most samples had mild OSA (119). The same might apply for our study population, as group classification was based on the PSQ in order to test its feasibility as an OSA screening tool. Performing PSG for a reliable OSA diagnosis would have idenitfied OSA patients and possibly, crossbite frequency might have changed in line with the literature. Additional factors that might have impacted on our findings include previous orthodontic therapy or a limited number of subjects in the current study. On this basis, we consequently cannot promote crossbites as an orthodontic risk factor but in consideration of previous literature, we would recommend crossbites for further testing.

Transversal widths

Palatal expansion and RME in particular have been introduced as a treatment option for OSA in childhood (39), taking into account that maxillary dental arches were narrower in "snorers" compared to controls. Corresponding data collected by Lofstrand-Tidestrom et al., Pirila-Parkkinen et al. and Cozza et al. underline the prevalence of reduced, mainly upper transversal widths (7, 41, 58). The same could be detected in adults with OSA (124). Cozza et al. who could also show reduced interarch dimensions for the mandible, proposed that due to the resulting narrowness the tongue would be moved compensating to a more upward and backward position. This would promote upper airway obstruction as the main pathology in OSA. Accordingly, we would have expected matching results in our study sample. However the opposite was the case: all transversal widths of maxilla and mandible (anterior as well as posterior) were relevantly increased in "snorers" compared to our

controls. Differences in anterior and posterior mandibular width were most evident. Underlying causes might be measurement errors, previous orthodontic treatment or an unrepresentative study sample for the general childhood population. Yet, efforts should be made to only include children who have not been orthodontically treated before in order to prevent bias. This non-agreement with current data highlights the importance of a large-scale study population without prior "manipulation" plus a proper OSA screening tool to establish risk factors for OSA in the future.

Sucking habits

Furthermore, we expected to find sucking habits as a cause for orofacial dysfunctions to be more common in "snorers". But surprisingly, more than twice as many of the control group reported sucking habits compared to the test group. Sucking of thumb, finger, pacifiers or other objects is considered harmless in infancy and early childhood. But it may lead to tooth misalignment, dysgnathy or orofacial dysfunctions not only in primary but also in permanent dentition, particulary if the habit has not been given up by the age of three to four (125). The deformities include anterior open bite, increased overjet, posterior crossbite, flaring maxillary incisors, anteriorly displaced maxilla as well as retruded and crowded mandible (126-128). Especially negative pressure in the mouth, frontal pressure and increased pressure from cheeks and lips while sucking lead to a narrow, protruded maxilla and a retruded mandible, resulting in a tendency towards Class II malocclusion (125, 126). Thus, these pathologies ought to be reflected in the control group. Maxilla and mandible were indeed relevantly narrower and frontal crowding was more frequent. However, "non-snorers" showed higher frequencies in *frontal* crossbites and *lateral* open bites. Moverover, we detected a Class II pattern more often in "snorers". To sum up, although sucking habits were unexpectedly more present in our control group, we could not notice the entire spectrum of their consequences in this study sample. Either sucking habits were not that severe or had been corrected orthodontically. Even though Lofstrand-Tidestrom et al. saw no difference concerning sucking habits in their

cohorts (7), our results cannot promote sucking habits as a striking feature in children at risk for OSA, such as demonstrated by e.g. Sauer et al. (85). Possible reasons range from non-reliable answers, as this was an anamnestic variable, to different manifestations of the habit or previous interventions as stated above. Follow-up projects are required to ascertain or disprove our results.

Open bite

Many authors have reported a higher prevalence of open bites in pediatric OSA/SDB patients. Subtelny defined the open bite as open vertical dimension between the incisal edges of the maxillary and mandibular anterior teeth although loss of vertical dental contact can occur between the anterior or the buccal segment (129). According to Sassouni they can be classified by origin in skeletal or dental (130). Looking at the anterior open bite, many etiological factors take influence: suction of objects, premature dental loss, macroglossia, tongue thrust, temporomandibular joint disorders, hyperplasic tonsils, mouth breathing, nasal obstruction, and skeletal abnormalities (6, 77). The frequency of open and lateral bites is stated in a ratio of 4 to 1 (131). With nasal obstruction, mouth breathing, and hyperplasic tonsils being characteristic for OSA, we also expected higher frequencies of open bites in "snorers". Our results however demonstrate a higher incidence to lateral open bites in the control group. The same could be found concerning anterior open bites, although differences were not relevant. Therefore, our findings cannot confirm Sauer et al. or Pirila-Parkkinen et al. who diagnosed more anterior open bites in OSA/SDB children than in normal controls (58, 85). Lateral open bites and their alleged association with OSA have not really been addressed in previous studies. A possible explanation again may lay in previous or initiated orthodontic treatment. Perez et al. observed the development of posterior open bite (POB) in adults receiving mandibular advancement device therapy for obstructive sleep apnea (132). POB was diagnosed in almost one fifth of the patients during treatment. Thus, in our case it would be conceivable that performed orthodontic therapy might have increased the coherence of lateral

open bites in general and in the control group of "non-snorers". Consequently, collecting prevalence data regarding open bites in our setting with a large number of children in orthodontic therapy, might not have provided reliable results to identify if open bites could be OSA risk factors. So, the importance of a study population with children who have not ever been treated orthodontically is illustrated with our results.

Lip configuration

The last relevant intergroup difference concerns lip configuration. As our data show, "snorers" tend to have a shorter lower lip configuration than controls. Lip configuration in general is influenced by soft tissue thickness, muscle tone (musculus orbicularis oris), incisor position as well as overlying bone tissue. It is therefore comprehensible, that orthodontic and dental changes in OSA patients affect these impacting factors and thus lip configuration. In a harmonic lip ratio, the lower third of the face is formed by one third of upper and two third of lower lip plus chin (113). Looking at our results, both groups on average had physiological lip configurations. To the author’s knowledge, a shorter lower lip configuration has not been described in OSA patients compared to controls before. Although we could point out a relevant difference in our study group, the variation seems minor and not pathological. Further studies with higher numbers of cases are needed to rule out if lip configuration ranks among significant characteristics for OSA in childhood.

In summary, this raises the question why our results are mainly contrary to existing literature with potential risk factors beeing more frequent in the control group of "non-snorers". In addition to prior discussed approaches of explanation, selection bias may have considerably impacted on our findings. The cohorts were based on orthodontic patients at an university hospital. This may include especially children beeing referred from private practices requiring challenging orthodontic therapy. So, these group of patients might have failed to objectively reflect the general pediatric population as our collective potentially contained more orthodontic pathologies right from the

beginning. In our view, the description of our study population (6.1) justifies this assumption. We believe that parents who's children have already been in universtiy hospital care (pre-term birth, asthma, etc.) tend to also opt for orthodontic treatment there, resulting in sampling bias.

As mentioned, previously performed orthodontic treatment might have significantly influenced our findings as well. The purpose of a therapy lies in the elimination of risk factors in order to prevent or heal the actual illness. Thus, it would be conceivable that potential risk factors in the test group vanished compared to controls because they had been successfully treated. Following this hypothesis, our findings would confirm the stated variables as orthodontic risk factors for OSA. Existing literature and the fact that the test group was characterised by typical OSA/SDB symptoms attest to this assumption. On the downside, the two study groups had almost received an equal amount of orthodontic care beforehand.

7.6 Conclusion

For the implementation of a future nationwide study project in orthodontic/dentist practices to evaluate orthodontic risk factors for OSA, we reached the following conclusions:

1. With the ORFOS pilot study, we could show practicability and feasibility of the presented OSA screening in a daily orthodontic or dental practice, in particular allowing for proposed suggestions for improvement.
2. Our tested methods could demonstrate favourable framework concerning acceptance, adherence and organisation.
3. The PSQ serves as a suitable screening tool, especially in combination with an examination. However, modifications as on measurement of change in symptoms and focus on severity should be considered.
4. Low costs, few necessary personnel and a fast evaluation were convincing arguments in favour of our ENT examination.
5. Orthodontists and dentists involved should be trained in order to achieve good data quality, standardisation, and time efficiancy. With the help of sample images and their experience, they are able to successfully perform the deviced ENT examination.
6. In our study setting, we could not clearly identify orthodontic risk factors for OSA in childhood.
7. But the ORFOS project revealed differences concerning edge-to-edge bite, frontal facial asymmetries, overbite, crossbite, transversal widths, sucking habbits and open bite between potential pediatric OSA patients and controls. These orthodontic parameters should be taken into account by the examiner.
8. Considering mentioned recommendations, further research will be required to establish OSA risk factors in childhood.

In the long term, expected benefits comprise an early diagnosis of OSA facilitating factors as well as a short caused-based medical care focussing on

the real cause of, or contributing components of OSA (44, 133). Intending to support existing research (7, 134), our findings are to endorse interdisciplinary work in order to foster early recognition, milder severity. So, expensive and difficult treatment of OSA at an older age might be avoided.

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9 Appendix

9.1 Tables

Table 4: Variables of orthodontic history and clinical examination

variable	definition	values
breathing		- mouth breathing - nose breathing - combination
swallowing pattern		- visceral - somatic
cephalic index	ratio of the maximum width of the head to its maximum length, multiplied by 100	- dolichocephalic (<75.9) - mesocephalic (76-80.9) - brachycephalic (81-85.4) - hyperbrachycephalic (>85.5)
facial index	ratio of the length of face to its maximal width between zygomatic prominences, multiplied by 100	- hypereuryprosop (<78.9) - euryprosop (79-83.9) - mesoprosop (84-87.9) - leptoprosop (88-92.9) - hyperleptoprosop (> 93)
upper third of the face	hairline to glabella	[mm]
middle third of the face	glabella to subnasal area	[mm]
lower third of the face	subnasal area to mentum	[mm]
total length of the face	hairline to mentum	[mm]

variable	definition	values
percentage upper third of the face		in %
percentage middle third of the face		in %
percentage lower third of the face		in %
lip configuration upper third		[mm]
lip configuration lower third		[mm]
percentage lip configuration upper third		in %
percentage lip configuration lower third		in %
lip step	relation upper lip to lower lip	- positive - straight - slightly negative (normal) - negative
lip closure	line of contact of the upper and lower lip in relaxed lip closure	- competent - incompetent - potentially competent
craniomandibular dysfunction - muscular	malfunction in the area of all structures that	- yes - no

variable	definition	values
craniomandibular dysfunction - mandibular joint	determine and control the position of the mandible to the maxilla	- yes - no
incisal edge distance - active		[mm]
incisal edge distance - passive		[mm]
face typ/profile		- ideal/average face - forward face - receding face (straight, sloping forwards, sloping backwards)
asymmetries of the face (frontal) I		- straight - asymmetry of the mandible to the right - asymmetry of the mandible to the left
asymmetries of the face (frontal) II		- straight - asymmetry of the midface to the right - asymmetry of the mandible to the left
signs of bruxism/grinding facets		- yes - no

variable	definition	values
gingivitis		- yes - no
forced bite	incorrect bite of both jaws due to misaligned teeth or varying degrees of upper and lower jaw	- no - dorsal - lateral - mesial

Table 5: Variables of dental model analysis

variable	definition	value
overjet	horizontal projection of upper teeth beyond the lower teeth; usually refers to incisors	[mm]
overbite	vertical overlap of upper teeth over lower teeth; usually refers to incisors	[mm]
deep bite	abnormally large vertical overlap of anterior teeth in centric occlusion	- no - yes, no contact to gingiva - yes, contact to gingiva
frontal crossbite	one or more teeth in the maxillary anterior/lateral segment is lingual to one or more of the opposing teeth in the mandibular anterior/lateral segment in maximum intercuspation	- no - yes
lateral crossbite		- no - to the right - to the left - on both sides
non-occlusion buccal	a situation in which the tooth or teeth in one arch fail to make contact with the tooth or teeth of the other arch	- no - on the right - on the left
non-occlusion lingual		- no - on the right - on the left
end-to-end bite/edge-to-edge occlusion	an occlusion in which the anterior teeth of both jaws meet along their incisal edges when the teeth are in centric occlusion	- no - yes

variable	definition	value
frontal open bite	a malocclusion in which some teeth cannot be brought into contact with opposing teeth and no vertical overlap is present	[mm]
lateral open bite		- no - yes
contact point deviation from 3 mm	deviation of the area of contact of approximating surfaces of two adjacent teeth	- no - yes
frontal crowding from 3 mm	exists when the sum of the mesiodistal widths of the teeth in an arch exceeds the arch circumference	- no - yes
lateral crowding		- no - yes
transversal width maxilla anterior	the distance between the left and right opposite in the upper or lower jaw, usually expressed in millimeters. The intercanine, interpremolar, or intermolar distance may be cited as the arch width	[mm]
transversal width maxilla posterior		[mm]
transversal width mandible anterior		[mm]
transversal width mandible posterior		[mm]
dental arch length (posterior)	the distance from the distal point of the most posterior tooth on one side of the upper or lower jaw to	[mm]

variable	definition	value
dental arch length (anterior)	the same point on the other side, usually measured through the points of contact between adjoining teeth	[mm]
protrusion of canines	a forward position of a canine	- no - maxilla - mandible
occlusion of teeth 6		- neutral - ½ premolar width - 1 premolar width (- = mesial; + = distal)
occlusion of teeth 3		- neutral - ½ premolar width - 1 premolar width (- = mesial; + = distal)
dental midline shift maxilla		- to the right - to the left
dental midline shift mandible		- to the right - to the left
mandibular midline shift		- to the right - to the left
width upper incisors		[mm]

variable	definition	value
width lower incisors		[mm]
Angle Class malocclusion	a definition of malocclusion based on the relationships between the first permanent molars	I, II, II/1, II/2, III

Table 6: Intergroup differences - clinical history

characteristic	statistical definition	valid n "snorer"	"snorer"	valid n "non-snorer"	"non-snorer"	risk ratio (RR)
sex # female	n (%)	42	25 (59.5 %)	120	67 (55.8 %)	1.07
sex # male	n (%)		17 (40.5 %)		53 (44.2 %)	0.92
age [years] †	median (min - max)	42	13 (6 - 16)	120	13 (6 - 16)	
premature baby	n (%)	41	8 (19.5 %)	109	24 (22 %)	0.89
premature baby # week of gestation [weeks] †	median (min - max)	4	32.5 (24 - 37)*	11	37 (34 - 37)*	
breast-fed	n (%)	39	32 (82.1 %)	113	94 (83.2 %)	0.99
breast-fed [months] [a]	mean (SD)	27	7.8 (5.53)	85	8.7 (5.59)	
heart failure/chronic heart disease	n (%)	37	2 (5.4 %)	114	2 (1.8 %)	3
neurodermatitis	n (%)	34	2 (5.9 %)	114	16 (14 %)	0.42
obstructive bronchitis	n (%)	36	6 (16.7 %)	110	10 (9.1 %)	1.84
asthma	n (%)	36	5 (13.9 %)	112	7 (6.2 %)	2.24
frequency of infections per year # never	n (%)	39	0	109	1 (0.9 %)	0*
frequency of infections per year # 1 - 2 times	n (%)		17 (43.6 %)		70 (64.2 %)	0.68*
frequency of infections per year # 3 - 4 times	n (%)		13 (33.3 %)		34 (31.2 %)	1.07*
frequency of infections per year # 5 - 7 times	n (%)		5 (12.8 %)		4 (3.7 %)	3.46*
frequency of infections per year # > 7 times	n (%)		4 (10.3 %)		0	0*

tonsilitis	n (%)	34	21 (61.8 %)	106	34 (32.1 %)	1.93*
otitis media	n (%)	33	22 (66.7 %)	112	60 (53.6 %)	1.24
pseudo-croup	n (%)	32	5 (15.6 %)	108	20 (18.5 %)	0.84
bronchitis	n (%)	35	20 (57.1 %)	107	44 (41.1 %)	1.39*
epiglotitis	n (%)	28	0	99	0	0
favourite sleeping position # supine	n (%)	37	10 (27 %)	100	22 (22 %)	1.23
favourite sleeping position # prone	n (%)	37	9 (24.3 %)	100	20 (20 %)	1.22
favourite sleeping position # right lateral	n (%)	37	17 (45.9 %)	100	51 (51 %)	0.9
favourite sleeping position # left lateral	n (%)	37	16 (43.2 %)	100	35 (35 %)	1.23
on regular medication	n (%)	36	12 (33.3 %)	113	15 (13.3 %)	2.5*
frequency of nasal congestion/obstructed nasal breathing/mouth breathing per week # never	n (%)	38	5 (13.2 %)	108	47 (43.5 %)	0.30*
frequency of nasal congestion/obstructed nasal breathing/mouth breathing per week # less than once	n (%)		18 (47.4 %)		53 (49.1 %)	0.97*
frequency of nasal congestion/obstructed nasal breathing/mouth breathing per week # 1 - 2 times	n (%)		6 (15.8 %)		4 (3.7 %)	4.27*
frequency of nasal congestion/obstructed nasal breathing/mouth breathing per week # 3 - 5 times	n (%)		4 (10.5 %)		1 (0.9 %)	11.67*

frequency of nasal congestion/obstructed nasal breathing/mouth breathing per week # 6 - 7 times	n (%)		5 (13.2 %)		3 (2.8 %)	4.71*
frequency of a sore throat per week # never	n (%)	40	23 (57.5 %)	115	61 (53 %)	1.08
frequency of a sore throat per week # 1 - 2 times	n (%)		17 (42.5 %)		54 (47 %)	0.90
hay fever	n (%)	40	8 (20 %)	117	16 (13.7 %)	1.46
pollen allergy	n (%)	40	8 (20 %)	116	11 (9.5 %)	2.11*
food allergy	n (%)	38	4 (10.5 %)	115	11 (9.6 %)	1.09
house dust allergy	n (%)	39	6 (15.4 %)	114	8 (7 %)	2.2
animal hair allergy	n (%)	37	5 (13.5 %)	115	4 (3.5 %)	3.86*
nasal septum deviation	n (%)	33	1 (3 %)	112	1 (0.9 %)	3.34
nasal concha hyperplasia	n (%)	32	0	114	0	0
enlarged polyps	n (%)	37	16 (43.2 %)	118	14 (11.9 %)	3.63*
enlarged tonsils	n (%)	37	16 (43.2 %)	114	13 (11.4 %)	3.79*
tympanic effusion	n (%)	35	6 (17.1 %)	112	11 (9.8 %)	1.74
bone fracture	n (%)	37	0	112	4 (3.6 %)	0
adenotomy	n (%)	42	12 (28.6 %)	120	11 (9.2 %)	3.11*
tonsillotomy	n (%)	37	1 (2.7 %)	117	1 (0.9 %)	3
tonsillectomy	n (%)	40	2 (5 %)	120	5 (4.2 %)	1.19
paracentesis	n (%)	40	2 (5 %)	118	3 (2.5 %)	2

intervention sinuses	n (%)	39	0	120	2 (1.7 %)	0
dummy use	n (%)	40	31 (77.5 %)	116	91 (78.4 %)	0.99
dummy use up to which year [years] †	median (min - max)	22	3 (0.5 - 4)	84	2.75 (0 - 6.5)	
thumb/finger sucking	n (%)	39	5 (12.8 %)	114	14 (12.3 %)	1.04
thumb/finger sucking up to which year [years] †	median (min - max)	6	3.5 (0 - 5.5)	12	3 (0 - 7)	
permanent sucking bottle	n (%)	40	15 (37.5 %)	115	29 (25.2 %)	1.49*
permanent sucking bottle up to which year [years] †	median (min - max)	13	2 (0 - 5)	20	2 (1 - 4.5)	
initial orthodontic diagnose # no	n (%)	36	6 (16.7 %)	100	17 (17 %)	0.98
initial orthodontic diagnose # yes	n (%)		29 (80.6 %)		77 (77 %)	1.05
initial orthodontic diagnose # not yet examined	n (%)		1 (2.8 %)		6 (6 %)	0.47
previous orthodontic therapy	n (%)	39	36 (92.3 %)	114	100 (87.7 %)	1.05

* $p < 0.1$; † not normallydistributed; [a] normally distributed

Table 7: Intergroup difference - demographic information

characteristic	statistical definition	valid n "snorer"	"snorer"	valid n "non-snorer"	"non-snorer"	risk ratio (RR)
with whom child lives primarily # parents	n (%)	40	34 (85 %)	117	99 (84.6 %)	1.0
with whom child lives primarily # father	n (%)		0		1 (0.9 %)	0
with whom child lives primarily # mother	n (%)		6 (15 %)		17 (14.5 %)	1.03
older siblings # none	n (%)	33	15 (45.5 %)	99	34 (34.4 %)	1.32
older siblings # one	n (%)		11 (33.3 %)		44 (44.4 %)	0.75
older siblings # two	n (%)		6 (18.2 %)		17 (17.2 %)	1.06
older siblings # three	n (%)		1 (3 %)		4 (4 %)	0.75
younger siblings # none	n (%)	33	12 (36.4 %)	100	57 (57 %)	0.64*
younger siblings # one	n (%)		15 (45.5 %)		37 (37 %)	1.23*
younger siblings # two	n (%)		6 (18.2 %)		6 (6 %)	3.03*
same age siblings # none	n (%)	33	32 (97 %)	100	97 (97 %)	1.0
same age siblings # one	n (%)		1 (3 %)		3 (3 %)	1.0
nationality mother # German	n (%)	40	34 (85 %)	116	115 (99.1 %)	0.85*
nationality mother # other	n (%)		6 (15 %)		1 (0.9 %)	16.67*
nationality father # German	n (%)	38	32 (84.2 %)	111	105 (94.6 %)	0.89*
nationality father # other	n (%)		6 (15.8 %)		6 (5.4 %)	2.93*
country of birth mother # Germany	n (%)	40	32 (80 %)	116	102 (87.9 %)	0.91
country of birth mother # other	n (%)		8 (20 %)		14 (12.1 %)	1.65
country of birth father # Germany	n (%)	38	31 (81.6 %)	114	94 (82.5 %)	0.99
country of birth father # other	n (%)		7 (18.4 %)		20 (17.5 %)	1.05
language at home # German	n (%)	40	38 (95 %)	115	114 (99.1 %)	0.96

language at home # other	n (%)	39	8 (20.5 %)	113	12 (10.6 %)	1.93
education mother # primary/lower secondary school	n (%)	40	10 (25 %)	115	22 (19.1 %)	1.31*
education mother # secondary school	n (%)		14 (35 %)		49 (42.6 %)	0.82*
education mother # polytechnical secondary school	n (%)		2 (5 %)		1 (0.9 %)	5.56*
education mother # technical college	n (%)		1 (2.5 %)		7 (6.1 %)	0.42*
education mother # A-Levels	n (%)		11 (27.5 %)		36 (31.3 %)	0.88*
education mother # other	n (%)		2 (5 %)		0	0*
education father # primary/lower secondary school	n (%)	38	21 (31.6 %)	112	27 (24.1 %)	1.31*
education father # secondary school	n (%)		5 (13.2 %)		42 (37.5 %)	0.35*
education father # polytechnical secondary school	n (%)		1 (2.6 %)		2 (1.8 %)	1.44*
education father # technical college	n (%)		5 (13.2 %)		8 (7.1 %)	1.86*
education father # A-Levels	n (%)		12 (31.6 %)		32 (28.6 %)	1.10*
education father # other	n (%)		3 (7.9 %)		1 (0.9 %)	8.8*
pro. education mother # apprenticeship	n (%)	37	10 (27 %)	111	45 (40.5 %)	0.67*
pro. education mother # business school	n (%)		6 (16.2 %)		26 (23.4 %)	0.69*
pro. education mother # technical college	n (%)		7 (18.9 %)		12 (10.8 %)	1.75*
pro. education mother # technical university	n (%)		1 (2.7 %)		7 (6.3 %)	0.43*
pro. education mother # university	n (%)		8 (21.6 %)		15 (13.5 %)	1.6*
pro. education mother # other	n (%)		0		3 (2.7 %)	0*
pro. education mother # none	n (%)		5 (13.5 %)		3 (2.7 %)	5*
pro. education father # apprenticeship	n (%)	35	10 (28.6 %)	110	38 (34.5 %)	0.83

pro. education father # business school	n (%)		2 (5.7 %)		12 (10.9 %)	0.52
pro. education father # technical college	n (%)		6 (17.1 %)		24 (21.8 %)	0.78
pro. education father # technical university	n (%)		8 (22.9 %)		11 (10 %)	2.29
pro. education father # university	n (%)		7 (20 %)		22 (20 %)	1.0
pro. education father # other	n (%)		0		2 (1.8 %)	0
pro. education father # none	n (%)		2 (5.7 %)		1 (0.9 %)	6.33
household smoking	n (%)	39	6 (15.4 %)	116	23 (19.8 %)	0.78

* $p < 0.1$

Table 8: Intergroup differences - ENT history and clinical findings

characteristic	statistical definition	valid n "snorer"	"snorer"	valid n "non-snorer"	"non-snorer"	risk ratio (RR)
impaired nasal breathing	n (%)	42	14 (33.3 %)	120	22 (18.3 %)	1.82*
dysphagia # without pain	n (%)	42	2 (4.8 %)	120	1 (0.8 %)	6
dysphagia # painful	n (%)		1 (2.4 %)		2 (1.7 %)	1.41
halitosis	n (%)	42	9 (21.4 %)	120	8 (6.7 %)	3.19*
salivation # normosalivation	n (%)	42	35 (83.3 %)	120	103 (85.3 %)	0.98
salivation # hyposalivation	n (%)		1 (2.4 %)		0	0
salivation # hypersalivation	n (%)		6 (14.3 %)		17 (14.2 %)	1.01
hypersalivation # while speaking	n (%)	5	1 (20 %)	13	6 (46.2 %)	0.43
hypersalivation # continuously	n (%)		4 (80 %)		7 (53.8 %)	1.49
height [cm] †	median (min - max)	42	159.5 (122 - 180)	119	162 (116 - 193)	
weight [kg] [a]	mean (SD)	40	50.05 (13.96)	118	46.58 (14.03)	
BMI †	median (min - max)	40	19.64 (12.09 - 28.57)*	117	17.86 (13.22 - 26.53)*	
enlarged cervical lymph nodes	n (%)	42	17 (40.5 %)	120	48 (40 %)	1.01
tympanic membrane retraction	n (%)	41	1 (2.4 %)	114	0	0*
tympanic effusion	n (%)	42	2 (4.8 %)	114	0	0*

nasal external malformation	n (%)	42	11 (26.2 %)	109	35 (29.2 %)	0.9
sigmatism	n (%)	42	2 (4.8 %)	119	8 (6.7 %)	0.72
open spontaneous mouth posture	n (%)	42	21 (50 %)	119	32 (26.9 %)	1.86*
audible nasal breathing impairment while the mouth remained closed	n (%)	36	9 (25 %)	113	24 (21.2 %)	1.18
nasal septal deformity	n (%)	42	12 (28.6 %)	119	37 (31.1 %)	0.92
nasal concha hyperplasia	n (%)	41	12 (31.7 %)	120	42 (35 %)	0.91
tonsils' size # reaching over post. velum	n (%)	40	13 (32.5 %)	120	29 (24.2 %)	1.34*
tonsils' size # "kissing tonsils"	n (%)		3 (7.5 %)		1 (0.8 %)	9.38*
tonsils' side difference	n (%)	40	7 (17.5 %)	113	8 (7.1 %)	2.46*
tongue size # normal	n (%)	41	21 (51.2 %)	119	60 (50.4 %)	1.02
tongue size # narrow	n (%)		7 (17.1 %)		35 (29.4 %)	0.58
tongue size # broad	n (%)		13 (31.7 %)		24 (20.2 %)	1.57
tongue position # on level to row of teeth	n (%)	39	20 (51.3%)	119	71 (59.7 %)	0.86
tongue position # below level to row of teeth	n (%)		4 (10.3 %)		21 (17.6 %)	0.59
tongue position # above level to row of teeth	n (%)		15 (38.5 %)		27 (22.7 %)	1.7
ratio of tongue size to leading dental arch # within row of teeth	n (%)	41	16 (39 %)	120	59 (49.2 %)	0.79

ratio of tongue size to leading dental arch # on row of teeth	n (%)		13 (31.7 %)		39 (32.5 %)	0.98
ratio of tongue size to leading dental arch # over row of teeth	n (%)		12 (29.3 %)		22 (18.3 %)	1.60
Mallampati I	n (%)	42	5 (11.9 %)	120	18 (15 %)	0.79
Mallampati II	n (%)		13 (31 %)		41 (34.2 %)	0.91
Mallampati III	n (%)		9 (21.4 %)		39 (32.5 %)	0.66
Mallampati IV	n (%)		15 (35.7 %)		22 (18.3 %)	1.95
position of the uvula tip # upper third	n (%)	42	6 (14.3 %)	119	38 (31.9 %)	0.45*
position of the uvula tip # middle third	n (%)		23 (54.8 %)		55 (46.2 %)	1.19*
position of the uvula tip # lower third	n (%)		13 (31 %)		26 (21.8 %)	1.42*
webbing # normal	n (%)	42	36 (85.7 %)	120	97 (80.8 %)	1.06
webbing # moderate	n (%)		0		3 (2.5 %)	0
webbing # narrow palatal arch	n (%)		6 (14.3 %)		20 (16.7 %)	0.86
distance hyoid-mentum [cm] †	median (min - max)	42	4.75 (3 - 7.5)	120	4.8 (3.4 - 6.5)	

* $p < 0.1$; † not normally distributed; [a] normally distributed

Table 9: Intergroup differences - orthodontic history and clinical findings

characteristic	statistical definition	valid n "snorer"	"snorer"	valid n "non-snorer"	"non-snorer"	risk ratio (RR)
sucking habbits	n (%)	42	4 (9.5 %)	120	29 (24.2 %)	0.39*
sigmatism	n (%)	42	7 (16.7 %)	120	27 (22.5 %)	0.74
early loss of milk teeth	n (%)	42	7 (16.7 %)	118	28 (23.7 %)	0.70
breastfeeding	n (%)	42	39 (92.9 %)	120	108 (90 %)	1.03
bottle feeding	n (%)	42	15 (35.7 %)	120	60 (50 %)	0.71
rickets prophylaxis	n (%)	42	37 (88.1 %)	120	105 (87.5 %)	1.01
accident/operation	n (%)	42	12 (28.6 %)	120	29 (24.2 %)	1.18
bruxism	n (%)	42	23 (54.8 %)	120	61 (50.8 %)	1.08
previous orthodontic care	n (%)	42	9 (21.4 %)	120	39 (32.5 %)	0.66
breathing pattern # mouth breathing	n (%)	42	14 (33.3 %)	120	31 (25.8 %)	1.29
breathing pattern # mixed nose and mouth breathing	n (%)		15 (35.7 %)		48 (40 %)	0.89
swallowing pattern # visceral	n (%)	42	19 (45.2 %)	120	54 (45 %)	1.00
swallowing pattern # somatic	n (%)		23 (54.8 %)		66 (55 %)	1.00
cephalic index # dolichocephalic	n (%)	41	5 (12.2 %)	120	14 (11.7 %)	1.04
cephalic index # mesocephalic	n (%)		5 (12.2 %)		20 (16.7 %)	0.73

cephalic index # brachycephalic	n (%)		4 (9.8 %)		20 (16.7 %)	0.59
cephalic index # hyperbrachycephalic	n (%)		27 (65.9 %)		66 (55 %)	1.2
facial index # hypereuryprosop	n (%)	41	0	120	3 (2.5 %)	0
facial index # euryprosop	n (%)		2 (4.9 %)		12 (10 %)	0.49
facial index # mesoprosop	n (%)		16 (39 %)		53 (44.2 %)	0.88
facial index # leptoprosop	n (%)		9 (22 %)		25 (20.8 %)	1.06
facial index # hyperleptoprosop	n (%)		14 (34.1 %)		27 (22.5 %)	1.52
upper third of the face [mm] †	median (min - max)	41	22 (10 - 44)	118	22 (10 - 53)	
middle third of the face [mm] †	median (min - max)	41	23 (8 - 37)	118	22 (7 - 46)	
lower third of the face [mm] †	median (min - max)	41	25 (9 - 38)	118	21 (9 - 49)	
total length of the face [mm] †	median (min - max)	41	72 (27 - 118)	118	66.5 (24 - 138)	
upper third of the face [%] †	median (min - max)	41	34 (24 - 38)	118	34 (29 - 43)	
middle third of the face [%] †	median (min - max)	41	32 (26 - 40)	118	32 (24 - 142)	
lower third of the face [%] †	median (min - max)	41	34 (27 - 50)	118	34 (21 - 83)	
lip configuration upper third [mm] †	median (min - max)	41	7 (3 - 14)	118	8 (4 - 18)	
lip configuration lower third [mm] †	median (min - max)	41	15 (6 - 25)*	118	18 (6 - 37)*	
lip configuration upper third [%] †	median (min -max)	41	34 (11 - 67)	118	36 (9 - 86)	

lip configuration lower third [%] †	median (min - max)	41	67 (26 - 129)*	118	69 (32 - 150)*	
lip step # positive	n (%)	41	18 (43.9 %)	118	60 (50.8 %)	0.86
lip step # straight	n (%)		7 (17.1 %)		24 (20.3 %)	0.84
lip step # slightly negative (normal)	n (%)		14 (34.1 %)		30 (25.4 %)	1.34
lip step # negative	n (%)		2 (4.9 %)		4 (3.4 %)	1.44
lip closure # competent	n (%)	41	29 (70.7 %)	118	90 (76.3 %)	0.93
lip closure # incompetent	n (%)		12 (29.3 %)		28 (23.7 %)	1.24
craniomandibular dysfunction # muscular	n (%)	42	0	119	7 (5.9 %)	0
craniomandibular dysfunction # mandibular joint	n (%)	42	2 (4.8 %)	119	10 (8.4 %)	0.57
incisal edge distance - active [mm] †	median (min - max)	42	45 (5 - 65)	117	44 (27 - 59)	
incisal edge distance - passive [mm] †	median (min - max)	42	47.5 (1 - 66)	117	47 (19 - 63)	
face type/profile # midface	n (%)	40	10 (25 %)	116	22 (19 %)	1.32
face type/profile # forward face	n (%)		23 (57.5 %)		60 (51.7 %)	1.11
face type/profile # receding face	n (%)		7 (17.5 %)		34 (29.3 %)	0.6
asymmetries of the face (frontal) I # mandible to the right	n (%)	41	2 (4.9 %)	118	21 (17.8 %)	0.28*
asymmetries of the face (frontal) I # mandible to the left	n (%)		4 (9.8 %)		15 (12.7 %)	0.77*
asymmetries of the face (frontal) II # midface to the right	n (%)	41	4 (9.8 %)	118	26 (22 %)	0.45
asymmetries of the face (frontal) II # midface to the left	n (%)		4 (9.8 %)		15 (12.7 %)	0.77

signs of bruxism	n (%)	42	24 (57.1 %)	118	69 (58.5 %)	0.98
gingivitis	n (%)	42	3 (7.1 %)	120	16 (13.3 %)	0.53
forced bite	n (%)	42	4 (9.5 %)	120	20 (16.7 %)	0.57

* $p < 0.1$; † not normally distributed; [a] normally distributed

Table 10: Intergroup differences - dental cast models

characteristic	statistical definition	valid n "snorer"	"snorer"	valid n "non-snorer"	"non-snorer"	risk ratio (RR)
overjet [mm] †	median (min - max)	42	3 (1 - 9)	117	3 (-4 - 11)	
overbite [mm] †	median (min - max)	42	4 (-5 - 7)*	117	3 (-5 - 9)*	
deep bite	n (%)	41	23 (56.1 %)	118	65 (55.1 %)	1.02
frontal crossbite	n (%)	41	4 (9.8 %)	118	28 (23.7 %)	0.41*
lateral crossbite	n (%)	41	17 (41.5 %)	118	49 (41.5 %)	1
non-occlusion buccal # on the right	n (%)	41	3 (7.3 %)	118	11 (9.3 %)	0.78
non-occlusion buccal # on the left	n (%)		1 (2.4 %)		2 (1.7 %)	1.41
non-occlusion lingual # on the right	n (%)	41	6 (14.6 %)	118	12 (10.2 %)	1.43
non-occlusion lingual # on the left	n (%)		2 (4.9 %)		9 (7.6 %)	0.64
edge-to-edge occlusion	n (%)	39	13 (33.3 %)	118	29 (24.6 %)	1.35*
frontal open bite	n (%)	41	3 (7.3 %)	118	15 (12.7 %)	0.57
lateral open bite	n (%)	40	3 (7.5 %)	118	22 (18.6 %)	0.40*
contact point deviation from 3 mm	n (%)	41	13 (31.7 %)	118	32 (27.1 %)	1.17
frontal crowding from 3 mm	n (%)	42	26 (61.9 %)	118	67 (56.8 %)	1.09

lateral crowding	n (%)	42	24 (57.1 %)	117	77 (65.8 %)	0.87
transversal width maxilla ant. [mm] †	median (min - max)	38	19.5 (12 - 44)*	109	18 (9 - 40)*	
transversal width maxilla post. [mm] †	median (min - max)	38	28.5 (14 - 52)*	109	24 (10 - 49)*	
transversal width mandible ant. [mm] †	median (min - max)	38	31.5 (11 - 39)*	109	18 (9 - 39)*	
transversal width mandible post. [mm] †	median (min - max)	38	41 (19 - 52)*	109	25 (14 - 52)*	
dental arch length post. [mm] †	median (min - max)	38	22 (15 - 31)	109	22 (15 - 34)	
dental arch length ant. [mm] †	median (min - max)	38	19 (9 - 33)	109	19 (7 - 26)	
protrusion of canines	n (%)	41	2 (4.9 %)	118	8 (6.8 %)	0.72
occlusion of teeth 6 # 1 Pb mesial	n (%)	41	0	118	1 (0.8 %)	0
occlusion of teeth 6 # 1/2 Pb mesial	n (%)		0		11 (9.3 %)	0
occlusion of teeth 6 # neutral	n (%)		10 (24.4 %)		29 (24.6 %)	0.99
occlusion of teeth 6 # 1/2 Pb distal	n (%)		23 (56.1 %)		56 (47.5 %)	1.18
occlusion of teeth 6 # 1 Pb distal	n (%)		8 (19.5 %)		21 (17.8 %)	1.1
occlusion of teeth 3 # 1/2 Pb mesial	n (%)	39	2 (5.1 %)	115	10 (8.7 %)	0.59
occlusion of teeth 3 # neutral	n (%)		17 (43.6 %)		42 (36.5 %)	1.19
occlusion of teeth 3 # 1/2 Pb distal	n (%)		13 (33.3 %)		50 (43.5 %)	0.77

occlusion of teeth 3 # 1 Pb distal	n (%)		7 (18 %)		13 (11.3 %)	1.59
dental midline shift maxilla # to the right	n (%)	39	10 (25.6 %)	118	27 (22.9 %)	1.12
dental midline shift maxilla # to the left	n (%)		1 (2.6 %)		14 (11.9 %)	0.22
dental midline shift mandible # to the right	n (%)	39	12 (30.8 %)	118	26 (22 %)	1.4
dental midline shift mandible # to the left	n (%)		7 (17.9 %)		33 (28 %)	0.64
mandibular midline shift # to the right	n (%)	39	5 (12.8 %)	118	17 (14.4 %)	0.89
mandibular midline shift # to the left	n (%)		4 (10.3 %)		9 (7.6 %)	1.36
width upper incisors [mm] †	median (min - max)	38	32 (22 - 36)	112	31 (0 - 37)	
width lower incisors [mm] †	median (min - max)	38	23 (16 - 29)	112	23 (0 - 29)	
Angle Class I	n (%)	40	9 (22.5 %)	117	28 (23.9 %)	0.94
Angle Class II	n (%)		26 (65 %)		72 (61.5 %)	1.06
Angle Class III	n (%)		5 (12.5 %)		17 (14.5 %)	0.86

* $p < 0.1$; † not normally distributed; [a] normally distributed

9.2 Figures

Abteilungsformblätter_01-01/FR-Befund_10

Patient: _____
Geb.- Datum: _____

FR-BEFUND

Basal
Sagittal

Messungen	Norm	Datum:	Datum:	Datum:
SNA	81°			
SNB	79°			
ANB ø ° ANB ind.	2°			°
SNPog	80°			
WITS	m: -1 mm w: 0 mm			

Vertikal

NSar (Sella <)	122°			
SarGo (Gelenk<)	141°			
arGoMe (Kiefer<)	129°			
NGoar (Go1)	55°			
NGoMe (Go2)	74°			
SN-MeGo	32°			
NS-SpP (Ink.<)	7°			
SpP-MeGo (Basis<)	25°			
SpP-OcP	11°			
MeGo-OcP	14°			
NSGn (Y-Achse)	66°			
SGo : NMe x 100	63,5 %			
NSpP:SpPMe x 100	79,5 %			

Dental

OK 1 - SN	102°			
UK 1 - MeGo	90°			
Interincisal <	135°			
N-Pog-OK 1	+ 3 mm			
N-Pog-UK 1	± 0 mm			

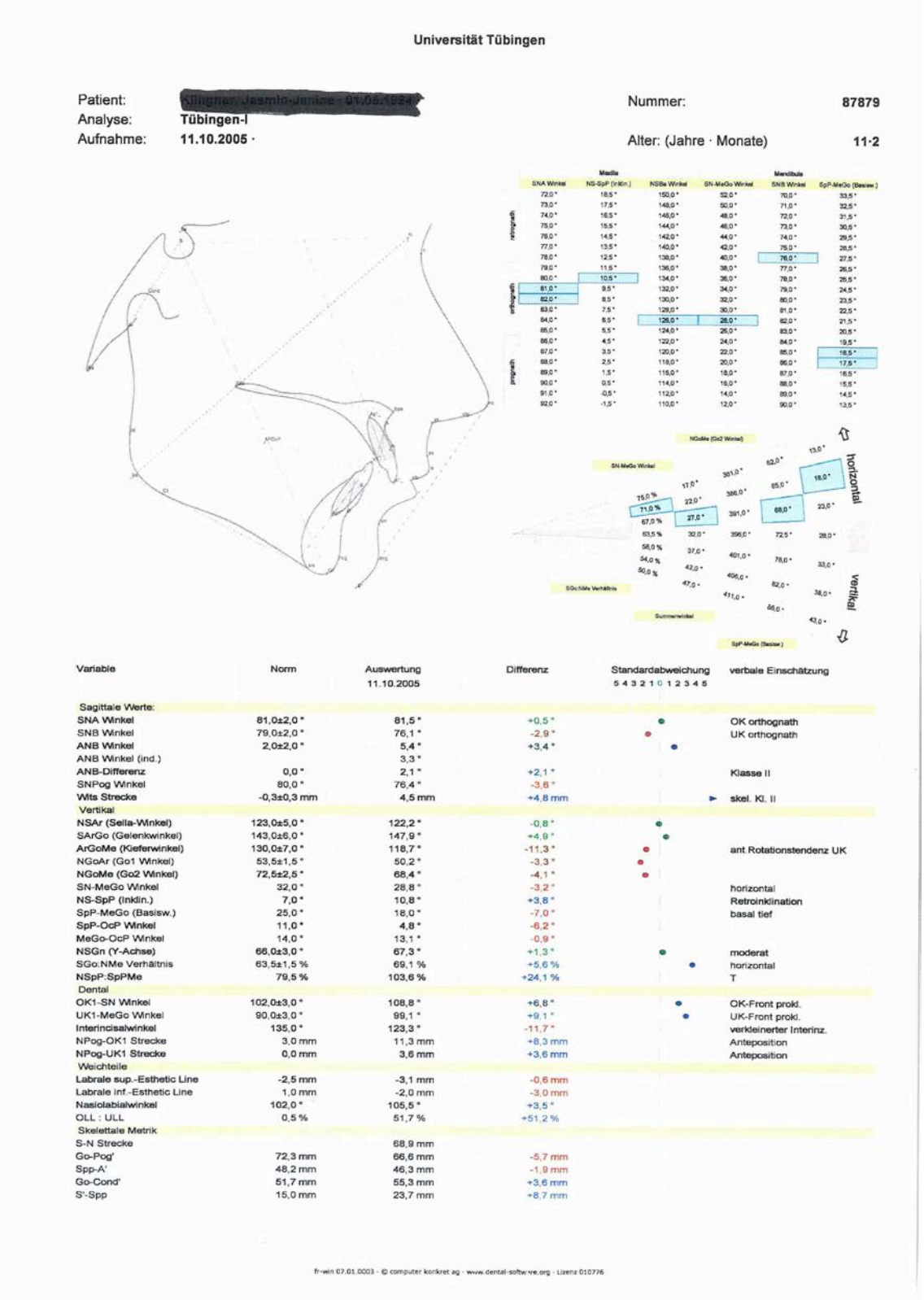
Weichteile

Esthetic-Line				
Labrale sup.	- 2,5 mm			
Labrale inf.	+ 1 mm			
NL <	102°			
OLL : ULL	1 : 2			

Skelettale Metrik

S-N (100%)				
Go - Pog´ (105%)				
Spp - A´ (70%)				
Go - Cond´ (75%)				
S´ - Spp	15 mm			

Figure 2: Cephalometric measurement I



Universität Tübingen

Patient: [redacted]
Analyse: Tübingen-I
Aufnahme: 11.10.2005 ·

Nummer: 87879
Alter: (Jahre · Monate) 11·2

Variable	Norm	Auswertung 11.10.2005	Differenz	Standardabweichung 5 4 3 2 1 0 1 2 3 4 5	verbale Einschätzung
Sagittale Werte:					
SNA Winkel	81,0±2,0 °	81,5 °	+0,5 °		OK orthognath
SNB Winkel	79,0±2,0 °	76,1 °	-2,9 °		UK orthognath
ANB Winkel	2,0±2,0 °	5,4 °	+3,4 °		
ANB Winkel (ind.)		3,3 °			
ANB-Differenz	0,0 °	2,1 °	+2,1 °		Klasse II
SNPog Winkel	80,0 °	76,4 °	-3,6 °		
Wits Strecke	-0,3±0,3 mm	4,5 mm	+4,8 mm		skel. Kl. II
Vertikal					
NSAr (Sella-Winkel)	123,0±5,0 °	122,2 °	-0,8 °		
SArGo (Gelenkwinkel)	143,0±6,0 °	147,9 °	+4,9 °		
ArGoMe (Kieferwinkel)	130,0±7,0 °	118,7 °	-11,3 °		ant.Rotationstendenz UK
NGoAr (Go1 Winkel)	53,5±1,5 °	50,2 °	-3,3 °		
NGoMe (Go2 Winkel)	72,5±2,5 °	68,4 °	-4,1 °		
SN-MeGo Winkel	32,0 °	28,8 °	-3,2 °		horizontal
NS-SpP (Inklin.)	7,0 °	10,8 °	+3,8 °		Retroinklination
SpP-MeGo (Basisw.)	25,0 °	18,0 °	-7,0 °		basal tief
SpP-OcP Winkel	11,0 °	4,8 °	-6,2 °		
MeGo-OcP Winkel	14,0 °	13,1 °	-0,9 °		
NSGn (Y-Achse)	66,0±3,0 °	67,3 °	+1,3 °		moderat
SGo:NMe Verhältnis	63,5±1,5 %	69,1 %	+5,6 %		horizontal
NSpP:SpPMe	79,5 %	103,6 %	+24,1 %		T
Dental					
OK1-SN Winkel	102,0±3,0 °	108,8 °	+6,8 °		OK-Front prokl.
UK1-MeGo Winkel	90,0±3,0 °	99,1 °	+9,1 °		UK-Front prokl.
Interincisalwinkel	135,0 °	123,3 °	-11,7 °		verkleinerter Interinz.
NPog-OK1 Strecke	3,0 mm	11,3 mm	+8,3 mm		Anteposition
NPog-UK1 Strecke	0,0 mm	3,6 mm	+3,6 mm		Anteposition
Weichteile					
Labrale sup.-Esthetic Line	-2,5 mm	-3,1 mm	-0,6 mm		
Labrale inf.-Esthetic Line	1,0 mm	-2,0 mm	-3,0 mm		
Nasolabialwinkel	102,0 °	105,5 °	+3,5 °		
OLL : ULL	0,5 %	51,7 %	+51,2 %		
Skelettale Metrik					
S-N Strecke		68,9 mm			
Go-Pog'	72,3 mm	66,6 mm	-5,7 mm		
Spp-A'	48,2 mm	46,3 mm	-1,9 mm		
Go-Cond'	51,7 mm	55,3 mm	+3,6 mm		
S'-Spp	15,0 mm	23,7 mm	+8,7 mm		

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Figure 3: Cephalometric measurement II

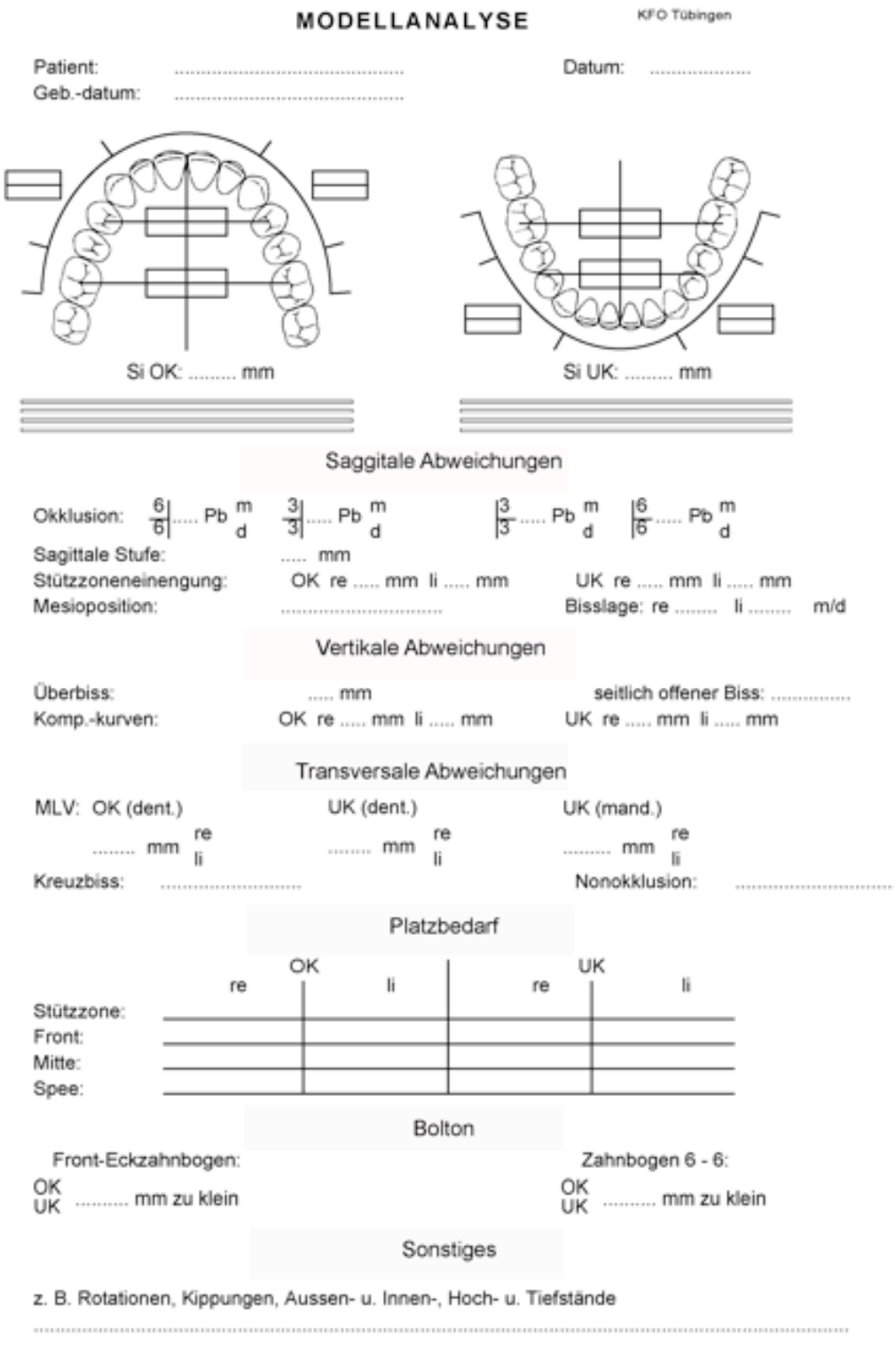


Figure 4: Model analysis

9.3 Questionnaires, information forms and documentation of clinical findings

- Information sheet for the parent/guardian
- Information sheet for the child
- Declaration of consent
- Information on data privacy protection
- Introduction of the questionnaires
- Clinical history
- PSQ
- SDSC
- ESS
- Demography
- PDSS
- ENT history and clinical findings
- Certificate of participation

ORFOS · Pädiatrische Schlafmedizin · Calwerstr. 7 · 72076 Tübingen

rsitätsklinik für Kinder- und Jugendmedizin

Kontakt
Pädiatrische Schlafmedizin, Calwerstr. 7, 72076 Tübingen
Tel. 07071/29-81283, Fax. 07071/29-4356
Email. schlafmedizin@med.uni-tuebingen.de

Datum: Mittwoch, 24. März 2010

Information zur Untersuchung "Kieferorthopädische Risikofaktoren für das obstruktive Schlaf-Apnoe-Syndrom im Kindesalter"

Liebe Eltern!

Wir wenden uns heute an Sie, weil wir um Ihre Mithilfe bitten möchten. Es geht um die Teilnahme an einer Untersuchung zur Erforschung von Ursachen des obstruktiven Schlaf-Apnoe-Syndroms im Kindes- und Jugendalter. Bitte nehmen Sie sich etwas Zeit und lesen dieses Informationsblatt durch.

Was ist das obstruktive Schlaf-Apnoe-Syndrom?
Das obstruktive Schlaf-Apnoe-Syndrom (Abkürzung: OSAS) ist eine nur im Schlaf auftretende Atmungsstörung, bei der es zu wiederkehrenden Atempausen (so genannte Apnoen) kommt. Betroffene Kinder bekommen dabei im Schlaf schlecht Luft und wachen davon immer wieder auf. Die Folgen sind wiederholte Phasen mit Sauerstoffmangel, ein gestörtes Abatmen von verbrauchter (d.h. Kohlendioxid reicher) Luft und ein gestörter Schlaf. Der Effekt ist in etwa so, als würde man ein Kind mehrere Male pro Stunde wecken und wieder einschlafen lassen.

Was für Folgen hat OSAS?
Kinder, die ein OSAS haben, können aufgrund des Sauerstoffmangels und des gestörten Schlafs unter folgenden Symptomen leiden: Tagesmüdigkeit und –schläfrigkeit, hyperaktives und aggressives Verhalten, Aufmerksamkeitsdefizit und Konzentrationsstörung, verminderte Gedächtnis- und Lernleistungen. Solche Symptome können eine große Belastung für die betroffenen Kinder und Ihre Familien sein.

Was ist die Ursache des OSAS?
In den meisten Fällen sind vergrößerte Polypen und Mandeln die Ursache für die Atemaussetzer. Die Verkleinerung und/oder Entfernung dieser Strukturen kann daher oft hilfreich sein. In letzter Zeit wurden aber auch einige Veränderungen am Kiefer (z.B. Überbiß) als Ursache eines OSAS angeschuldigt. Hier würde eine Verkleinerung oder Entfernung von Polypen oder Mandeln nicht helfen. Über diese kieferorthopädischen Ursachen ist aber noch zu wenig bekannt, sodass viele Kinder mit OSAS wahrscheinlich falsch behandelt werden.

Unser Anliegen – eine Untersuchung
Wir wollen die Versorgung von Kindern mit OSAS verbessern und machen eine Untersuchung an 500 Kindern zu kieferorthopädischen Ursachen des OSAS. Ziel ist es heraus zu finden, ob und welche Veränderungen am Kiefer (z.B. Überbiß) Ursache eines OSAS sein könnten. Das würde neue Möglichkeiten in der Therapie des OSAS aufzeigen. **Dazu wollen wir Sie und Ihr Kind um Ihre Teilnahme ersuchen.**

Durchführung der Untersuchung
Im Prinzip verändert sich der kieferorthopädische Ambulanzbesuch für Sie und Ihr Kind nur wenig. Wie sonst auch, erfolgt die kieferorthopädische Untersuchung durch Ihren behandelnden Kieferorthopäden. **Im Rahmen dieser Untersuchung wird Ihr Kind nur etwas ausführlicher als sonst untersucht:** Zusätzlich zur üblichen kieferorthopädischen Untersuchung werden Sie und Ihr Kind zu Symptomen und Folgen eines möglicherweise vorliegenden OSAS befragt und Ihr Kind auf Besonderheiten im HNO-Bereich hin untersucht. Die Befragung dauert etwa 20 Minuten, die HNO-Untersuchung (Hals-, Nasen-, Ohrenuntersuchung) etwa 10 Minuten. Dies wird in der Wartezeit auf Ihren Termin durchgeführt, sodass Sie keinen Zeitverlust haben.

Persönlicher Nutzen
Die im Rahmen der Untersuchung durchgeführte ausführliche Befragung zu Symptomen und Folgen eines OSAS könnte Hinweise auf das tatsächliche Vorliegen dieser Erkrankung bei Ihrem Kind bringen. Sollten diese Hinweise vorliegen werden wir Ihren behandelnden Kieferorthopäden und – bei Wunsch – auch Sie informieren. Wir bieten Ihnen dann gerne auch weitere Beratung an.

Belastungen und Risiken
Da es sich um eine Befragung und eine einfache HNO-Untersuchung handelt sind keine Risiken zu erwarten.

Rechte
Die Teilnahme an der Untersuchung ist in jedem Fall vollkommen freiwillig. Sie können jederzeit, formlos, ohne Angabe von Gründen und ohne Nachteile für die weitere Behandlung Ihres Kindes Ihr Einverständnis widerrufen. Die Untersuchung wird daraufhin sofort abgebrochen. Ihre Rechte bezüglich des Datenschutzes und die Einwilligungserklärung zum Datenschutz finden Sie auf einem gesonderten Informationsblatt.

Für das Untersuchungsteam,

Dr. med. dent. Bernd Koos
Universitätsklinik für Zahn-, Mund- und Kieferheilkunde

Dr. med. univ. Michael S. Urschitz, M.Sc.
Universitätsklinik für Kinder- und Jugendmedizin

ORFOS · Pädiatrische Schlafmedizin · Calwerstr. 7 · 72076 Tübingen

mail. schlafmedizin@med.uni-tuebingen.de

Datum: Mittwoch, 24. März 2010

Information für Kinder zur Untersuchung "Kieferorthopädische Risikofaktoren für das obstruktive Schlaf-Apnoe-Syndrom im Kindesalter"

Hallo!

Warum bin ich heute beim Zahnarzt?

Du bist heute beim Zahnarzt weil bei Deinen Zähnen oder Deinem Kiefer etwas nicht in Ordnung ist. Auf Grund dieser Auffälligkeit könntest Du möglicherweise aber auch in der Nacht nicht richtig gut Luft bekommen und sogar zu atmen aufhören (so genannte Atemaussetzer oder Schlaf-Apnoen). Das wäre schlecht für Dich, weil Du dann nicht gut schlafen kannst, am nächsten Tag müde bist oder Dich nicht gut konzentrieren kannst. Wir wissen aber noch nicht welche Auffälligkeiten an Zähnen oder Kiefer diese Atemaussetzer verursachen. Das müssen wir noch erforschen. Daher führen wir zur Zeit eine Untersuchung an 500 Kindern durch und dafür brauchen wir Deine Mithilfe!

Wenn Du an dieser Untersuchung teilnimmst, kannst Du uns dabei sehr helfen!

Was muss ich machen, wenn ich an dieser Untersuchung teilnehmen möchte?

Wenn Du teilnehmen möchtest, musst Du auf einem Blatt unterschreiben, bei einer Befragung und bei einer zusätzlichen Untersuchung Deiner Nase und Deines Mundes mitmachen. Mehr ist es nicht, weil die Untersuchungen des Zahnarztes sowieso gemacht werden, egal ob Du an dieser Untersuchung teilnimmst oder nicht. Die zusätzliche Befragung richtet sich hauptsächlich an Deine Eltern, Du selbst musst nur acht Fragen beantworten. Die Untersuchung von Nase und Mund tut überhaupt nicht weh und dauert etwa zehn Minuten. Du musst Dir dabei nur einmal in die Nase und den Mund schauen lassen. Dazu musst du den Mund weit aufmachen.

Was habe ich davon, wenn ich an dieser Untersuchung teilnehme?

Wenn Du teilnimmst, bekommst Du von uns eine **Urkunde für eine erfolgreiche Teilnahme.** Die kannst Du dann Deinen Freunden zeigen. Deine Eltern erfahren auch, ob Du möglicherweise diese Atemaussetzer hast. Wenn alles in Ordnung ist, wird sie das sehr beruhigen. Falls etwas nicht in Ordnung ist, werden wir Dich und Deine Eltern beraten, was weiter zu tun ist.

Eines musst Du noch wissen!

Du kannst jederzeit während der Untersuchung sagen, dass Du nicht mehr mitmachen möchtest. Dann hören wir sofort auf! **Wir würden uns aber sehr freuen, wenn Du teilnehmen möchtest!**

Für das Untersuchungsteam,

Dr. med. dent. Bernd Koos
Universitätsklinik für Zahn-, Mund- und Kieferheilkunde

Dr. med. univ. Michael S. Urschitz, M.Sc.
Universitätsklinik für Kinder- und Jugendmedizin

ORFOS · Pädiatrische Schlafmedizin · Calwerstr. 7 · 72076 Tübingen

niversitätsklinik für Kinder- und Jugendmedizin

Kontakt
Pädiatrische Schlafmedizin, Calwerstr. 7, 72076 Tübingen
Tel. 07071/29-81283, Fax. 07071/29-4356
Email. schlafmedizin@med.uni-tuebingen.de

Datum: Mittwoch, 24. März 2010

Einverständniserklärung zur Untersuchung "Kieferorthopädische Risikofaktoren für das obstruktive Schlaf-Apnoe-Syndrom im Kindesalter"

Ich wurde über die Ziele, die Dauer, den Ablauf und den Nutzen der Untersuchung sowie über Belastungen und Risiken der Teilnahme meines Kindes mündlich und schriftlich aufgeklärt und erkläre mich damit einverstanden, dass mein Kind

Vorname: _____ **Familienname:** _____

Geburtsdatum meines Kindes: |__|__|. |__|__|. |__|__|__|__|
Tag Monat Jahr

Geschlecht meines Kindes: weiblich…☐ männlich…☐

an dieser Untersuchung teilnimmt. Ich bin auch darüber informiert, dass die Teilnahme an der Untersuchung vollkommen freiwillig ist und dass ich ohne Angabe von Gründen und ohne Nachteile jederzeit meine Einwilligung widerrufen kann.

Datum	Unterschrift der Mutter/ des Vaters*	Unterschrift des Kindes

* Unterschreibt ein Elternteil allein, erklärt er mit seiner Unterschrift zugleich, dass ihm das Sorgerecht allein zusteht oder dass er im Einverständnis mit dem anderen Elternteil handelt.

ORFOS · Pädiatrische Schlafmedizin · Calwerstr. 7 · 72076 Tübingen

81283, Fax. 07071/29-4356
Email. schlafmedizin@med.uni-tuebingen.de

Datum: Mittwoch, 24. März 2010

Information zum Datenschutz zur Untersuchung "Kieferorthopädische Risikofaktoren für das obstruktive Schlaf-Apnoe-Syndrom im Kindesalter"

Wir verpflichten uns selbstverständlich zur Wahrung der ärztlichen Schweigepflicht und zum vertraulichen Umgang mit allen erhobenen Daten. Es werden nur Daten erhoben, die für eine sinnvolle Auswertung der Untersuchung unbedingt notwendig sind. Die erhobenen Daten werden ausschließlich zur Auswertung dieser Untersuchung verwendet. Es werden keine Kopien der personenbezogenen Krankenakten angefertigt. Die Erhebung und Auswertung von Daten erfolgt den gesetzlichen Vorschriften entsprechend ausschließlich in pseudonymisierter (verschlüsselter) Form. Das heißt, personenbezogene Daten wie Name, Geburtsdatum und Adresse werden bereits während der Erhebung durch einen nicht-sprechenden Code ersetzt. Eine Zuordnung der Daten zu einzelnen Patienten ist danach nur noch durch das Untersuchungsteam möglich. Die Weitergabe an Dritte und Veröffentlichung von Daten erfolgt den gesetzlichen Vorschriften entsprechend ausschließlich in anonymisierter Form. Das heißt, der Code wurde entfernt, sodass nun überhaupt keine Zuordnung der Daten zu einzelnen Patienten mehr möglich ist. Sie können später jederzeit, formlos, ohne Angabe von Gründen und ohne Nachteile für die weitere Behandlung Ihres Kindes Ihr Einverständnis zur Verwendung der Daten widerrufen. Sollten die Daten noch nicht anonymisiert sein, werden sie daraufhin sofort vernichtet bzw. aus der elektronischen Datenverarbeitung gelöscht.

Ich erkläre mich damit einverstanden, dass die im Rahmen dieser Untersuchung erhobenen Daten/ Krankheitsdaten auf Frage- und Dokumentationsbögen sowie elektronischen Datenträgern aufgezeichnet und ausgewertet werden dürfen. Der Umgang mit personenbezogenen Daten wurde mir erklärt.

Datum	Unterschrift der Mutter/ des Vaters*	Unterschrift des Kindes

* Unterschreibt ein Elternteil allein, erklärt er mit seiner Unterschrift zugleich, dass ihm das Sorgerecht allein zusteht oder dass er im Einverständnis mit dem anderen Elternteil handelt.

inikum Tübingen

ORFOS Project
Kieferorthopädische Risikofaktoren für das
obstruktive Schlaf-Apnoe-Syndrom im Kindesalter

Fragebogen zur Untersuchung "Kieferorthopädische Risikofaktoren für das obstruktive Schlaf-Apnoe-Syndrom im Kindesalter"

Liebe Eltern,

Vielen Dank, dass Sie sich bereit erklärt haben an dieser wissenschaftlichen Untersuchung teilzunehmen. Mit diesem Fragebogen erheben wir nun Symptome und Folgen eines möglicherweise vorliegenden obstruktiven Schlaf-Apnoe-Syndrom. Bitte nehmen Sie sich wieder etwas Zeit um diesen Fragebogen auszufüllen und markieren Ihre Antworten durch einen Haken (☑). Nachfolgend ein Beispiel für die korrekte Markierung einer Antwort:

13. Ist es schwer Ihr Kind morgens zu wecken?

Ja… Nein… ✓

1. ***Dieser Fragebogen wurde ausgefüllt am*** _ _ Tag _ _ Monat _ _ _ _ Jahr

2. ***Wer beantwortet diesen Fragebogen?*** Mutter…☐ Vater…☐ andere Person: .....

3. ***Wurde Ihr Kind zu früh geboren?***
   nein...☐ ja...☐ weiß nicht…☐
   => wenn ja, in welcher Schwangerschaftswoche? In der ..... Woche

4. ***Wurde Ihr Kind gestillt?***
   nein…☐ ja…☐
   => wenn ja, wie lange? ……. Monat(e)

5. ***Ist von einem Arzt bei Ihrem Kind schon einmal eine der folgenden Erkrankungen festgestellt worden?***
   Herzfehler oder chronische Herzerkrankung……..... nein…☐ ja…☐ weiß nicht…☐
   => wenn ja, welche? .....
   Neurodermitis (atopisches/endogenes Ekzem, atypische Dermatitis). nein…☐ ja…☐ weiß nicht…☐
   Obstruktive (spastische/asthmatische) Bronchitis……..… nein…☐ ja…☐ weiß nicht…☐
   Asthma bronchiale……..... nein…☐ ja…☐ weiß nicht…☐

6. ***Wie oft treten Infekte (z.B. Schnupfen, Husten, Ohrenschmerzen, etc.) bei Ihrem Kind auf?***
   nie...☐ 1-2x pro Jahr...☐ 3-4x pro Jahr...☐ 5-7x pro Jahr...☐ mehr als 7x pro Jahr...☐

7. ***Ist von einem Arzt bei Ihrem Kind schon einmal eine der folgenden Infektionen festgestellt worden?***
   Mandelentzündung (Tonsillitis)……..…..… nein…☐ ja…☐ weiß nicht…☐
   Mittelohrentzündung (Otitis)……..…… nein…☐ ja…☐ weiß nicht…☐
   Pseudokrupp…..…….... nein…☐ ja…☐ weiß nicht…☐
   Bronchitis…… nein…☐ ja…☐ weiß nicht…☐
   Epiglottitis……... nein…☐ ja…☐ weiß nicht…☐

8. ***Welches ist die Lieblingsschlafposition Ihres Kindes?***
   Rückenlage…☐ Bauchlage…☐ Rechtsseitenlage…☐ Linksseitenlage…☐

9. ***Nimmt Ihr Kind regelmäßig Arzneimittel (inkl. pflanzliche und homöopathische) ein?***
   nein…☐ ja…☐
   => wenn ja, welche? ……

10. ***Weitere Angaben zu Ihrem Kind (z.B. Grunderkrankungen, Syndrome, Unfälle, Operationen, etc.):***

.....

.....

.....

11. Wie oft hat Ihr Kind eine verlegte oder verstopfte Nase, bekommt schlecht Luft durch die Nase oder atmet durch den Mund?

nie…☐ weniger als 1x pro Woche…☐ 1-2x pro Woche…☐ 3-5x pro Woche…☐ 6-7x pro Woche…☐

12. Wie oft klagt Ihr Kind über Halsschmerzen?

nie…☐ weniger als 1x pro Woche…☐ 1-2x pro Woche…☐ 3-5x pro Woche…☐ 6-7x pro Woche…☐

13. Ist von einem Arzt bei Ihrem Kind schon einmal eine der folgenden Allergien festgestellt worden?

Heuschnupfen…… nein…☐ ja…☐ weiß nicht…☐
Pollen…… nein…☐ ja…☐ weiß nicht…☐
Nahrungsmittel…… nein…☐ ja…☐ weiß nicht…☐
Hausstaub…… nein…☐ ja…☐ weiß nicht…☐
Tierhaare…… nein…☐ ja…☐ weiß nicht…☐
Andere? ……

14. Ist von einem Arzt bei Ihrem Kind schon einmal eine der folgenden Auffälligkeiten im Hals-, Nasen-, Ohren-Bereich (HNO-Bereich) festgestellt worden?

Nasenscheidewandverkrümmung… nein…☐ ja…☐ weiß nicht…☐
Nasenmuschelvergrößerung…… nein…☐ ja…☐ weiß nicht…☐
vergrößerte Polypen…… nein…☐ ja…☐ weiß nicht…☐
vergrößerte Mandeln…… nein…☐ ja…☐ weiß nicht…☐
Paukenerguss im Mittelohr…… nein…☐ ja…☐ weiß nicht…☐
Knochenbruch (Fraktur)…… nein…☐ ja…☐ weiß nicht…☐

15. Wurden bei Ihrem Kind schon einmal eine der folgenden Eingriffe im HNO-Bereich durchgeführt?

Polypen entfernt (Adenotomie)…… nein…☐ ja…☐ weiß nicht…☐
=> wenn ja, wie oft durchgeführt? ……. mal
=> wenn ja, in welchem Jahr zuletzt durchgeführt? Im Jahr ……..

Mandeln verkleinert (Tonsillotomie)…… nein…☐ ja…☐ weiß nicht…☐
=> wenn ja, wie oft durchgeführt? ……. mal
=> wenn ja, in welchem Jahr zuletzt durchgeführt? Im Jahr ……..

Mandeln entfernt (Tonsillektomie)…… nein…☐ ja…☐ weiß nicht…☐
=> wenn ja, wie oft durchgeführt? ……. mal
=> wenn ja, in welchem Jahr zuletzt durchgeführt? Im Jahr ……..

Paukenröhrchen eingelegt (Parazentese)… nein…☐ ja…☐ weiß nicht…☐
=> wenn ja, wie oft durchgeführt? ……. mal
=> wenn ja, in welchem Jahr zuletzt durchgeführt? Im Jahr ……..

Eingriff im Bereich der Nasennebenhöhlen.. nein…☐ ja…☐ weiß nicht…☐
=> wenn ja, wie oft durchgeführt? ……. mal
=> wenn ja, in welchem Jahr zuletzt durchgeführt? Im Jahr ……..

16. Hat Ihr Kind jemals einen Schnuller verwendet?

nein, niemals…☐ ja, aber nicht regelmäßig…☐ ja, regelmäßig…☐

=> wenn ja, wie lange? Bis zum ……. Lebensjahr

17. Hat Ihr Kind jemals am Daumen oder Finger gelutscht?

nein, niemals…☐ ja, aber nicht regelmäßig…☐ ja, regelmäßig…☐

=> wenn ja, wie lange? Bis zum ……. Lebensjahr

18. Hat Ihr Kind jemals eine Dauernuckelflasche verwendet?

nein, niemals…☐ ja, aber nicht regelmäßig…☐ ja, regelmäßig…☐

=> wenn ja, wie lange? Bis zum ……. Lebensjahr

19. Hat Ihr Kind eine vom Zahnarzt oder Kieferorthopäden diagnostizierte Zahn- oder Kieferfehlstellung (z.B. Überbiss, Kreuzbiss, offener Biss, etc.)?

nein…☐ ja…☐ bisher nicht untersucht…☐ weiß nicht…☐

=> wenn ja, welche? .....

20. Hatte oder hat Ihr Kind jemals eine kieferorthopädische oder kieferchirurgische Therapie (z.B. Gaumenplatte, Zahnspange, Kieferoperation, etc.)?

nein…☐ ja…☐

=> wenn ja, welche? ……

Bitte beantworten Sie die Fragen in Bezug auf das Verhalten Ihres Kindes während des Schlafes und des Wachseins. Die Fragen beziehen sich darauf, wie sich Ihr Kind gewöhnlich/normalerweise im letzten Monat verhalten hat und nicht unbedingt in den letzten Tagen, da diese nicht typisch sein müssen, falls es Ihrem Kind nicht gut ging. Bitte kreuzen Sie Ihre Antworten an.

1. ***Haben Sie bemerkt, dass Ihr Kind während des Schlafens…***
   …mehr als die Hälfte der Zeit schnarcht?
   Ja…☐ Nein…☐ Weiß nicht…☐
   …immer schnarcht?
   Ja…☐ Nein…☐ Weiß nicht…☐
   …laut schnarcht?
   Ja…☐ Nein…☐ Weiß nicht…☐
   …schwer oder laut atmet?
   Ja…☐ Nein…☐ Weiß nicht…☐
   …Schwierigkeiten hat zu atmen oder nach Luft ringt?
   Ja…☐ Nein…☐ Weiß nicht…☐
2. ***Haben Sie jemals gesehen, dass Ihr Kind in der Nacht aufhört zu atmen?***
   Ja…☐ Nein…☐ Weiß nicht…☐
3. ***Neigt Ihr Kind tagsüber dazu, durch den Mund zu atmen?***
   Ja…☐ Nein…☐ Weiß nicht…☐
4. ***Hat Ihr Kind einen trockenen Mund, wenn es morgens aufwacht?***
   Ja…☐ Nein…☐ Weiß nicht…☐
5. ***Macht Ihr Kind gelegentlich ins Bett?***
   Ja…☐ Nein…☐ Weiß nicht…☐
6. ***Fühlt sich Ihr Kind nach dem Aufwachen am Morgen nicht erfrischt?***
   Ja…☐ Nein…☐ Weiß nicht…☐
7. ***Hat Ihr Kind ein Problem mit Schläfrigkeit am Tag?***
   Ja…☐ Nein…☐ Weiß nicht…☐
8. ***Hat ein Lehrer oder anderer Betreuer darauf hingewiesen, dass Ihr Kind tagsüber schläfrig erscheint?***
   Ja…☐ Nein…☐ Weiß nicht…☐
9. ***Ist es schwierig, Ihr Kind morgens aufzuwecken?***
   Ja…☐ Nein…☐ Weiß nicht…☐
10. ***Wacht Ihr Kind morgens mit Kopfschmerzen auf?***
    Ja…☐ Nein…☐ Weiß nicht…☐
11. ***Hat Ihr Kind zu irgendeiner Zeit seit der Geburt aufgehört normal zu wachsen?***
    Ja…☐ Nein…☐ Weiß nicht…☐
12. ***Ist Ihr Kind übergewichtig?***
    Ja…☐ Nein…☐ Weiß nicht…☐
13. ***Mein Kind…***
    …scheint oft nicht zuzuhören, wenn es direkt angesprochen wird.
    Ja…☐ Nein…☐ Weiß nicht…☐
    …hat oft Schwierigkeiten, Aufgaben oder Aktivitäten zu bewältigen.
    Ja…☐ Nein…☐ Weiß nicht…☐
    …ist oft leicht abgelenkt durch äußere Reize.
    Ja…☐ Nein…☐ Weiß nicht…☐
    …zappelt oft mit Händen und Füßen oder rutscht im Sitzen hin und her.
    Ja…☐ Nein…☐ Weiß nicht…☐
    …ist ständig in Bewegung oder verhält sich wie von einem Motor angetrieben.
    Ja…☐ Nein…☐ Weiß nicht…☐
    …unterbricht oder mischt sich oft bei anderen ein (z.B. platzt dazwischen bei Gesprächen oder Spielen)
    Ja…☐ Nein…☐ Weiß nicht…☐

Kreuzen Sie bei den folgenden Fragen <u>selten</u> für 1-3 Mal pro Monat, <u>gelegentlich</u> für 1-2 Mal pro Woche, <u>häufig</u> für 3-5 Mal pro Woche oder <u>immer</u> für nahezu täglich an:

1. ***Wie viele Stunden Schlaf bekommt Ihr Kind in den meisten Nächten?***
   9-11 h…☐ 8-9 h...☐ 7-8 h...☐ 5-7 h...☐ weniger als 5 h...☐
2. ***Wie lange braucht Ihr Kind nach dem zu Bett gehen gewöhnlich zum Einschlafen?***
   weniger als 15 min…☐ 15-30 min...☐ 30-45 min...☐ 45-60 min...☐ länger als 60 min...☐
3. ***Mein Kind geht widerwillig zu Bett.***
   nie...☐ selten...☐ gelegentlich...☐ häufig...☐ immer...☐
4. ***Mein Kind hat abends Schwierigkeiten beim Einschlafen.***
   nie...☐ selten...☐ gelegentlich...☐ häufig...☐ immer...☐
5. ***Mein Kind ist beim Einschlafen ängstlich oder fürchtet sich.***
   nie...☐ selten...☐ gelegentlich...☐ häufig...☐ immer...☐
6. ***Mein Kind schreckt beim Einschlafen auf oder zuckt zusammen.***
   nie...☐ selten...☐ gelegentlich...☐ häufig...☐ immer...☐
7. ***Mein Kind zeigt rhythmische Bewegungen beim Einschlafen wie z.B. Wippen oder Kopfschütteln.***
   nie...☐ selten...☐ gelegentlich...☐ häufig...☐ immer...☐
8. ***Mein Kind erlebt beim Einschlafen intensive traumartige Szenen.***
   nie...☐ selten...☐ gelegentlich...☐ häufig...☐ immer...☐
9. ***Mein Kind schwitzt übermäßig während des Einschlafens.***
   nie...☐ selten...☐ gelegentlich...☐ häufig...☐ immer...☐
10. ***Mein Kind wacht mehr als zweimal pro Nacht auf.***
    nie...☐ selten...☐ gelegentlich...☐ häufig...☐ immer...☐
11. ***Nachdem mein Kind in der Nacht aufgewacht ist, hat es Schwierigkeiten wieder einzuschlafen.***
    nie...☐ selten...☐ gelegentlich...☐ häufig...☐ immer...☐
12. ***Mein Kind zuckt im Schlaf wiederholt mit den Beinen, verändert während der Nacht mehrfach seine Schlafposition oder strampelt die Bettdecke weg.***
    nie...☐ selten...☐ gelegentlich...☐ häufig...☐ immer...☐
13. ***Mein Kind hat in der Nacht Schwierigkeiten beim Atmen.***
    nie...☐ selten...☐ gelegentlich...☐ häufig...☐ immer...☐
14. ***Mein Kind schnappt nach Luft oder macht Atempausen.***
    nie...☐ selten...☐ gelegentlich...☐ häufig...☐ immer...☐
15. ***Mein Kind schnarcht.***
    nie...☐ selten...☐ gelegentlich...☐ häufig...☐ immer...☐
16. ***Mein Kind schwitzt übermäßig während der Nacht.***
    nie...☐ selten...☐ gelegentlich...☐ häufig...☐ immer...☐
17. ***Ich habe beobachtet, dass mein Kind schlafwandelt.***
    nie...☐ selten...☐ gelegentlich...☐ häufig...☐ immer...☐
18. ***Ich habe beobachtet, dass mein Kind im Schlaf spricht.***
    nie...☐ selten...☐ gelegentlich...☐ häufig...☐ immer...☐
19. ***Mein Kind knirscht im Schlaf mit den Zähnen.***
    nie...☐ selten...☐ gelegentlich...☐ häufig...☐ immer...☐
20. ***Mein Kind wacht schreiend oder verwirrt aus dem Schlaf auf, wobei ich den Eindruck habe, dass ich nicht zu ihm durchdringen kann. Am nächsten Morgen kann sich mein Kind nicht an die Situation erinnern.***
    nie...☐ selten...☐ gelegentlich...☐ häufig...☐ immer...☐
21. ***Mein Kind hat Alpträume, an die es sich am nächsten Tag nicht erinnert.***
    nie...☐ selten...☐ gelegentlich...☐ häufig...☐ immer...☐
22. ***Mein Kind ist am Morgen ungewöhnlich schwer zu wecken.***
    nie...☐ selten...☐ gelegentlich...☐ häufig...☐ immer...☐
23. ***Mein Kind wacht morgens müde auf.***
    nie...☐ selten...☐ gelegentlich...☐ häufig...☐ immer...☐
24. ***Mein Kind hat das Gefühl, sich nicht bewegen zu können, wenn es morgens aufwacht.***
    nie...☐ selten...☐ gelegentlich...☐ häufig...☐ immer...☐
25. ***Mein Kind fühlt sich tagsüber schläfrig.***
    nie...☐ selten...☐ gelegentlich...☐ häufig...☐ immer...☐
26. ***Mein Kind schläft plötzlich in unangebrachten Situationen ein.***
    nie...☐ selten...☐ gelegentlich...☐ häufig...☐ immer...☐

Wie wahrscheinlich ist es, dass Ihr Kind in einer der folgenden Situationen einnicken oder einschlafen würde – sich also nicht nur müde fühlt? Selbst wenn Sie Ihr Kind in einigen der unten genannten Situationen in der letzten Zeit nicht erlebt haben, versuchen Sie bitte trotzdem, sich vorzustellen, wie diese auf Ihr Kind gewirkt hätten.

1. Im Sitzen lesen

würde niemals einnicken ..... ☐
geringe Wahrscheinlichkeit einzunicken ..... ☐
mittlere Wahrscheinlichkeit einzunicken..... ☐
hohe Wahrscheinlichkeit einzunicken ..... ☐

2. Beim Fernsehen

würde niemals einnicken ..... ☐
geringe Wahrscheinlichkeit einzunicken ..... ☐
mittlere Wahrscheinlichkeit einzunicken..... ☐
hohe Wahrscheinlichkeit einzunicken ..... ☐

3. Ruhiges Sitzen an einem öffentlichen Ort (z.B. Theater, Kino oder bei einer Vorstellung)

würde niemals einnicken ..... ☐
geringe Wahrscheinlichkeit einzunicken ..... ☐
mittlere Wahrscheinlichkeit einzunicken..... ☐
hohe Wahrscheinlichkeit einzunicken ..... ☐

4. Als Mitfahrer in einem Auto während einer einstündigen Fahrt ohne Unterbrechung

würde niemals einnicken ..... ☐
geringe Wahrscheinlichkeit einzunicken ..... ☐
mittlere Wahrscheinlichkeit einzunicken..... ☐
hohe Wahrscheinlichkeit einzunicken ..... ☐

5. Sich nachmittags zum Ausruhen hinlegen, wenn es die Umstände erlauben

würde niemals einnicken ..... ☐
geringe Wahrscheinlichkeit einzunicken ..... ☐
mittlere Wahrscheinlichkeit einzunicken..... ☐
hohe Wahrscheinlichkeit einzunicken ..... ☐

6. Mit jemandem zusammensitzen und sich unterhalten

würde niemals einnicken ..... ☐
geringe Wahrscheinlichkeit einzunicken ..... ☐
mittlere Wahrscheinlichkeit einzunicken..... ☐
hohe Wahrscheinlichkeit einzunicken ..... ☐

7. Ruhiges Sitzen nach einem Mittagessen

würde niemals einnicken ..... ☐
geringe Wahrscheinlichkeit einzunicken ..... ☐
mittlere Wahrscheinlichkeit einzunicken..... ☐
hohe Wahrscheinlichkeit einzunicken ..... ☐

8. In der Schule während des Unterrichts

würde niemals einnicken ..... ☐
geringe Wahrscheinlichkeit einzunicken ..... ☐
mittlere Wahrscheinlichkeit einzunicken..... ☐
hohe Wahrscheinlichkeit einzunicken ..... ☐

Für die Feststellung der Repräsentativität unserer Untersuchung benötigen wir auch noch einige demographische Angaben zu Ihrer Familie. Diese Angaben unterliegen selbstverständlich auch dem Datenschutz, werden nicht an Dritte weitergegeben und ausschließlich im Rahmen dieser Untersuchung ausgewertet:

1. Bei wem lebt Ihr Kind hauptsächlich? (Hier bitte nur ein Kreuz machen!)

Eltern…☐ Mutter…☐ Vater…☐ Großeltern/andere Verwandte…☐

sonstige:……

2. Mit wie vielen älteren und jüngeren Geschwistern lebt Ihr Kind zusammen? (Inkl. Halbgeschwister und angeheiratete Geschwister)

Mein Kind lebt mit keinen Geschwistern zusammen…☐ → weiter mit Frage 3

Mein Kind lebt mit _ _ älteren Geschwistern zusammen

Mein Kind lebt mit _ _ jüngeren Geschwistern zusammen

Mein Kind lebt mit _ _ gleichaltrigen Geschwistern zusammen

3. Welche Staatsangehörigkeit haben Sie? (Bitte für beide Elternteile angeben!)

Mutter: Deutsch…☐ andere Staatsangehörigkeit…☐ welche? ……

Vater: Deutsch…☐ andere Staatsangehörigkeit…☐ welche? ……

4. In welchem Land sind Sie geboren? (Bitte für beide Elternteile angeben!)

Mutter: In Deutschland…☐ in einem anderen Land…☐ in welchem? ……

Vater: In Deutschland…☐ in einem anderen Land…☐ in welchem? ……

5. Welche Sprachen werden bei Ihnen zuhause gesprochen?

Deutsch…☐ andere Sprachen…☐ welche? ……

6. Welchen höchsten Schulabschluss haben Sie? (Nennen Sie bitte nur den höchsten Abschluss. Bitte für beide Elternteile angeben!)

	Mutter / Partnerin	Vater / Partner
Grundschul-/Hauptschulabschluss	☐	☐
Realschulabschluss (Mittlere Reife)	☐	☐
Abschluss Polytechnische Oberschule (POS)	☐	☐
Fachhochschulreife (Abschluss einer Fachoberschule)	☐	☐
Abitur (Gymnasium bzw. EOS)	☐	☐
Anderer Schulabschluss	☐	☐
Noch keinen Schulabschluss	☐	☐
Schule beendet ohne Schulabschluss	☐	☐

7. Haben Sie eine abgeschlossene Berufsausbildung? Wenn ja, welche? (Nennen Sie bitte nur den höchsten Abschluss. Bitte für beide Elternteile angeben!)

	Mutter / Partnerin	Vater / Partner
Lehre (beruflich-betriebliche Ausbildung)	☐	☐
Berufsschule, Handelsschule (beruflich-schulische Ausbildung)	☐	☐
Fachschule (z.B. Meister-Technikerschule, Berufs- oder Fachakademie	☐	☐
Fachhochschule, Ingenieurschule	☐	☐
Universität, Hochschule	☐	☐
Anderer Ausbildungsabschluss	☐	☐
Noch in beruflicher Ausbildung (Azubi, Student)	☐	☐
Kein beruflicher Abschluss (und auch nicht in der Ausbildung)	☐	☐

8. Wird in Ihrem Haushalt geraucht?

nein…☐ ja, aber nur außerhalb der Wohnräume (z.B. Balkon)…☐ ja, auch innerhalb der Wohnräume…☐

Dieser Fragebogen wird **vom Kind selbst** beantwortet! Bitte beantworte die folgenden Fragen so zutreffend wie möglich, indem Du jeweils eine der Antworten markierst.

1. ***Wie oft schläfst Du während Unterrichtsstunden ein oder wirst schläfrig?***
   Immer...☐ Häufig...☐ Manchmal...☐ Selten...☐ Nie...☐

2. ***Wie oft wirst Du schläfrig oder müde, während Du Deine Hausaufgaben machst?***
   Immer...☐ Häufig...☐ Manchmal...☐ Selten...☐ Nie...☐

3. ***Bist Du normalerweise die meiste Zeit des Tages munter?***
   Immer...☐ Häufig...☐ Manchmal...☐ Selten...☐ Nie...☐

4. ***Wie oft bist Du tagsüber müde und schlecht gelaunt?***
   Immer...☐ Häufig...☐ Manchmal...☐ Selten...☐ Nie...☐

5. ***Wie oft hast Du damit Schwierigkeiten, morgens aus dem Bett aufzustehen?***
   Immer...☐ Häufig...☐ Manchmal...☐ Selten...☐ Nie...☐

6. ***Wie oft schläfst Du wieder ein, nachdem Du morgens geweckt worden bist?***
   Immer...☐ Häufig...☐ Manchmal...☐ Selten...☐ Nie...☐

7. ***Wie oft brauchst Du jemanden, der Dich morgens weckt?***
   Immer...☐ Häufig...☐ Manchmal...☐ Selten...☐ Nie...☐

8. ***Wie oft hast Du das Gefühl, mehr Schlaf zu brauchen?***
   Immer...☐ Häufig...☐ Manchmal...☐ Selten...☐ Nie...☐

ieferorthopädische Risikofaktoren für das
obstruktive Schlaf-Apnoe-Syndrom im Kindesalter

ge zum bestimmenden Zahnbogen)

Zunge liegt innerhalb der Zahnreihe...☐

Zunge liegt an/auf der Zahnreihe...☐

Zunge reicht über Zahnreihe hinaus...☐

aumenbögen...☐

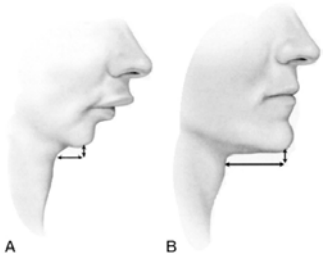
23. Abstand Hyoid-Mentum? ……. cm

24. Sonstiges: ……...

……

……

……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Universitätsklinikum Tübingen

ORFOS Project
Kieferorthopädische Risikofaktoren für das obstruktive Schlaf-Apnoe-Syndrom im Kindesalter

Ein Gemeinschaftsprojekt der Universitätsklinik für Zahn-, Mund- und Kieferheilkunde und der Universitätsklinik für Kinder- und Jugendmedizin

afmedizin · Calwerstr. 7 · 72076 Tübingen

Projektleitung
Dr. med. dent. Bernd Koos
Universitätsklinik für Zahn-, Mund- und Kieferheilkunde

Beratung
Dr. med. univ. Michael S. Urschitz, M.Sc.
Universitätsklinik für Kinder- und Jugendmedizin

Kontakt
Pädiatrische Schlafmedizin, Calwerstr. 7, 72076 Tübingen
Tel. 07071/29-81283, Fax. 07071/29-4356
Email. schlafmedizin@med.uni-tuebingen.de

Datum: Dienstag, 27. April 2010

TEILNAHMEURKUNDE

.....

HAT AN DER UNTERSUCHUNG „KIEFERORTHOPÄDISCHE RISIKOFAKTOREN FÜR DAS OBSTRUKTIVE SCHLAF-APNOE-SYNDROM IM KINDESALTER" ERFOLGREICH TEILGENOMMEN.

Tübingen, am .....

Für das Untersuchungsteam

Dr. med. dent. Bernd Koos
Universitätsklinik für Zahn-, Mund- und Kieferheilkunde

Dr. med. univ. Michael S. Urschitz, M.Sc.
Universitätsklinik für Kinder- und Jugendmedizin

10 Information and declaration concerning the student's own work

The following persons were directly involved in the ORFOS project and the dissertation's development process:

- Prof. Dr. med. Ch. F. Poets (Medical Director of the Neonatology Department, University Children's Hospital Tuebingen, Germany; doctoral thesis supervisor; second proofreader)
- Prof. Dr. med. M. Urschitz (Specialist in Child and Youth Medicine/Epidemiology/Sleep Medicine, Institute of Medical Biostatistics, Epidemiology and Informatics, University Mainz, Germany; doctoral thesis tutor Pediatrics; first proofreader)
- Dr. med. B. Koos (Senior Physician at the University Medical Center, Clinic for Orthodontics, Kiel, Germany; doctoral thesis tutor Orthodontics)
- Dr. med. Dr. dent. S. Müller-Hagedorn (Specialist in Orthodontics and Pediatrics; doctoral thesis co-tutor Orthodontics)
- Ms I. Seitz (dentist; doctoral candidate Orthodontics)
- Ms C. M. Ring (junior doctor in the University Department of Anesthesiology and Intensive Care Medicine Tuebingen; doctoral candidate Pediatrics)

Details of who has done which contribution to this doctoral thesis are listed below.

C. M. Ring (doctoral candidate):

Generating the ENT history and examination process with the help of Prof. Dr. Urschitz; recruitment of the probands with the help of the Deparment of Orthodontics, at the University Centre of Dentistry, Oral Medicine and Maxillofacial Surgery, UKT; performing the ENT history and examination; performing the orthodontic history and partly the orthodontic examination under the guidance of Dr. Koos; entering data into the database and their preparation under the guidance of Prof. Dr. Urschitz; statistic analysis and evaluation of all collected data with adivce from Prof. Dr. Urschitz, the Institute for Clinical Epidemiology and Applied Biometry, University of Tuebingen,

Germany, and the Institute for Statistic Schreier, Tuebingen, Germany; writing the doctoral thesis; generating the included tables; literature research with the help of Prof. Dr. Poets and Prof. Dr. Urschitz

Prof. Dr. Urschitz (tutor):

Supervision and assistance; application for the ethics committee; setting the topic for the doctoral thesis; study design; providing the questionnaires and information sheets (PSQ, ESS, PDSS, Demography, SDSC, certificate of attendance, declaration of consent, data privacy protection); first proofreader

Dr. Koos (tutor):

Supervision and assistance Orthodontics; study design; tutor for Ms Seitz; orthodontic care of the proband children; setting the basic conditions to carry out the study (patient cohort, premises)

Ms Seitz (doctoral candidate Orthodontics):

Model analysis; cephalometric analysis; entering orthodontic data into the database

Dr. Dr. Müller-Hagedorn (co-tutor):

Supervision and assistance Orthodontics; support with statistical analysis and orthodontic questions; provision of orthodontic literature

I hereby declare that this doctoral thesis is my own work and that it does not contain other people's work without this being stated. I also declare that the bibliography contains all the literature I have used in writing the thesis, and

that all references refer to this bibliography. I hereby confirm that the above information, to my knowledge, is correct and complete.

Tuebingen, _____

_____

(Carmen M. Ring)

11 Acknowledgement

It gives me great pleasure in acknowledging the support and help from the following people to this dissertation, my education and insight into medical research:

I would like to show my gratitude, first and foremost, to Prof. Dr. med. Poets, Medical Director of the Department of Neonatology, University Children's Hospital, Tuebingen, Germany, for giving me the opportunity to work on this doctoral thesis and for putting his trust in my abilities.

Also, I owe sincere and earnest thankfulness to my supervisor Prof. Dr. med. Urschitz, specialist in Child and Youth Medicine/Epidemiology/Sleep Medicine, Institute of Medical Biostatistics, Epidemiology and Informatics, University Mainz, Germany, who encouraged and challenged me through the planning and implementation of our clinical "ORFOS" trail.

This study would not have been possible without the participation and cooperation of all children and their parents who filled out questionnaires and took their time for the examinations. I share the credit of my work with you.

I am indebted and thankful for the close working relationship with Dr. med. Koos, Senior Physician at the University Medical Center, Clinic for Orthodontics, Kiel, Germany, Dr. Dr. Müller-Hagedorn, and Isabell Seitz in order to make cross-disciplinary collaboration possible.

I am obliged to the whole team of the Department of Orthodontics, University Hospital, Center for Dentistry, Oral Medicine and Maxillofacial Surgery,

Tuebingen, Germany, who supported me with my investigations. Especially the qualified dental employees always helped me with words and deeds.

Moreover, I want to express my thanks to the Institute for Clinical Epidemiology and Applied Biometry, University of Tuebingen, Germany, for their expert advice concerning my statistical evaluation.

To sum up, it is a great pleasure to thank everyone who supported me in writing my dissertation. My heartfelt appreciation is extended to my family and friends.