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# ASSESSMENT OF VOICE AMONG EMERGING HIGH-RISK POPULATION GROUPS

With special emphasis on kindergarten teachers, children with laryngeal reconstruction, and workers exposed to organic dust

**AHMED GENEID**

ACADEMIC DISSERTATION

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Cover photograph: Among the oldest advice on vocal hygiene and proper behavior. This Arabic word does not seem to have an exact parallel in English. Perhaps the best translation is to apply modesty and to lower your voice. Quran, Luqmaan 31:19. By Arabic calligrapher Abdelghani Azzi, copyrights to Ahmed Geneid

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*To my beloved wife Heba, our Fairuz,*
*my dear parents, and my sisters*

أني رأيت أنه لا يكتب أحد كتابا في يومه إلا وقال في غده: لو غُيّر هذا لكان أحسن, ولو قُدّم هذا لكان يستحسن, ولو قُدّم هذا لكان أفضل, ولو تُرك هذا لكان أجمل, وهذا من أعظم العبر وهو دليل علي استيلاء النقص علي جُملة البشر.

I have seen that whenever someone writes a book, he says the next day: If this part could be changed, it would be better; if this were added, it would be appreciated more; if this part were brought forward, it would be superior; if this part were left out, it would read better. In this is one of the greatest lessons: it is proof that defectiveness dominates over mankind.

**Imad ad-Din al-Isfahani** (1125 – 1201 C.E.): historian, scholar, rhetorician, and chancellor of Saladin. Born in Isfahan, Iran, studied in Baghdad, Iraq, lived and worked in Cairo, Egypt, and died in Damascus, Syria.

# CONTENTS

# LIST OF ORIGINAL PUBLICATIONS

This study is based on the following publications, which are referred to in the text by their Roman numerals:

I. Geneid A, Rönkkö M, Airaksinen L, Voutilainen R, Toskala E, Alku P, Vilkman E. Pilot study on acute voice and throat symptoms related to exposure to organic dust: preliminary findings from a provocation test. Logoped Phoniatr Vocol 2009;34(2):67-72.

II. Geneid A, Rönkkö M, Voutilainen R, Airaksinen L, Toskala E, Alku P, Vilkman E. Detecting inaudible vocal organ changes through glottal inverse filtering. J Voice 2012 Mar;26(2):154-163.

III. Geneid A, Pakkasjärvi N, Aherto A, Roine R, Sintonen H, Lindahl H, Pitkäranta A. Outcomes of early infancy laryngeal reconstruction on health- and voice-related quality of life. Int J Pediatr Otorhinolaryngol 2011 Mar;75(3):351-355.

IV. Kankare E, Geneid A, Laukkanen A-M, Vilkman E. Subjective Evaluation of Voice and Working Conditions and Phoniatric Examination in Kindergarten Teachers. Folia Phoniatr Logop 2011 Jul 6;64(1):12-19.

# ABBREVIATIONS

| | |
|---|---|
| AQ | Amplitude Quotient |
| BVP | Buffalo Voice Profile |
| B.C. | Before Common Era |
| C.E. | Common Era |
| ENT | Ear, Nose and Throat specialty of medicine |
| Fo | Fundamental frequency |
| GRBAS | Scale for perceptual analysis of voice; a measure of the overall Grade, Roughness, Breathiness, Asthenia and Strain of voice |
| HRQoL | Health-Related Quality of Life |
| GIF | Glottal Inverse Filtering |
| LPR | Laryngopharyngeal reflux |
| LTR | Laryngotracheal reconstruction |
| NAQ | Normalized amplitude quotient |
| NHR | Noise to Harmonics Ration |
| OQ1 | Open Quotient calculated from the primary opening |
| OQ2 | Open Quotient calculated from the secondary opening |
| OQa | Open Quotient calculated from the amplitude domain |
| pVHI | Pediatric Voice Handicap index |
| PVOS | Pediatric Voice Outcomes Survey |
| PVRQoL | Pediatric Voice-Related Quality of Life |
| SGS | Subglottal stenosis |
| SPL | Sound Pressure Level |
| SQ1 | Speed Quotient calculated from the primary opening |
| VAS | Visual Analogue Scale |
| VCD | Vocal Cord Dysfunction |
| VPA | Vocal Profile Analysis Scheme |
| VRQoL | Voice-Related Quality of Life |
| VTP | Vocal Tract cross-sectional Plane |

# ABSTRACT

In recent decades, school teachers and singers have been more or less the center of attention among voice researchers due to their specific occupational needs. However, other population groups have also begun to draw attention. One susceptible group comprises workers exposed to organic dust in mills, bakeries, and similar workplaces. Some of these workers may develop a certain work-related voice disorder that results not from voice misuse or abuse, but from the reaction of the larynx to organic dust and other irritants. Children who underwent Laryngotracheal reconstruction (LTR) during infancy due to subglottic stenosis may have a deviation from the norms in their Health-Related Quality of Life (HRQoL), Voice-Related Quality of Life (VRQoL) or voice quality in the long term. Field research has focused little attention on possible voice problems among kindergarten teachers. Their risk for voice problems stems mainly from different individual and ergonomic factors related to their work and workplaces. This study aims to shed light on these newly emerging vulnerable groups by assessing their voices.

In this thesis, we aimed: 1. to study the possible effects of organic dust exposure on the voice as a work-related voice disorder and to examine its acoustic correlates using glottal inverse filtering; 2. to investigate the long-term effects of LTR on health- and voice-related quality of life in addition to the voice quality of children who underwent these surgeries in early infancy; 3. to examine not only the voice quality, and effect of working conditions on the voice, but also organic findings in the larynges of kindergarten teachers in their workplaces.

Studies I & II investigated nine subjects with suspected occupational rhinitis or asthma. These subjects had single-blinded exposure to organic dust and placebo substances. Self-assessments of voice and throat symptoms were recorded on the Visual Analogue Scale (VAS) both before and after exposures. We carried out a perceptual assessment of the voice samples, and conducted an acoustic analysis of the 180 samples using Glottal Inverse Filtering (GIF). Study III entailed a retrospective review of children who underwent surgery for subglottic stenosis between 1990 and 2005. Of the 17 children identified, 10 fulfilled the inclusion criteria and participated in the study. We assessed HRQoL and PVRQoL and the children underwent perceptual voice assessment. In the last study (IV), 119 female kindergarten teachers volunteered to participate. They responded to a questionnaire on voice habits, voice symptoms, and the degree to which different working conditions may adversely affect their voices. We also carried out a videolaryngoscopic examination of teachers in their workplaces.

Studies I & II showed that some self-reported voice and throat symptoms changed significantly after exposure to organic dust, although perceptual assessment had failed to detect these changes. However, GIF analysis revealed changes representing those that the subjects reported. Moreover, the second Vocal Tract cross-sectional Plane (VTP) correlated inversely with some of the subject-reported changes. In Study III, HRQoL and PVRQoL surveys scores showed no differences between subjects and controls. The subjects had significantly lower PVOS scores than did the controls. Perceptual assessment revealed that the subjects' voices were worse off on some dimensions. The last study (IV) showed that 71.5% of the examined teachers reported frequent strain on their voice, and 56.3% reported hoarseness without infection. Clear organic findings occurred in 10.9% of the cases and showed no correlation with subjective voice symptoms.

The previous results may have detected a new occupational risk group with voice disorder upon exposure to organic dust. This group felt their voice problems better than the voice clinicians heard them. GIF successfully detected changes that are in line with those subject-reported changes. In addition, these results provide an example of the potential of the phonation system to compensate for changes in the voice source. This thesis also provides valuable information about the long-term effects of LTR. Previous studies of short-term effects referred to similar results for effects on voice quality. Nearly 10% of the kindergarten teachers exhibited organic findings, which is less than the percentages reported in previous studies probably thanks to the more accurate methodology used in this study. Overall, this thesis adds to the medical literature on voice assessment among risk groups in that it contributes new and valuable knowledge about emerging risk groups vulnerable to voice problems.

# 1 INTRODUCTION

The larynx has been considered a mere mechanical passage of air protecting humans from aspiration, which is its main function. Voice, being a secondary function of the larynx, came into the spotlight of medical research and interest only recently. When Manuel Garcia visualized the larynx in 1855 (1), he opened the door to looking into the larynx in vivo and utilizing his mirror for clinical use.

The bulk of research on voice disorders among risk groups has focused mainly on teachers and singers. Their occupational needs in schools and while singing have more or less been the center of attention of voice clinicians for decades. With advancements in studies on voice and the care provided to voice patients, attention has broadened to include new population groups due to their risk for voice disorders.

This study covers three population groups whose voice problems are drawing attention. The first group is workers in mills, bakeries and those in other occupations who are exposed to organic dust and suffer from voice problems due to such exposure. The second group comprises children who underwent surgery for subglottic stenosis in their early infancy. The third group comprises kindergarten teachers, whose voice disorders are seldom subject of field studies.

An in-depth examination of these risk groups is necessary in order to understand their vulnerability to voice problems and to assess their voices. Some workers in mills, factories and bakeries are exposed to organic dust. Many of them develop a certain work-related voice disorder that results not from voice misuse or abuse, but from the reaction of the larynx to those substances which may alter the indoor air quality in their workplaces. Such a group merits further investigation to shed light on the possible link between organic dust (e.g. flour and sawdust) and voice in terms of the reactions of the voice box (Larynx) to such substances. Studies in the medical literature of the reaction of the larynx to organic dust and indoor air quality in general are rare. The reactions of the larynx in such situations often remain inaudible to others. Whether the reactions are allergic or non-allergic or even a combination of both is a question that captures our attention.

The second group includes children who underwent laryngeal reconstruction due to subglottic stenosis resulting from severe congenital or acquired causes. Although mild congenital stenosis per se requires no treatment, the most severe cases require tracheostomy and laryngoplasty. Prolonged intubation may lead to acquired subglottic stenosis at the level of the cricoid ring. Thin web stenoses can be resected by laser, but more severe scarring may require tracheostomy and subsequent laryngoplasty with bone/cartilage grafting. Studies investigating the

effects of these procedures on the developing larynx and their long-term effects on voice are rare, although this risk group is growing with improvements in neonatal care and the rising survival rate of premature babies.

The third group included in the thesis comprises kindergarten teachers. Their voice disorders have been studied much less than those of school teachers, perhaps because school teachers are heavy voice users and comprise a larger occupational group (2-5). However, the ergonomics and individual elements of voice use in kindergarten presents a unique situation for vocal load on teachers. Examining such ergonomic and individual elements and exploring the effects of these elements in kindergarten teachers' workplaces will be an excellent addition to the medical literature.

The symptoms of voice problems that may exist among these groups concern not merely voice quality in terms of voice hoarseness, but also laryngeal symptoms such as coughing, throat clearing, feeling of pain, itching, tickling, mucus or a lump in the throat, all of which are common among voice patients. These symptoms affect the individual's wellbeing not only at work, but also during leisure time. In clinical practice with voice disordered patients, they often report the need to rest their voices and throats after work. Working parents may suffer from limitations in their verbal social activities and be unable to read stories to their own children or attend choirs or other hobbies which require voice. On the other hand, if the voice patient is a child, voice problems may affect his or her quality of life in terms of play activities and verbal communication with others. Health- and voice-related quality of life are both important terms and measures in assessing voice disorders in addition to the reported voice and throat symptoms.

# 2 REVIEW OF THE LITERATURE

## 2.1 COMMON AND NEWLY EMERGING HIGH-RISK POPULATION GROUPS

From the beginning of voice research, attention has focused on singers and teachers as the most common population groups at risk for voice disorders in different countries and cultures around the world. In Finland, where this study took place, about 25% of the total Finnish labour force works in professions which require the use of the voice (6). As expected, those working in teaching or business top the list. A review of the literature on occupational groups at risk for voice disorders (7) found estimates similar to those found in Finland; in fact, American studies estimate that about 25% of the American working population considers their voice a critical tool in their work (8). A 1998 literature review indicated that the occurrence of voice problems in the general US population ranges from 3% to 9% (9). Another study suggested that the lifetime prevalence of voice disorders in the general population could be as high as 30% (10).

The main population groups at risk for voice disorders and which top the list of patients going to voice clinics were singers, school teachers, lawyers, clergy and telemarketers (11). It is worth noting that attention tends to focus more on school teachers than on kindergarten teachers (12).

School teachers have been topping the list of at-risk population groups mainly due to heavy use of the voice and background noise. Many studies aimed to explore the prevalence of voice disorders in such an important population group (3-5,13-15). Frequency rates differ widely between studies, ranging from 4.4% to nearly 90% (5,16-21). Such huge disparities in the prevalence of voice disorders stem from differences in the methodologies used in each study. One study based on organic vocal fold lesions (16) found a prevalence of 4.4%, whereas studies based on self-reported symptoms of voice saw a dramatically high prevalence of 90% (17).

Singers also comprise a population group often at high risk for voice disorders; many studies have explored various aspects of their voice problems (22-27). A study by Phyland et al. (28) reported that, as a group, singers have high prevalence rates of vocal disability (69%), diagnosed vocal conditions (44%), and handicaps defined as the "inability to perform due to a voice problem" (27%) during the year preceding the study. The authors attributed such high rates to the inclusion of common colds and other upper respiratory tract infections in the subjects' own assessment of voice problems. This recalls a similar finding among teachers with voice disorders in which 90% reportedly suffered (subjectively) from voice problems (17). Again, however, the wide variety of methodologies employed

in these studies makes direct comparison of the results difficult. The results revealed that 21% of non-singers in the study reported one or more occurrences of a diagnosed vocal condition, and about 41% of them experienced vocal disability.
A number of other population groups are becoming at risk for voice disorders. These groups include telemarketers, aerobics instructors, cheerleaders, children who have undergone laryngeal surgery, workers in bakeries and factories (where work-related voice disorders are not based on voice abuse), and teachers in kindergartens. These last three groups are discussed in detail later.

Studies of telephone employees found that about 68% of them reported one or more symptoms of "vocal attrition" and that nearly half of them had to be absent from work due to voice problems (29). Vocal attrition in this context is the "wear and tear of the vocal mechanism and the overall reduction of the vocal capabilities associated with acute or chronic abuse of the phonatory system". The growing interest in studying the voice of telemarketers and in the studies examining them (7) is largely motivated by the explosive growth in the call-center industry in recent decades (30).

Aerobics instructors are also an emerging population group for whom the physical demands of the job add to the vocal ones, which are sometimes exacerbated by the absence of microphones – especially among those instructing in water aerobics. A study of female aerobics instructors indicated that they generally experience more hoarseness and voice loss in addition to a higher prevalence of nodules than do individuals participating in aerobics (31). Another study (32) showed that 44% of the subjects reported experiencing voice loss. In addition, 42.6% of them reported partial voice loss either while instructing class or immediately following it. The study also documented increased episodes of voice loss, hoarseness, and sore throat among the instructors since they began instructing.

A few studies carried out in the 1980s focused attention on voice problems among cheerleaders. The studies point to cheerleaders' tendency to develop vocal nodules and increased voice disorders (33, 34).

## 2.2 METHODS OF VOICE ASSESSMENT

The evaluation of voice and methods tailored to its assessment have evolved through years. Possibly the first-ever reference to communication disorders, including speechlessness, appears in the Edwin Smith papyrus. It described 50 traumatic surgical cases, including a number of cases of loss of speech (35). However, a depiction of the lung and trachea included in the papyrus showed no separate larynx (35,36).

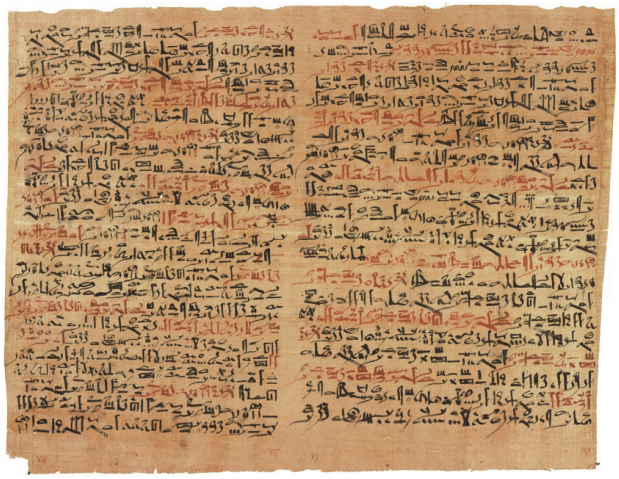

**Figure 1.** The Edwin Smith papyrus: the world's oldest surgical book written in Egypt around 1600 B.C.E. The text shown here is part of a description of facial trauma appearing on plates 6 and 7 of the papyrus. Public domain picture.

Hundreds of years later, Hippocrates (460-370 B.C.E.) identified voice change as one of the keys to diagnosing systemic diseases. However, about 600 years passed before Galenius (130-200 C.E.) described laryngeal muscles and cartilages as well as their innervation by the recurrent laryngeal nerve. Since then, the larynx has been known as the source of the voice. Such a huge step forward enabled evaluation of the voice, at least perceptually and by palpation. Abu Bakr Al-Razi (Latin: Rhazes) (865-925 C.E.) described voice disorders and their treatment based on types of voice, with special emphasis on vocal hygiene. He even described the effects of low respiratory output on the voice, drawing attention to the role of the lungs in the vocal system. His work can be considered a true breakthrough in voice evaluation and treatment for his time (37).

**Figure 2.** A European depiction of Rhazes in Gerard of Cremona's "Recueil des traités de médecine", 1250-1260. Gerard de Cremona translated the textbooks of numerous Islamic scholars, including Rhazes. Public domain picture.

Ibn-Sina (Latin: Avicenna) (980-1037 C.E.) later added to this breakthrough with his excellent description of the anatomy of the larynx, which resembles what we find in anatomy books today. However despite Al-Razi's breakthrough, evaluation of the voice remained limited to the perception of it and the palpation of its source, the larynx. Such a limitation was lifted only by the introduction of the laryngeal mirror in 1855 by Manuel Garcia (1). Since then, visualization of the larynx was added to the methods of voice evaluation. Developments since then have followed on the basis of indirect in vivo laryngoscopy by Manuel Garcia. In 1878, Oertel introduced the idea of laryngeal stroboscopy, but a suitable device appeared only in 1895 (38,39). This device included a perforated wheel that interrupts the light, allowing the examiner to see the vibrations of the vocal folds. By the 1960s, stroboscopic systems similar to what we have today were introduced into voice clinics. Nevertheless, clinical voice labs, laryngeal electromyography, and radiological studies have continuously served as an adjunct and compatible methods in assessing the voice.

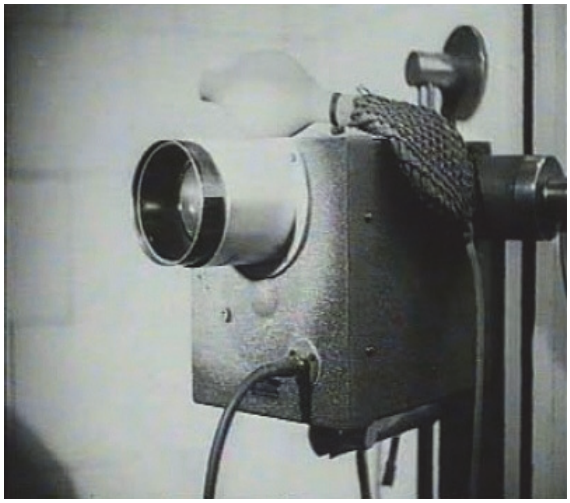

**Figure 3.** Strobolaryngoscopy in the 1950s in a phoniatrics clinic, Prague, Czech Republic. Courtesy of F. Šram. Printed with permission.

This thesis has used voice assessment methods, some of which (e.g., glottal inverse filtering) are relatively new in this context. Others, such as the VRQoL survey and the HRQoL questionnaire, deserve more attention. The subjects and methods section contains a detailed description of the methods used in each study. However, the following section offers an introduction to different methods of voice assessment in clinical work and research. Different ways exist to classify and describe these methods. Sataloff, for example, seemed to group different voice assessment techniques together in his book Clinical Assessment of Voice for Clinical Purposes in 2005 (22). He grouped and described the techniques in the

following chapters: patient history, special considerations relating to members of the acting profession, physical examination, the clinical voice laboratory, laryngeal electromyography, laryngeal photography and videography, laryngeal computer tomography, and new dimensions in measuring voice treatment outcomes and quality of life. In the 1980s, however, Kotby (40) proposed another relatively older classification that groups methods of voice assessment into elementary diagnostic procedures, clinical diagnostic aids, and additional instrumental measures. The following is a modified classification, by this thesis author, that groups these different methods of voice assessment into three broader groups that are easy-to-remember. These are primary, secondary and tertiary diagnostics methods.

### 2.2.1 PRIMARY DIAGNOSTIC METHODS

These methods include anamnesis, medical examination, maximum phonation time, auditory perceptual assessment and mirror laryngoscopy. Still, the patient interview and the patient's own assessment of voice remain the basic methods. When dealing with work-related voice disorders, certain voice disorders are better felt than heard. Nevertheless, patients in voice clinics often present with complaints of dysphonia that occur on workdays, but not during their visit to the voice clinician. A detailed medical history and medical examination is the first step in examining a patient with a voice disorder.

Measuring maximum phonation time is one of the simple but important tests to assess a patient's phonatory ability. Maximum phonation time is measured with a stopwatch: the patient is instructed to sustain the vowel [a] as long as possible after deep inspiration and at his/her most comfortable volume level. Durations obtained are easily comparable to normal values (41).

Perceptual assessment of the voice is a subjective psychoacoustic analysis with different quality categories and rating scales. GRBAS (41) quality categories, developed by the Japanese Society of Logopedics and Phoniatrics, have served for years in perceptual analysis for clinical purposes. These categories measure the overall Grade, Roughness, Breathiness, Asthenia and Strain of the voice (GRBAS). Two other forms of assessment have also seen use, but to a narrower extent: the Buffalo Voice Profile (BVP) and the Vocal Profile Analysis Scheme (VPA). The BVP was developed to rate 12 voice parameters among children on a five-point equal-appearing interval scale in which 1 is normal and 5 is severe. Some of its parameters rate vocal features and others rate the general aspects of voice behaviour (42). VPA is a method in which a trained clinician listens to a two- to four-minute tape recording of a speaker reading and speaking and evaluates the voice across 31 parameters in relation to a specifically defined baseline (43). Other scales include the Visual Analogue Scale (VAS), which is commonly used to assess subjective vocal characteristics on a continuum (44). This scale offers the

possibility to avoid discrete jumps from none to mild and so on. The patient assesses his or her own symptoms on a continuum.

Mirror laryngoscopy still remains the primary tool for examining patients with voice disorders, especially where videolaryngoscopy is unavailable. In developing countries and even in some of the developed countries, combining mirror laryngoscopy with a microscope, in the hands of an experienced phoniatrician, offers a good alternative to videolaryngoscopy when it is either not working or unavailable.

### 2.2.2 SECONDARY DIAGNOSTIC METHODS

These diagnostic aids fall into two main dimensions. The first is optical visualization of the vocal folds using rigid or flexible laryngoscopy with the latter passing through the nose of the patient. The second is audio recording. Optical visualization can be achieved with or without video recording for documentation and further analysis. Nevertheless, using a stroboscope during examination enables the clinician to visualize the vocal folds during vibrations as long as they vibrate regularly. Optical visualization is usually coupled with the ability to obtain a magnified picture and video of the vocal folds. Recording the pictures and videos obtained enables later assessment of the larynx. The previously mentioned optical visualization with or without stroboscopy should, when available in a clinic, be considered a primary diagnostic method. Audio recording for documentation, follow up, feedback to patients, and further analysis is the second most important of the secondary methods. Of course, certain specifications exist for recording audio samples and should be always taken into account (45).

### 2.2.3 TERTIARY DIAGNOSTIC METHODS

Tertiary diagnostic methods include acoustic analysis of the voice, high-speed filming of the vocal folds, aerodynamic measurements, and a number of other instrumental measures of the voice.

Acoustic analysis includes simple acoustic measures (frequency, intensity, harmonics, and spectrum), voice perturbation, voice range profile, and Glottal Inverse Filtering (GIF). Some of these analysis methods such as the voice range profile, can be performed in real time; others, such as inverse filtering, can analyze recorded audio signals. A growing number of software programs enable such analysis on personal computers. The most important requirement for acoustic analysis is that the quality of the recorded signal and the recording environment meet the required criteria. The voice range profile represents the vocal range as well as the minimum and maximum voice intensity and voice frequency. Glottal

Inverse Filtering is a promising method of acoustic analysis that studies the pulsating glottal waveform by removing the effects of vocal tract resonance. Glottal excitation can be quantified through a number of both time-domain and spectral parameters. Such parameters can involve both time-based as well as amplitude-based measures. A review of the strengths and limitations of GIF's estimation methods, parameterization techniques, and applications can be found in the review study by Alku (46).

High-speed filming of the vocal folds enables clinicians to see the actual vibrations of the vocal folds rather than their stroboscopic representation. This method also enables clinicians to see the mucosal waves even in asymmetric vibrations of the vocal folds. Clinicians have used high-speed filming since the 1940s (47) with subsequent developments in using it mainly in research. Its clinical use has been limited by time-consuming film development and analysis in addition to its high expense. Recently, a growing number of studies (48,49) have been looking into developing cheaper versions of high-speed systems to counter the high prices and also to ensure its use in research purposes (50). A slowly growing number of voice clinics are shifting to the use of high-speed filming of the vocal folds as a routine diagnostic method. Aerodynamic measurements serve to measure the driving power of the vibration of the vocal folds by measuring subglottal pressure along with a number of other aerodynamic parameters. Other types of instrumental investigations such as ElectroNeuroMyoGraphy (ENMG) and radiological investigations serve as diagnostic tools for identifying the cause of voice disorders.

## 2.3 LARYNGEAL REACTIONS TO DUST AS AN IMPORTANT AGENT OF INDOOR AIR QUALITY REDUCTION

In general, voice problems result from an interaction between genetic and environmental factors or result from solely environmental factors. The latter seem to play an important role in the development of voice disorders, especially those related to one's occupation and workplace (51,52). Vilkman listed common work-related factors affecting voice including dust as an indoor air quality reducing agent (53).

For decades, voice-disordered patients have been accused of causing their voice problems themselves by abusing their own voices through incorrect techniques. Research has shown that such a point of view is profoundly unjust (53). Work-related voice disorders per se are not always due to vocal loading imposed by the occupational tasks of the subject, but can also be due to the effects of dust or other factors reducing indoor air quality. In this context, the term "work-related disorder" is more suitable than is "occupational disease". An occupational disease is a disease contracted as a result of exposure to risk factors arising from work activity. However, an occupational disease must satisfy the causal relationship between exposure in a specific working environment or work activity and a

specific disease (i.e., that the disease occurs among a group of exposed persons with a frequency above the average morbidity of the rest of the population) (54). Accordingly, the term “work-related voice disorder” is more suitable until a formal cause-effect relationship is confirmed and formally adopted.

An emerging population group at risk for work-related voice disorders due to exposure to dust rather than to vocal loading include workers in mills, bakeries and factories, all experiencing exposure to organic dust. For some time, this group remained outside the scope of voice research for a rather simple reason. The larynx has long been considered an immunologically non-essential organ that merely acts as a passage and mechanical valve. Attention to its immunological properties has been something of a luxury that began to appear in the medical literature rather late.

Studies in the 1990s and since have demonstrated the immunological abilities of the human and animal larynx (55-60). Studies of the reactions of the vocal organ to organic dust are scarce. One of the most important of them is a study of occupational laryngitis by Sala et al. (61) in 1994. The study reported on 20 patients that had occupational laryngitis with immediate allergic or immediate specific chemical hypersensitivity. Of the 1910 patients examined at the Finnish Institute of Occupational Health, those 20 patients were the only ones found to show laryngeal signs of occupational laryngitis. Among the agents that caused occupational laryngitis were organic dust substances such as flours, obeche, and plants. Munoz et al. described reactions in the form of Vocal Cord Dysfunction (VCD) on exposure to wood dust (62). During inhalation tests, dysphonia, chest tightness, and inspiratory stridor were recorded with no significant decrease in the level of forced expiratory volume in one second. Another study examined patients with VCD that began after exposure to mostly chemical and non-organic irritants (63). The patients with Irritant Vocal Cord Dysfunction (IVCD) suffered from dysphonia in addition to asthma-like symptoms.

Climatic conditions and their effects on vocal performers were also found to cause laryngeal reactions. Singers studied by Richter et al. (64) complained of dust and other indoor air agents that affect their voices. Their study found that dust concentrations on stage exceeded occupational guidelines in Germany, where the study took place. In their daily clinical practice, phoniatricians and laryngologists often encounter voice patients with larynges that react strongly to smells and smoke. In cases of laryngeal hyper-reactivity, even small concentrations of indoor air impurities may cause symptoms. Such symptoms may mimic those of VCD. Nevertheless, it is relatively common to encounter patients with vocal organ symptoms that are more felt by the patient than heard by the clinician. According to the author, the vocal organ in such instances is hypothetically able to maintain, to a certain degree, the end product: voice. In other words, the reactions of the vocal organ, within certain limitations, will not be perceived perceptually, but felt subjectively and possibly detected acoustically.

## 2.4 IMPACT OF LARYNGEAL RECONSTRUCTION ON VOICE AND VOICE-RELATED QUALITY OF LIFE

Subglottic stenosis (SGS) is sometimes characterized by the impairment of breathing. In such situations, SGS requires surgical intervention to alleviate the stenosis. Laryngeal reconstruction in the form of an Anterior Cricoid Split (ACS), with or without grafts, emerged during the 1980s to facilitate extubation in children with subglottic stenosis (65). The idea behind ACS is to enlarge the subglottic space with a sufficiently large respiration passage.

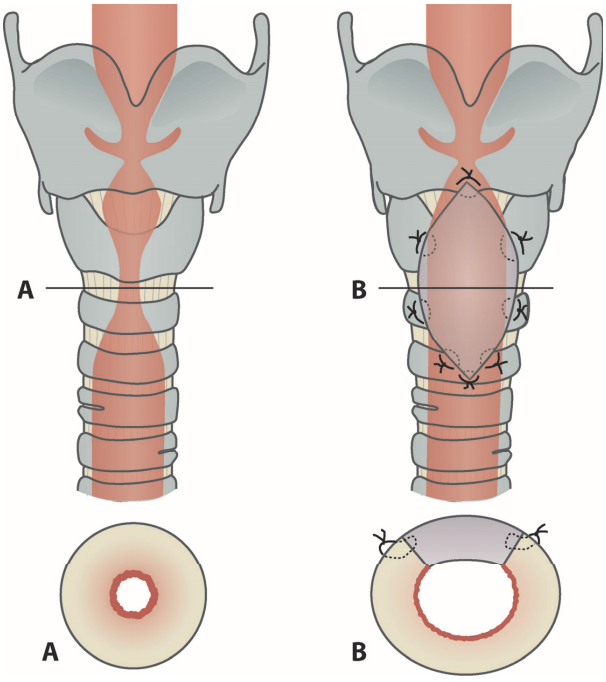


**Figure 4.** Anterior cricoid split with rib cartilage graft. A. Subglottic stenosis, anterior view, and cross section. B. Subglottic stenosis with rib graft interposition, anterior view and cross section. Copyrights to Ahmed Geneid

Treatment of SGS is mainly surgical regardless of whether its cause is congenital or iatrogenic due to prolonged intubation. Children who undergo this surgery comprise a small group that undergo laryngeal surgery in an early phase of their lives with possible effects on the voice-producing part of the larynx, their voice, and voice-related quality of life later on. Advances in neonatal intensive care units seem to have reduced mortality while contributing to a growing number of infants experiencing prolonged intubation (66). Studies of the effects of ACS focused mostly on its success in securing respiration and mitigating the complications associated with it (67-70). However, no studies have attempted to explore the

effects of these procedures on HRQoL, VRQoL or voice over the long term. The reasons for this include an inability to evaluate the voice in young children in order to assess damage to the vocal tract, inadequate normative data, small-sample groups of patients who undergo this form of surgery, and confounding interactions of comorbidities (e.g., pulmonary disease) in children with medically complex conditions (71).

## 2.5 IMPACT OF WORKING IN KINDERGARTENS ON KINDERGARTEN TEACHERS

The attention school teachers receive with regard to their voices and related problems far exceeds the attention received by teachers in kindergartens even though kindergartens are specifically designed to be places of children's play and activities and where noise is an obvious by-product. Kindergarten teachers encounter the same risk factors for vocal loading, including environmental and personal ones (72). In addition, they also encounter other demands and work-related factors due to the characteristics of their job. They must work with children outdoors, where background noise resulting from wind, traffic and other noise sources is usually higher. The need to raise one's voice level, especially during outdoor activities, is always present. The absence of portable voice amplifiers in many kindergartens exacerbates this problem. Kindergarten teachers use their voices in different contexts while playing, reading and singing with the children. Such contexts require different intonations with subsequently different fundamental frequencies and voice qualities.

In Sweden, a study of a relatively small number of subjects found that mean background noise levels for its ten pre-school teachers was 76.1 dBA (range 73.0-78.2) (73), which is about 20 dB higher than what is recommended for communication. The level of background noise was measured with two microphones placed on the sides of the subject's head at equal distances from the mouth. Such high background noise levels lead to subsequent automatic increases in sound levels in accordance with the Lombard effect (74). The subjects spoke on average 9 dB louder. An excellent study conducted by Sala et al. (75) focused on vocal loading among kindergarten teachers and risk factors that may increase the prevalence of voice disorders among them. The study, carried out in 27 Finnish kindergartens, compared the findings from 51 teachers to those from 25 hospital nurses. That study used a microphone located on the suprasternal notch to measure speaking SPL and another one on the left shoulder to measure the background noise levels. Among the important results was that the teachers spent on average 40% of their working time speaking. This percentage was much higher than for nurses (28%). In addition, the average speech level was 78 dB (LAeq, 0.3 m), 6 dB higher than for nurses. That study also recorded the background noise level in the kindergartens by placing the measuring microphone in the corner of the room 1 m from both walls. The measurement period of 7 hours was sufficient.

The average background noise level recorded was 67 dB (LAeq). The background noise level that persisted for 50% or more of the recording period was 53 dB, which requires the speaker to raise his or her voice. In addition, of the 70 rooms checked for acoustics, only 12 had a satisfactory level of speech transmission within the rooms. In countries such as Finland, where this thesis work took place, the relatively low humidity of indoor air may negatively affect the voice, especially during long heating-periods in winter, when low indoor humidity levels are common. Low indoor humidity is known to affect the vocal folds and lead to increases in voice symptoms (76-78). Noise levels in kindergartens range from 75 to 80 dBA with peak values at 120 dBA (79). Moreover, the design of the kindergarten and its furniture aims mainly to provide the best functionality for children rather than for adults. In Finland, two field studies identified organic findings that ranged from 14% to 29% depending on the method of examination and definition of laryngeal findings (80, 81).

# 3 AIMS OF THE STUDY

This study aimed to evaluate different voice parameters in three emerging populations that are at risk for voice disorders.

The specific aims were:

1. To study the effects of organic dust exposure on the voice as a work-related risk factor for voice disorders and to define organic dust-related voice symptoms.
2. To investigate the acoustic features of the voice that represent changes in voice quality upon exposure to organic dust by improving the application of GIF in the study of these changes.
3. To study the quality of life and voice of children who underwent laryngeal surgeries in their infancy or early childhood and to obtain a deeper understanding of the effects of these operations on the voice later in life.
4. To investigate kindergarten teachers' voice and throat symptoms, their recovery from vocal fatigue and their ability to withstand occupational vocal loading, as well as to study the relationship between these symptoms and organic findings detected in laryngeal examinations.

# 4 SUBJECTS AND METHODS

The individual studies of this thesis are identified with Roman numerals. All patients in Studies I-IV were examined at either the Department of Otorhinolaryngology and Phoniatrics, Helsinki University Central Hospital, Helsinki, Finland or the Finnish Institute of Occupational Health, Helsinki, Finland.

In all studies, either the patients themselves or their guardians, if the patient was a child, provided their written informed consent. The protocols of all of the studies were approved by the Ethics Review Board of the Helsinki and Uusimaa Hospital District. All pictures included this thesis are either copyrighted to the author or were obtained with permission from the holder of their copyrights. Individuals who appear in pictures in this thesis gave me their permission to use the pictures.

## 4.1 STUDIES I & II

The subjects of both studies were nine volunteers (five female, four male) with a mean age of 40.1. Their ages ranged from 26 to 60. All were referred to the Finnish Institute of Occupational Health (FIOH) for inhalation challenge tests (82) due to suspected occupational asthma or rhinitis from exposure to organic dust. None of them had a voice disorder or upper respiratory tract infection at the time of the tests, and none had received vocal training before.

Tests for specific ImmunoglobulinE (IgE)-mediated hypersensitivity: We performed skin prick tests on all subjects to investigate IgE-mediated specific hypersensitivity. IgE blood samples were taken from seven of the nine subjects, as the remaining two were suspected of having a hypersensitivity to wood dust, for which IgE tests were unavailable (83).

Exposure test: Subjects were exposed to the organic dust substances and placebo (lactose). Lactose is widely used as a placebo substance in testing for occupational asthma and rhinitis. To date, no allergic reactions to it are known. The concentration of lactose and organic dust in the tests was low enough to preclude any nonspecific reaction, but high enough to elicit an allergic or specific hypersensitivity reaction.

Subjects were exposed in a 6 m3 ventilated air-tight chamber according to the criteria specified in the FIOH (82). Exposure tests were single–blinded, as subjects were unaware of the substance to which they were exposed. However, many of them were able to notice the substance to which they claimed to be

reactive based on familiarity with the smell of the dust or the reactions they began to exhibit.

Vocal symptoms: Symptoms were investigated both before and after exposure to the organic dust. The voice symptom categories were: 1. My voice is overstrained, 2. My voice is hoarse or husky, 3. I feel like I have a lump in my throat, 4. I feel like I have a choker around my neck, 5. I have a feeling of mucus in my throat and/or I need to clear my throat frequently, 6. My throat is dry and/or itchy, 7. My voice is weak/my voice does not resonate, 8. My voice is tense or I feel I must make an effort to speak, 9. My voice is creaky, 10. My voice often breaks when I speak, 11. I feel short of breath/I need to gasp for air, and 12. I feel difficulty starting phonation. The patients' symptoms were assessed by the VAS rating scale from 0 to 100 along a 100-mm line. The VAS was adapted from Lehto et al. (44). All subjects were instructed to complete their VASs no more than 5 min before and after exposure. The form, with its descriptions of different vocal symptoms, appears in Appendix A in English and Finnish.

Perceptual voice quality was assessed from both reading samples and sustained phonations of the vowel [a]. The perceptual assessment of the reading samples was carried out blindly by three voice clinicians. The voice quality categories for the reading samples were the audible categories from the above-mentioned form. The audible categories were: My voice is overstrained, My voice is hoarse or husky, My voice is weak/my voice does not resonate, My voice is tense or I feel I must make an effort to speak, My voice is creaky, and My voice often breaks when I speak. The VAS rating scales used by the voice clinicians also ranged from 0 to 100 on a 100-mm-long line. The voice samples for the perceptual assessment were randomized.

Four voice clinicians blindly assessed the perceptual voice quality of the sustained vowel phonations using the Grade, Roughness, Breathiness, Asthenia, and Strain (GRBAS) scale as modified by the author. The voice clinicians listened to paired samples from the nine subjects. Each paired sample included a pre- and post-exposure voice recording. The modified scale precluded separate analysis of each voice recording, but instead permitted the voice clinician to study the change in the voice recordings. After listening to the paired samples, the voice clinician assessed them against the following four parameters: (1) Which voice sample is generally worse? (2) Which is rougher? (3) Which is breathier? (4) Which is more strained?. To evaluate the samples, the clinicians used a dichotomizing method in which equal samples ranked as zero. Otherwise, the sample that was generally worse, rougher, breathier, or more strained ranked as one, and the other sample as zero. This method provided a clear assessment whether a change had taken place and in which direction. The scale appears in Appendix B in both English and Finnish.

The voice samples were recorded in a sound-proof booth close to the exposure chamber. Recordings were taken from each subject before and after exposure to both organic dust and placebo. Voice recording included a (1) passage text and (2) long sustained vowel at certain SPLs. The text included a meaningful sample, a weather forecast of 72 words in three paragraphs. The patients were instructed to read these words three times. The second part of the recording included the sustained vowel [a] at 60, 70, 80, and 90 dBA. Sound levels were measured with a sound level meter placed 40 cm from the lips of the subjects. The meter was a Radio Shack SPL meter, model number 33-2055, set to frequency weighting (A) and time weighting slow.

Recording was carried out with a head-mounted condenser microphone (AKG, C444) placed 4 cm from the lips and a disk player (iRiver 140) with a sampling rate of 44.1 kHz. The recordings were later transferred to a personal computer and stored on the hard drive in digital format. Voice recordings were always carried out 5 min before and after exposure.

An otolaryngologist assessed ENT status before exposure to the placebo and organic dust and within 15 minutes after exposure. The otolaryngologist assessed the findings of the mirror laryngoscopy as well as nasal mucosal secretions. Nasal mucosal reactions were scored according to the scoring criteria of Hytönen et al. (84). We recorded asthmatic reactions upon exposure to the organic dust and placebo and measured peak expiratory flow (PEF) and FEV1 15 min before the challenge and repeatedly thereafter until completion of the voice recordings. In these immediate reactions, changes of 15% were considered diagnostic of asthmatic reaction.

Acoustical analysis with GIF was carried out for voices recorded before and after exposure to placebo and the organic dust substances using TKK Aparat, a program developed for semiautomatic inverse filtering (85). Calculation of the GIF parameters included time-based and frequency-based parameters. The calculation of various parameters required the determination of critical time-instants from glottal flows and their derivatives, as described in Figure 6 and Equations 2–10 in the study by Airas (85) (pp 55-56). Vocal Tract cross-sectional Planes (VTPs), estimated with Aparat, represent the cross-sectional area of the vocal tract along the axis from the vocal folds to the lips.

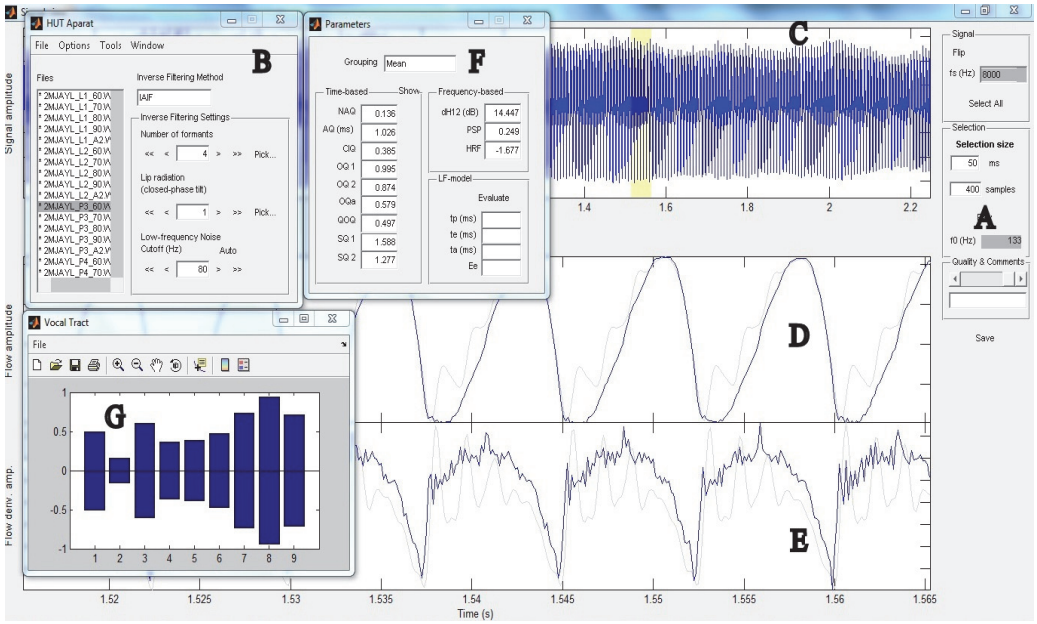


**Figure 5.** Screen shot from Aparat, taken by this thesis author, showing its most important functions. A: The manual selection of the length of the sample and sampling frequency. B: The manual selection of the number of formants as well as the lip radiation and cut-off frequency of the sample. C: The audio signal. D: The glottal waveform. E: The derivative of the inverse-filtered sample. F: The GIF parameters. G: A mathematical representation of the vocal tract developed from the analyzed audio signal.

## 4.2 STUDY III

A review of the children's hospital records from the Hospital District of Helsinki and Uusimaa revealed that 17 children underwent laryngotracheal reconstruction in the period from 1 January 1990 through 31 December 2005. After excluding children with permanent tracheostomies and one child who died after surgery, 13 were invited to participate in the study. Of these children, 10 chose to participate; all the participants were boys, and five of them had undergone laryngeal reconstruction in the form of a cricoid split with grafting. Three children suffered from asthma, seven suffered from language and speech disorders, and five had concomitant congenital anomalies such as ventricular septal defect, undescended testicles, fallot tetralogy, or VATER association. Ear, nose and throat surgeries were relatively common among the participants. Each child had a control of similar age and gender. The control group comprised the children of the staff at the ENT Hospital of the University of Helsinki. The subjects were divided into two groups: one ranging from 2 to 11 years, and the other from 12 to 15 years. This

division was based on the HRQoL questionnaires and on their agreement with the ages of the subjects. HRQoL was assessed by the 16D instrument in the older subgroup, and the 17D instrument in the younger subgroup (86,87) since they are generic questionnaires that represent multidimensional, standardized, sensitive, self-administered measures of HRQoL. Both questionnaires appear in Appendix C in Finnish and English.

In addition, voice-related quality of life was measured by two questionnaires: the Paediatric Voice Outcomes Survey (PVOS) and the Paediatric Voice-Related Quality of Life survey (PVRQoL) (88,89). The main difference between them is that the PVOS is a four-item survey designed to measure PVRQoL, whereas the PVRQoL survey is a more detailed ten-item survey adapted from the adult VRQoL survey. Both were translated into Finnish and back into English by certified translators. The Finnish and English versions of the PVOS and PVRQoL surveys appear in Appendices D & E, respectively.

Voice samples were recorded from each child in the study and from the control groups, with the exception of one child who had Down syndrome and no vocabulary at the time of data collection. The voice samples included a reading sample consisting of 41 words or a spontaneous speech containing at least 41 words. Recordings were carried out using a portable hard-disk recorder (iRiver 140) with a sampling rate of 44.1 kHz. A head-mounted condenser microphone (AKG C444) was located on one side of the mouth at a distance of 3 cm from the lips. The distance was monitored by one of the researchers. The samples were transferred to a personal computer for editing. Two experienced voice therapists with more than five years' experience in treating voice disorders carried out the perceptual assessment. Voice clinicians used a VAS, which ranged from 0 to 100 and included the following six voice quality categories: 1. Voice is overstrained, 2. Voice is hoarse or husky, 3. Voice is weak/does not resonate, 4. Voice is tense or feeling the need to make effort when speaking, 5. Voice is creaky, 6. Voice breaks during speaking. The 16D scores were compared to those of the control children (n = 235) from a survey performed in various schools in the greater Helsinki area.

## 4.3 STUDY IV

A total of 186 kindergarten teachers from Helsinki and Tampere, two of the largest cities in Finland, volunteered for the study through an internet questionnaire. Altogether 119 of them were selected for videolaryngoscopy examination, which was carried out as a field examination. The selection criteria assumed that at least two or more subjects came from the same workplace.

All participants completed a questionnaire with four types of questions: background information, self-assessment of voice quality and voice use, voice symptoms and their severity in addition to working conditions that negatively

affect the voice. The questionnaire derives from previous ones used in different studies at the University of Tampere, Finland (15,80,90). In this study, more detailed questions about environmental issues were added to the questionnaire.

The second section of the questionnaire was dedicated to self-assessment of the teacher's own voice. It contained questions about voice quality, one's ability to project one's voice, a question about recovery from vocal fatigue, and a question about how kindergarten teachers' voices withstand occupational vocal loading.

**Figure 6.** Set-up of the portable videoendoscopy system in a playroom at one of the kindergartens in Tampere, Finland. The photo shows the portable recording system and the small space in which the examination took place. Photograph: Ahmed Geneid.

The third section included questions on what we called vocal fatigue symptoms, which include voice and throat symptoms that may lower a person's ability to cope with occupational and social vocal demands. This section included the following nine descriptors: (1) My voice gets strained. (2) My voice is hoarse without infection. (3) I have a lump or mucus in the throat. (4) I have irritation or tickle in the throat. (5) I have tiredness and/or pain in the throat or neck after speaking. (6) I have tiredness and/or pain in the throat or neck after singing. (7) I have voice breaks when I am talking. (8) I have had aphonia without infection. (9) After a working day my voice is so fatigued that it causes trouble in social life. The fourth and last section included questions about working conditions; the subjects were asked to estimate the possible negative impact of their working conditions on their voices. Further information on the previously mentioned sections and questions is available in Article IV. The questionnaire itself is available in Appendix F in both Finnish and English.

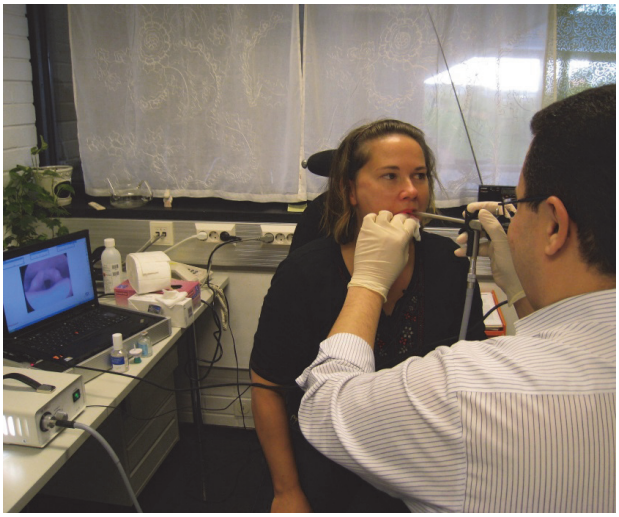

**Figure 7.** The set-up and use of portable videoendoscopy during a field examination. On the left side is the light source and the video-recording system. The photo shows the setting of the examination and the portable system. Permission obtained from individuals appearing in it. Photograph: Ahmed Geneid.

Altogether 119 kindergarten teachers underwent a laryngeal examination in the field with a mobile videolaryngoscopy unit (rpSzene-Mobile, Rehder/Partner GmbH, Germany). The system included a small 1/3" CCD camera (model rpCam250, Rehder/Partner) mounted with a 28- to 35-mm auto-focus zoom lens combined with a 70° laryngeal telescope (model 4450,47, Richard Wolf, Germany) and a cold halogen light source (model rp 150, Rehder/Partner). The recordings were carried out in the kindergarten using the mobile endoscopy system. The patient was asked to produce a sustained and intermittent [e:] before and after throat clearing. The author of this thesis completed and studied the recordings. Evaluation was performed using an endoscopic form that included the following items: (1) degree of interarytenoid edema, (2) degree and location of redness in the vocal folds, (3) thickness, location, adhesivity, and type of mucus on the vocal folds, (4) shape of the glottis during adduction, and (5) symmetry of adduction-abduction movement. Other deviations from normal were also noted.

Some of these above-mentioned items were further classified into subcategories. Thickness of the mucus layer was classified into three degrees: runny or even, moderately thick, and quite thick mucus. The location of the mucus was also classified into four categories: (1) uniform or not visible, (2) anterior third of the vocal folds or anterior commissure, (3) between the anterior and middle third of the vocal folds, or (4) in the posterior third of the vocal folds. This classification was carried out according to Hsiung (91). Mucus types were classified into either normally uniform or uneven mucus. Uneven mucus types were subdivided into three types according to Hsiao et al. (92): Type 1 is characterized by rough mucus on the surface of the vocal folds that may be sticky enough to form bridging threads between the vocal folds during abduction. Type 2 typically has tiny mucus

bubbles along the free margins of the vocal folds at the anterior commissure or at the junction between the anterior third and the posterior two thirds, resembling vocal fold nodules. Type 3 is characterized by mucus lumps that act as masses on the vocal folds. Adhesivity of the mucus to the vocal folds was assessed after throat clearing into one of three types: normal, moderately sticky, and sticky. The form used for assessment of endoscopic findings is in Appendix G.

# 5 STATISTICAL METHODS

In the studies of this thesis, SPSS (releases 13.0.1 to 18.0.0) served in statistical analysis of the data. Study I used ANOVA for repeated measurements. Study II used the Levene test for equality of variances and the independent samples t-test for equality of means to check for the effect of gender on the GIF values. Whenever the effect of gender was significant, a comparative analysis of the GIF values was performed using the Wilcoxon signed rank test at different SPLs separately for males and females. On the other hand, whenever the effect of gender was insignificant, a paired samples t-test was carried out at different SPLs together for males and females.

The Wilcoxon signed rank test served to statistically analyze the perceptual assessment of the voice samples recorded at 80 dBA because of the skewed distribution of the parameters. The Pearson correlation test served to evaluate the correlations between changes in the second VTP and changes in the subjects' assessments according to the VAS parameter scoring upon exposure to organic dust. The Pearson correlation test served to analyze the correlation of changes in GIF parameters and changes in the VAS parameter scores. Moreover, the Spearman correlation test served to calculate the interrater reliability in the GIF results.

In Study III, descriptive statistics served to describe the demographic characteristics of the study and control groups. Differences in HRQoL as well as in PVOS and PVRQoL surveys' results between the study and control groups were compared using the independent samples t-test. The perceptual assessment of the voice samples was studied with the Wilcoxon signed-rank test. In Study IV, relationships between the variables and between the results from the questionnaire and laryngoscopic methods were assessed with Spearman's rho.

# 6 RESULTS

## 6.1 STUDIES I & II: EFFECT OF ORGANIC DUST EXPOSURE ON VOICE AND THE DETECTION OF RESULTING INAUDIBLE VOCAL SYSTEM CHANGES THROUGH GIF

The aim of these two studies was to study the effects of organic dust exposure on the voice as a work-related risk factor for voice disorders and to define organic dust-related voice symptoms. These studies also aimed to investigate the acoustic features of the voice that represent changes that occur in voice quality upon exposure to organic dust by improving the application of GIF in studying these changes.

Seven of the subjects tested positive on the skin prick test. Of these, six tested positive on specific IgE tests. Five of the nine subjects developed an immediate-type asthmatic reaction during or immediately after exposure, and four of the subjects were classified as having occupational rhinitis. The different types of organic dusts tested appear in detail in Table 1 of Article I.

Exposure to organic dust resulted in significant changes in a number of voice and throat self-reported symptoms. The symptoms that changed significantly included feeling that the voice is hoarse or husky, feeling that the voice is weak or that it does not resonate, tense voice or needing effort when speaking, and difficulty in starting phonation. In addition, subjects had feelings of shortness of breath or the need to gasp for air. The voice clinicians' perceptual assessment of the reading samples revealed no statistically significant findings either upon exposure to organic dust or to the placebo. None of the subjects showed any recognized changes in mirror laryngoscopy after placebo or organic dust exposure.

GIF analysis was carried out for the recorded voice samples. The reading samples were analyzed for possible changes upon exposure to organic dust and placebo with no significant changes found. Analysis of sustained phonations of the vowel [a] revealed no significant changes in the F0 values. The paired samples t-test was calculated for the GIF parameters of the sustained vowel [a] recorded at different SPLs. The analysis revealed a number of significant changes upon exposure to organic dust that included a decreased SQ1 value at 70 dBA, an increased OQ1 at 80 dBA, an increased AQ at 90 dBA ($P < 0.05$), and an increased AQ at 80 dBA ($P < 0.01$). On the other hand, exposure to placebo resulted in a significant reduction in OQ2 at 80 dBA ($P < 0.05$). Interestingly, OQ1 showed an overall increase upon exposure to organic dust and an overall decrease upon exposure to placebo at all dBA levels. OQ2 showed a similar trend, with the exception of exposure to placebo at 90 dBA. Perceptual assessment of sustained phonation of the vowel [a]

recorded at 80 dBA was carried out because of the interest in these changes in OQ1. The analysis revealed no significant changes in perceptual voice quality upon exposure to organic dust at 80 dBA. Interestingly, statistically significant changes occurred upon exposure to placebo at the same dBA. The voice generally became better, less hoarse, and less breathy after exposure to placebo.

Interest in the changes detected at 80 dBA led to thinking about extracting the VTPs from the sustained phonation samples. The samples chosen were recorded at 80 dBA. We chose this specific dBA because it showed significant increasing changes in OQ1 upon exposure to organic dust and an overall trend toward a decrease upon exposure to placebo. This comes in addition to the perceptual voice changes noted above. We found that changes in the measurements of second VTP from before to after exposure to organic dust correlated with changes in the subjects' vocal symptoms in the following two parameters: the parameter of feeling that the voice is tense or feeling the need to make an effort when speaking correlated inversely (0.743; $P < 0.05$) with changes in the second VTP. The parameter of feeling short of breath or the need to gasp for air also correlated inversely (0.844; $P < 0.01$) with changes in the second VTP. The correlation of the second VTP with the GIF parameters revealed no significant findings. Correlating the GIF parameters of the vowel [a] at 80 dBA with the VAS parameters of the symptoms recorded before and after exposure to organic dust revealed a number of significant relationships. F0 correlated inversely with the feeling of a lump in the throat and the feeling of mucus in the throat and/or the need to clear one's throat frequently. NAQ correlated inversely with the feeling of shortness of breath or the need to gasp for air. OQa correlated inversely with the parameter of feeling mucus in the throat and/or the need to clear the throat frequently in addition to the voice breaking while speaking. SQ1 correlated inversely with the feeling of difficulty to start phonation.

## 6.2 STUDY III: EFFECTS OF LARYNGEAL RECONSTRUCTION ON THE VOICE AND VOICE-RELATED QUALITY OF LIFE

This study aimed to determine the quality of life and voice of children who underwent laryngeal surgeries in their infancy or early childhood and to deepen our understanding of the effects of these operations on the voice later in life. Ten children and adolescents eligible for the study agreed to participate. By calculating the total 16D score, we found that the study group had a lower score (0.936) than did the control group (0.989); the population controls had a score of 0.949. This difference was not statistically significant, meaning that the children in the study group had no worse health-related quality of life than did children in the control group or in the population controls. Two dimensions showed greater, though still insignificant, differences between the study group, on the one hand, and the control group and population controls on the other. On the dimensions of

elimination and speech, the study group obviously scored lower than did the control group and the population controls.

Five children were eligible for the 17D questionnaires, but one of them had Down syndrome; with no vocabulary at the time of data collection, this child had significantly lower scores than did the other four children of the study group. Consequently, his score was excluded along with that of his control. The score of the study group was 0.902, and of the control group, 0.969. The difference between them, however, was not statistically significant.

PVRQoL was checked by both the PVOS and PVRQoL surveys. Statistical analysis revealed a significant difference only with the PVOS, suggesting that voice-related quality of life was poorer among children in the study group than among those in the control group. The study group had a mean of 85.6, whereas the mean of the control group was 96.9. The perceptual assessment of voice quality showed that the study group had worse voice quality (higher scores) on the following voice quality categories: 1. Voice is overstrained, 2. Voice is hoarse or husky, and 3. Voice is weak/does not resonate.

## 6.3 STUDY IV: VOICE AND LARYNGEAL FINDINGS AMONG KINDERGARTEN TEACHERS

This study aimed to investigate the voice and throat symptoms of kindergarten teachers, their recovery from vocal fatigue, and any vocally loading environmental risk factors. In addition, the study aimed to explore the relationship between these symptoms and organic findings detected in the laryngeal examination. The subjects of the study evaluated their voice quality; 78% of them evaluated their voice quality as good, fairly good or excellent. The same number reported that their voice withstood vocal loading fairly well, well or remarkably well. Altogether 86% reported that their voice got tired during the workday, but recovered well by the following workday; 62% had some kind of voice education.

The mean of the score calculated from the prevalence/severity section of the vocal fatigue symptoms was 51 (range 1-120, SD 26). Only 6% of the participants reported no symptoms of vocal fatigue. The weekly frequency of vocal fatigue symptoms were 28.6%, 21%, and 10.1%, respectively, for ≥ 1, ≥ 2 and ≥ 5 symptoms. These percentages increased to 74.8%, 63.9%, and 47.1%, for symptoms that occurred monthly or more often.

The mean score obtained from the section on the negative impact of working conditions on voice was 100 (range 53-168, SD 23). Noise in the workplace was the most detrimental, especially the activity noise produced by children. More than 73% of the subjects estimated the noisiness to affect their voices much or very much. Laryngeal examination revealed that 13 (10.9%) of the subjects had

organic findings at the time of examination. Such organic findings included vocal fold nodules in 6 teachers, restricted abduction-adduction movement of the vocal folds in 4, bowing of the vocal folds in 3, of whom 1 also had limited vocal fold movement, and contact granuloma in 1. A total of 36 subjects had interarytenoid edema, 28 of whom had no accompanying organic findings. Adding these 28 subjects to the number of pathological cases would have increased the percentage of subjects with organic findings to 34.4%. Other minor findings included 12 subjects with mild redness in their vocal folds. Mucus presentation on the vocal folds was also classified into even and uneven mucous; 43% of the subjects had an even mucus layer. Those with uneven mucus were divided into two groups. 49.6% had moderately thick mucus, and 6.7% had quite thick mucus.

The correlation between background information (e.g. age, working experience, size of group, and vocal education) and vocal symptoms, self-assessment of voice and working conditions revealed no significance. A relatively moderate, but still significant, correlation emerged between self-assessed voice symptoms and self-assessments of the negative impact of working conditions. “Vocalizing time”, one of the seven categories of working conditions affecting the voice, included a five-step scale from “not at all” to “too much” of the following categories: reading aloud, singing at work, oral teaching, use of a loud voice, and total speaking time during the workday. “Vocalizing time” correlated with the total of voice symptoms ($rho = 0.56$, $p = 0.01$). In addition, it was noted that the variable “hoarseness without infection” from the category of voice symptoms also correlated with the total of the variable “vocalizing time” ($rho = 0.53$, $p = 0.01$). The findings of the laryngeal examination showed no correlation with the subjective voice symptoms. Moreover, they showed no correlation with any of the parameters reported in the questionnaire.

# 7 DISCUSSION

The motivation for this study has been the growing number of voice patients from a number of new risk groups. Voice clinicians are accustomed to teachers and singers comprising the bulk of their patients, but new patient groups are emerging and drawing attention to their rather different vocal symptoms. The fact that some of their vocal symptoms are rather inaudible is not new in the field of voice research. Examining those inaudible symptoms acoustically, however, is new. Nevertheless, examining kindergarten teachers on a broader level than previous studies have, and in their workplaces, offers a new perspective on their voice problems. Additionally, to date no one has examined children who have undergone surgery due to subglottic stenosis for the effects of laryngeal surgeries on their HRQoL and VRQoL or their long-term effects on the voice.

Accordingly, this thesis covers three high-risk groups: workers with susceptibility to work-related voice disorders other than vocal abuse, the most common cause of work-related voice disorders, children who underwent surgery in early infancy due to subglottic stenosis, and kindergarten teachers, whose voice problems receive less attention than do the voice problems of school teachers.

## 7.1 STUDIES I & II: EFFECT OF ORGANIC DUST EXPOSURE ON VOICE AND THE DETECTION OF RESULTING INAUDIBLE VOCAL SYSTEM CHANGES THROUGH GIF

*The voice changed according to the self-assessment of the patients, but not according to the perceptual assessment*

This study revealed that a number of voice and throat symptoms changed significantly upon exposure to organic dust. Such changes went undetected, however, during the perceptual assessment carried out for the recorded voice samples. The symptoms that changed significantly included feeling shortness of breath and/or the need to gasp for air, weak voice that does not resonate, tense voice or effortful phonation, difficulty starting phonation, and hoarse or husky voice. In our study, seven of the subjects tested positive on the skin prick test, and six of the seven subjects tested had positive specific IgE tests. This result is in line with those of a study by Sala et al. (61) in which patients with allergic laryngitis, upon exposure to flours or plants, tested positive on skin prick tests. In addition, 11 of the 13 patients who tested positive on the skin prick tests had elevated levels of IgE antibodies to the same agent. Personal communication with the author revealed that, after undergoing the provocation tests, many of the patients examined at the institute had varying cases of dysphonia. Allergic laryngitis is defined as a voice disorder that is 1) associated with exposure to a certain agent, 2)

has symptoms and signs associated with exposure, 3) shows signs of specific hypersensitivity demonstrated by either skin prick tests or IgE blood tests, and 4) is reproducible in exposure tests (61). Symptoms include those of the vocal system, whether audible or inaudible. Signs can appear in the form of either minimal erythema or edema of the vocal folds or changes in the acoustic parameters from pre- to post-exposure.

Changes detected in the voice and throat symptoms in our study may have resulted from allergic or non-allergic reactions. Non-allergic reactions can be mechanical resulting from coughing or throat clearing during the experiment. The physical qualities of the dust may also have altered the vibrations of the vocal folds. Organic dust may have led to dryness of the vocal folds or irritated the mucus membranes, causing a discrepancy in the mucosal wave symmetry, thus resulting in the reported changes in vocal symptoms. These changes may also have stemmed from allergic reactions of the larynx or from combined allergic and non-allergic reactions. The notion that an allergic mechanism is the cause of the changes or at least of most of them is more likely than the mechanical mechanism. Coughing and throat clearing cannot explain the difficulty in starting phonation. If we take into account the results of recent studies of the effects of allergy on the voice, allergy remains as a solid explanation for these changes. Allergy may also cause excessive mucous and edema of the vocal folds. Such mucous, which is heavier than in persons without allergy, causes discrepancies in the symmetry of the mucosal wave (93). Such resultant asymmetry causes both perceptual and acoustical changes in voice quality. Nevertheless, such asymmetry is usually accompanied by the need for throat clearing and coughing.

At the histochemical level, Ishida et al. (94) found that the human laryngeal mucosa is capable of inducing allergic reactions. On a broader level, the effect of allergy on the voice is thought to originate from edema of the respiratory tract and a possible association with allergic rhinitis (93). While allergic rhinitis means that the allergic reaction occurred in the nose and paranasal sinuses, allergic rhinitis may still be associated with allergic reactions in nearby organs also. Allergy may also be the etiology behind vocal symptoms and even behind signs diagnosed as Laryngopharyngeal reflux (95). In addition, another study showed that singers with more vocal symptoms suffer from more allergic diseases than do singers with no vocal complaints (96). Roth and colleagues also documented a causal relationship between allergy and dysphonia in the absence of sinus or lower airway allergic responses (97). A study by Simberg et al. found that university students with confirmed respiratory allergies exhibit more frequently occurring vocal symptoms than do students with no known allergy. They also found that when allergies have been treated, the vocal symptoms decreased (98). The same notion that allergy is the main mechanism behind such changes seems more feasible when we take into consideration that some of the VAS symptoms that changed significantly in this study also changed in other studies on allergic subjects. Jackson-Menaldi et al. recorded findings of dysphonia among 15 allergic

patients (93). Dixon (99) reported similar findings where difficulty initiating phonation and intermittent dysphonia proved to be associated with delayed food allergy. In his study, the perceptual assessment found no significant changes. A recent review of laryngeal allergy concluded that although the literature has focused little attention upon the relationship between allergy and voice, the evidence is nevertheless growing. The authors called for further investigations into the underlying inflammatory mechanisms mediating the laryngeal response to allergy (100).

In our study, the perceptual assessment found no significant findings, most likely because the allergic tissue reactions were so mild that they provoked only inaudible symptoms and some acoustic changes in the voice that went perceptually unnoticed. Accordingly, this is an occupational risk group reporting voice and throat symptoms that are felt and heard more by the patients themselves than by others. This work-related voice disorder probably results from exposure to substances in the work environment and not from vocal loading.

*Acoustic analysis reporting perceptually undetected changes in voice.*

In this study, we used GIF to detect changes reported by patients that went unnoticed in the perceptual assessment. The GIF of acoustic signals offers a number of advantages and disadvantages. Among its advantages is that it is non-invasive, requires only a short audio signal, and goes straight to the origin of the voice signal. On the other hand, its disadvantages are that when the GIF input is the speech pressure wave that has been recorded without the flow mask, it estimates only the alternating current (AC) and not the direct current (DC). GIF is also easily affected by perturbations in the voice and background noise. Still, GIF remains an excellent non-invasive method of acoustic analysis of the voice.

GIF revealed that exposure to organic dust caused significant changes in a number of GIF parameters. These changes either did not occur or occurred in the opposite direction upon exposure to placebo. Table 1 summarizes the changes and the significances of the GIF parameters that changed. Changes in OQ1 point towards more breathiness in the voice after exposure to organic dust and towards less breathiness after placebo. F0 changes were not the reason behind the changes that occurred in OQ1 values. F0 nearly decreased at most of the dBA levels, it was expected to increase with the rising OQ parameter values (101). The overall reduction in OQ1 and OQ2 values upon exposure to placebo may be due to the water solubility of lactose. This solubility may have improved the mucosal wave of the vocal folds during vibrations by reducing the viscosity of the covering mucous. Interestingly, perceptual assessment of the voice samples containing the sustained vowel [a] recorded before and after exposure to organic dust revealed no changes. However, perceptual assessment of the voice samples recorded before and after

exposure to placebo showed that the voice changed significantly and became generally better, less rough, and less breathy after exposure to placebo. Such a finding fits with the changes in GIF parameters. It should be noted, however, that we used a novel modified form of the GRBAS scale to perceptually assess the sustained vowel [a] samples because we aimed to detect the direction in which the voice changed.

**Table 1.** Summary of the most important changes in GIF parameters upon exposure to organic dust and placebo.

| Parameter changed | Type of exposure | Type of change | Meaning |
|---|---|---|---|
| **OQ1** | Organic dust | Significant increase at 80 dBA and overall increase at other levels. | OQ1 describes voice quality along the breathy-pressed axis (102,103). Accordingly, the voice became breathier after exposure to organic dust, whereas its breathiness decreased after exposure to placebo. |
| | Placebo | Overall trend to decrease. | |
| **AQ** | Organic dust | Significant increase | AQ decrease with phonation shifting from breathy to pressed (104); in this study, the opposite occurred. Voice breathiness increased significantly after exposure to organic dust. However, the overall tendency to increase on exposure to placebo precluded developing a hypothesis on this GIF parameter. |
| | Placebo | Overall tendency to increase, not significant | |

*Acoustic analysis, self-assessment questionnaires and perceptual assessment; which to use?*

In this study, the subjects assessed their own voices on VAS scales. In addition, voice clinicians acoustically analyzed their voices and perceptually assessed the voice samples collected. This study showed that the subjects indeed noticed changes in their voices that went largely unnoticed in the perceptual assessment carried out by the voice clinicians. At the same time, acoustic analysis did confirm the subjects' self-reported changes. In this context, it is possible to distinguish the role of each of the above-mentioned voice assessment methods. The subjects' own assessment of their voice symptoms remains the best way to subjectively describe the changes in the voice and laryngeal symptoms of the patients with work-related

voice disorders (105). Nevertheless, self-assessment of one's voice is an excellent method for patients to assess the improvement or worsening of their own symptoms. Perceptual assessment of voice is limited by the severity of the changes in the voice. In other words, subtle voice symptoms or inaudible throat symptoms can benefit little from perceptual assessment of the voice. Accordingly, a survey of the symptoms seems to be more sensitive than the perceptual assessment of voice quality in identifying possible changes due to exposure.

Acoustic analysis of the voice also has its limitations, mainly the absence of normative values upon which voices can classified into normal and abnormal or dysphonic voice. Despite its limitations, as this study shows, acoustic analysis of the voice is reliable when the subject is acting as her own control, meaning when the subject's voice is recorded before and after exposure to a certain influencing factor. This reliability remains regardless of whether the factor is vocal loading, exposure to an irritant, voice therapy, or surgery. Accordingly, each of these methods has its own benefit in the assessment of patients' voices. Acoustic analysis remains an important tool in assessing the voice and is most helpful and reliable when used to follow up on changes in the voice or when assessing changes in the voice due to imposed stresses. Acoustic analysis is also useful in medico-legal problems, such as assessing work-related voice disorders and working abilities. Acoustic analysis provides voice clinicians with a rare objective measure of the voice that is more appealing to insurance companies and social authorities. The use of acoustic analysis in this context is quite reliable, especially when the voice is assessed before and after exposure to the agent that is causing the reduction in working ability. In this context, it is also important to control for voice level in order to avoid its effect on other acoustic parameters of the voice.

*A compensation mechanism?*

The changes in the measurement of the second VTP after exposure to organic dust and its inverse correlation with two inaudible voice and throat symptoms are noteworthy. This study reported a number of voice and throat symptoms that, according to the patients, changed despite remaining undetected in the perceptual assessment. At the same time, GIF analysis revealed a number of significant changes, which agrees with the patients' self-reported changes. Such findings raise the possibility that we are able to compensate for changes in our phonation system in a way that retains the quality of our voice as perceived by others (Figure 8), perhaps by the vocal tract compensating for changes in the larynx itself. Alternatively, the vocal tract itself may react on exposure to organic dust in a way that alleviates the effects of changes in the larynx.

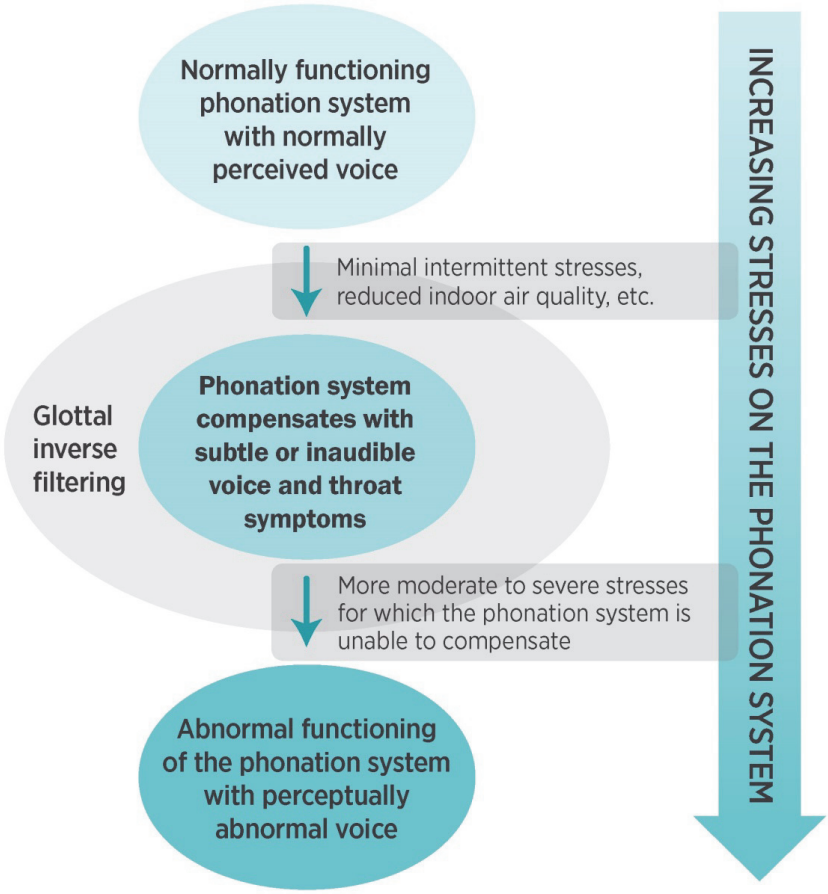


**Figure 8.** The stepwise process of the phonation system reactions under different stresses with the role of inverse filtering in detecting its changes.

## 7.2 STUDY III: EFFECTS OF LARYNGEAL RECONSTRUCTION ON THE VOICE AND VOICE-RELATED QUALITY OF LIFE

The motivation for studying this risk group stems from the absence of previous studies of the long-term effects of surgeries performed on them. All of the previous studies focused on the complications, failures and mortality rate of the

surgeries. Of the 13 children eligible, 10 participated in this study. Given the limitations on participation in this study (some participants came from other cities, yet received no compensation), a response rate of 77% is acceptable. In this study, analysis of the 17D and 16D scores revealed no significant differences, possibly because of the relatively small number of subjects. Nevertheless, it may indeed provide a true representation of the children's normal HRQoL.

Two dimensions showed a greater, but not significant, discrepancy in the 16D scores. The difference in the elimination and speech dimensions, however, is noteworthy, and may stem (as the authors hypothesized) from the change in the subglottal volume resulting from the surgery. In other words, an abnormal volume of the subglottic area with lower subglottal pressure may have led to the inability to build sufficient subglottal pressure to perform the above-mentioned functions easily.

On the other hand, the scores from the PVOS indicate that voice-related quality of life was significantly lower for the study group. Similarly, a previous study that tested the Paediatric Voice Handicap Index (pVHI) on children before and after laryngeal reconstruction children found that they scored lower than did their controls (106). PVOS seems to be more robust and easily applicable to younger children than is PVRQoL survey. A question such as "My child has trouble using the telephone or speaking with friends in person" (one of the questions on the PVRQoL survey) is inapplicable to the very young children in our study. The voices of the children who underwent laryngeal reconstruction were perceptually worse than those of their normally developed peers on the following three parameters: 1. Voice is overstrained, 2. Voice is hoarse or husky, and 3. Voice is weak/does not resonate.

These findings of the long-term effects are similar to the findings of studies of the short-term effects on vocal quality carried out in the 1990s (71,107). These studies concluded that vocal quality is generally disturbed for those who have undergone surgery. It should be noted, however, that this study included a control group and blinded perceptual assessment, in contrast to previous studies. Nevertheless, we studied long-term rather than short-term effects. One study (108) published in 2009 examined the long-term voice outcomes of partial cricotracheal resection in children with severe subglottic stenosis. Partial cricotracheal resection involves a different surgical technique from that used in Cotton Plasty. Among the 77 patients studied, 18% had a normal voice, 64% had mild dysphonia (described as a hoarse voice with some difficulty being heard or understood in loud environments), 13% had moderate dysphonia (weak voice or ventricular band phonation with easy fatigability), and 5% had severe dysphonia (breathy voice with difficulty communicating). The results of this thesis point to similar long-term adverse effects on the voice from this surgery or from the combined effect of subglottic stenosis and this surgery performed as a treatment. The effects in this situation are similar, if not worse. Overall, this study contributes to the study of

the long-term effects of operations performed to treat subglottic stenosis in infants.

## 7.3 STUDY IV: VOICE AND LARYNGEAL FINDINGS AMONG KINDERGARTEN TEACHERS

The motivation for studying this risk group was the comparative lack of studies that address their voice symptoms and laryngeal findings, especially in field examinations. In the present study, 21% of the subjects exhibited weekly two or more of the nine symptoms defined as vocal fatigue. Previous studies reported higher percentages ranging from 32% to 37% among kindergarten and school teachers (80,81,109). Voice education, which more than half of our subjects received, may have been the reason for the much lower percentage reported previously (110). In the present study, 86% of the subjects reported that they recovered well from vocal fatigue by the next workday. This finding agrees with the results of one study (111) in which teachers recovered 90% within 12–18 h after vocal loading. Vocal strain results in microtraumas of the vocal folds. Such microtraumas and different phases of repair and growth are evident histologically in the vocal folds with various hypothesized mechanisms of injury (112,113).

In this study, we carried out laryngeal examinations in the teachers' workplaces. We excluded cases with interarytenoid edema or mild redness of the vocal folds as an organic finding in the larynx. The exclusion of subjects with those two findings may have lowered the percentage of organic changes in the vocal folds of our subjects below that in previous studies with a different methodology. Our study revealed that 11% of the teachers in kindergartens had organic changes. When Sala et al. (81) used only a laryngeal mirror during examinations in workplaces, the percentage was 29%. In another study in which 80% of the subjects were examined with a rigid laryngoscope and the rest with a laryngeal mirror, the percentage was 14% (80). Examination with a rigid endoscope most likely adds to the accuracy and sensitivity of detection of organic findings. Adding subjects with interarytenoid edema would have raised the percentage of organic findings to 34.4%. Laryngeal examination revealed vocal fold nodules, limitation of movement, and bowing of the vocal folds to be the main organic findings. A study by Niebudek-Bogusz et al. (114) also pointed to the frequency of vocal fold nodules and bowing of the vocal folds among laryngeal organic findings in teachers, but their study included teachers with previously reported voice problems. Teachers with laryngeal organic findings had no worse self-assessment of voice symptoms than did teachers without such findings. Only two of the subjects with organic findings had low scores on the self-assessment of voice symptoms. This is nothing new in terms of teachers (80) or in terms of voice patients in general. Voice and throat symptoms correlate only slightly with findings of laryngeal examination. Perhaps when the subject is aware of subtle changes in the voice, he or she attempts to avoid overloading it. In other words, perhaps the subject who is less

aware of such changes does not react and thus paves the way for organic changes to take place.

In the subjects' own estimation of the negative impact of the working environment on their voice, noise was the most detrimental. This result agrees with the results of earlier studies (72,77,80) in which estimated noise was the most harmful to teachers' voices. In the presence of noise, the Lombard effect causes the speaker to automatically raise his or her voice level, F0 and voice strain, thus increasing the strain on his or her voice and impairing comfortable voice production. Reducing noise in kindergartens is the main strategy in avoiding voice strain among kindergarten teachers. The negative impact of working conditions showed a moderate correlation with self-evaluation of voice symptoms. Those aware of their voice problems may also have been aware of the negative impact of their work on it.

This study, which relies on its methodology, provided the most accurate up-to-date figures on organic findings among kindergarten teachers. In addition, the results of the questionnaire provide a valuable contribution to the research on voice problems among kindergarten teachers.

# 8 CONCLUSIONS

1. Workers in bakeries, mills, factories, and other workplaces where organic dust exposure occurs are susceptible to a work-related voice disorder. Such a voice disorder appears as symptoms felt and reported by the subjects themselves rather than as ones perceived by others.

2. The phonation system may be capable of compensating for minimal stresses to maintain the quality of its end product, the voice, and the vocal tract may play an important role in such compensation. GIF proved useful in detecting changes in voice and throat symptoms, including inaudible changes.

3. Although children and teenagers who underwent corrective surgery for subglottic stenosis in early infancy exhibit a normal health-related quality of life, they nevertheless exhibit a lower pediatric voice-related quality of life than their peers. Moreover, the perceptual quality of their voices is also poorer than that of their peers.

4. Vocal fatigue symptoms are common among kindergarten teachers, most of whom recover from vocal fatigue by the following day. Laryngeal organic findings show no correlation with self-assessment of voice.

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# APPENDICES

Appendix A: Visual Analogue Scale (VAS)
Appendix B: Modified scale for perceptual analysis of voice; a measure of the overall Grade, Roughness, Breathiness, Asthenia and Strain of voice (GRBAS)
Appendix C: The 16-dimensional (16D) and 17-dimensional (17D) instruments
Appendix D: Pediatric Voice Outcomes Survey (PVOS)
Appendix E: Pediatric Voice-Related Quality of Life survey (PVRQoL survey)
Appendix F: Questionnaire used in Article IV
Appendix G: Form used for assessment of endoscopic findings

## APPENDIX A

**English version of VAS, translated by the author**.

Exposure test code ----------

Date ----------

VOICE SYMPTOMS QUESTIONNAIRE

Reply to the statements below by placing a mark depicting how much you feel the symptom

Example.
My voice is overstrained
0_____x_____100
Not at all Very much

1. My voice is overstrained.
0_____100
Not at all Very much

2. My voice is hoarse or husky.
0_____100
Not at all Very much

3. I feel like I have a lump in my throat.
0_____100
Not at all Very much

4. I feel like I have a choker around my neck.
0_____100
Not at all Very much

5. I have a feeling of mucus in my throat and/or I need to clear my throat frequently.
0_____100
Not at all Very much

6. My throat is dry and/or itchy.
0_____100
Not at all Very much

7. My voice is weak/my voice does not resonate.

0_____100

Not at all Very much

8. My voice is tense or I feel I must make an effort to speak.

0_____100

Not at all Very much

9. My voice is creaky.

0_____100

Not at all Very much

10. My voice often breaks when I speak.

0_____100

Not at all Very much

11. I feel short of breath/I need to gasp for air

0_____100

Not at all Very much

12. I feel difficulty in starting phonation.

0_____100

Not at all Very much

**Finnish version of VAS**

Äänitutkimuksen koodi ----------

Päivämäärä ----------

ÄÄNIOIREKYSELY

Vastaa väittämiin merkitsemällä janalla kuinka paljon kysyttyä oiretta tunnet

Esim.
Ääneni on rasittunut.
0_____x_____100
Ei lainkaan Hyvin paljon

1. Ääneni on rasittunut.
0_____100
Ei lainkaan Hyvin paljon

2. Ääneni on käheä tai karhea.
0_____100
Ei lainkaan Hyvin paljon

3. Minulla on palan tunnetta kurkussani.
0_____100
Ei lainkaan Hyvin paljon

4. Minusta tuntuu kuin panta puristaisi kaulaani.
0_____100
Ei lainkaan Hyvin paljon

5. Minulla on liman tunnetta kurkussa ja/tai minun täytyy selvitellä kurkkuani.
0_____100
Ei lainkaan Hyvin paljon

6. Kurkkuani kuivaa ja/tai kutisee.
0_____100
Ei lainkaan Hyvin paljon

7. Ääneni tuntuu hennolta/heikolta/ei soi.
0_____100
Ei lainkaan Hyvin paljon

8. Ääneni on kireä tai minulla on ponnistelun tunne puhuessani.

0_____100

Ei lainkaan Hyvin paljon

9. Ääneni narisee.

0_____100

Ei lainkaan Hyvin paljon

10. Ääneni katkeilee tai pettää puhuessani.

0_____100

Ei lainkaan Hyvin paljon

11. Tuntuu kuin ilma loppuisi / minun täytyy haukkoa ilmaa.

0_____100

Ei lainkaan Hyvin paljon

12. Äänentuoton aloittaminen on vaikeaa

0_____100

Ei lainkaan Hyvin paljon

## APPENDIX B

**English version of the modified GRBAS scale, translated by the author.**

Which is generally worse?

□ A □ B □ The same

Which is rougher?

□ A □ B □ The same

Which is breathier?

□ A □ B □ The same

Which is more strained?

□ A □ B □ The same

**Finnish version of the modified GRBAS scale**

Kumpi on yleisesti huonompi?

□ A □ B □ Sama

Kumpi on karheampi?

□ A □ B □ Sama

Kumpi on vuotavampi?

□ A □ B □ Sama

Kumpi on puristeisempi?

□ A □ B □ Sama

## APPENDIX C

**English version of the 16D, printed with permission.**

QUALITY OF LIFE QUESTIONNAIRE (16D©)

Instructions*:*
This questionnaire is all about how you are right now. Please, read the questions carefully. Each question has five answers to choose from. Choose the answer that is closest to the way you are today and mark it with a cross (X).

Question 1
( ) I feel healthy and energetic
( ) I feel slightly weary, tired or weak
( ) I feel moderately weary, tired or weak
( ) I feel very weary, tired or weak
( ) I feel extremely weary, tired or weak

Question 2
( ) I can easily see words in books and TV text without glasses
( ) I can easily see words in books and TV text with glasses
( ) I cannot easily see words in books and TV text, even with glasses
( ) I cannot read books and TV text, even with glasses, but I can see well enough to walk without a guide
( ) I cannot see well enough to walk without a guide, i.e. I am almost or totally blind

Question 3
( ) I do not have any breathing problems
( ) I get breathless during heavy work or sports, or when walking fast on flat ground or slightly uphill (not the same as being out of breath after running)
( ) I get breathless when walking on flat ground
( ) I get breathless even with the lightest activity, e.g. washing or dressing myself
( ) I am breathless almost all the time, even when resting

Question 4
( ) I do not feel at all anxious, stressed or nervous
( ) I feel slightly anxious, stressed or nervous
( ) I feel moderately anxious, stressed or nervous
( ) I feel very anxious, stressed or nervous
( ) I feel extremely anxious, stressed or nervous

Question 5
( ) I hear normal speech well without a hearing aid
( ) I hear normal speech with slight difficulty, but I don't need a hearing aid

( ) I need a hearing aid, but I can hear well with it
( ) I hear poorly even with a hearing aid
( ) I am totally deaf

Question 6
( ) I have no problems with sleeping
( ) I have slight problems with sleeping, e.g. it is sometimes difficult to fall asleep, or I sometimes wake up at night
( ) I have moderate problems with sleeping, e.g. restless sleep, or feeling I have not slept enough
( ) I have great problems with sleeping, e.g. I have to take sleeping pills often or every night, or I usually wake at night or too early in the morning
( ) I find sleeping almost impossible, even with full use of sleeping pills, or I stay awake most of the night

Question 7
( ) I am able to eat without any difficulty
( ) I am able to eat with slight difficulty (e.g. slowly, clumsily or with special appliances)
( ) I need some help from another person in eating
( ) I am not able to feed myself at all, so I must be fed by someone else
( ) I am unable to eat at all, so I must be fed by tube or directly into my blood

Question 8
( ) I have no physical troubles or symptoms, e.g. pain, ache, feeling sick or itchy
( ) I have slight physical troubles or symptoms, e.g. pain, ache, feeling sick or itchy
( ) I have moderate physical troubles or symptoms, e.g. pain, ache, feeling sick or itchy
( ) I have severe physical troubles or symptoms, e.g. pain, ache, feeling sick or itchy
( ) I have unbearable physical troubles or symptoms, e.g. pain, ache, feeling sick or itchy

Question 9
( ) I am able to speak clearly, audibly and fluently
( ) I have slight difficulties with speaking, e.g. I sometimes stumble over words, or mumble, or my voice breaks
( ) I can make myself understood, but my speech is e.g. disjointed, faltering, stuttering or stammering.
( ) Most people have great difficulty understanding my speech
( ) I can only make myself understood by gestures

Question 10
( ) My weight, height and what I look like do not bother me
( ) My weight, height or what I look like bother me slightly
( ) My weight, height or what I look like bother me moderately
( ) My weight, height or what I look like bother me seriously
( ) My weight, height or what I look like bother me extremely

Question 11

( ) My state of health does not interfere with going to school or having hobbies
( ) My state of health makes it slightly difficult to go to school or have hobbies
( ) My state of health makes it moderately difficult to go to school or have hobbies
( ) My state of health makes it almost impossible to go to school or have hobbies
( ) My state of health makes it impossible to go to school or have hobbies

Question 12

( ) I can walk easily without an appliance (e.g. crutches or wheelchair)
( ) I have difficulty in walking, but I am able to walk without an appliance, e.g. crutches or wheelchair
( ) I cannot walk without an appliance, e.g. crutches or wheelchair, but with it I can move around well
( ) Moving around is very difficult, even with an appliance
( ) I cannot move around at all and I am bedridden

Question 13

( ) My state of health does not interfere with making friends or being with them
( ) My state of health makes it slightly difficult to make friends or be with them
( ) My state of health makes it moderately difficult to make friends or be with them
( ) My state of health makes it almost impossible to make friends or be with them
( ) My state of health makes it impossible to make friends or be with them

Question 14

( ) I am able to think clearly and logically
( ) I have slight problems in thinking clearly and logically
( ) I have moderate problems in thinking clearly and logically
( ) I have serious problems in thinking clearly and logically
( ) I am totally confused and unsure of the time and where I am

Question 15

( ) My bladder and bowels work normally
( ) I have a slight problem with my bladder or bowels, e.g. difficulties with urination, or hard or loose stools
( ) I have moderate problems with my bladder or bowels, e.g. occasional accidents, or bad constipation or diarrhoea
( ) I have serious problems with my bladder or bowels, e.g. frequent ‘accidents’, or need for enemas or catheters
( ) I have no control at all over my bladder or bowel functions

Question 16

( ) I do not feel at all sad, melancholic or depressed
( ) I feel slightly sad, melancholic or depressed
( ) I feel moderately sad, melancholic or depressed
( ) I feel very sad, melancholic or depressed
( ) I feel extremely sad, melancholic or depressed

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**Finnish version of the 16D, printed with permission.**

TERVEYTEEN LIITTYVÄN ELÄMÄNLAADUN MITTARI (16D©)

Lue ensin läpi huolellisesti kunkin kysymyksen kaikki vastausvaihtoehdot. Merkitse sitten rasti (X) sen vaihtoehdon kohdalle, joka kuvaa parhaiten nykyistä terveydentilaasi. Tee näin kaikkien kysymysten 1-16 kohdalla. Kustakin kysymyksestä rastitetaan siis vain yksi vaihtoehto.

Vastauspäivämäärä _____._____._____

Henkilötunnus _____

Kysymys 1

( ) Tunnen itseni terveeksi ja elinvoimaiseksi.
( ) Tunnen itseni hieman uupuneeksi, väsyneeksi tai voimattomaksi.
( ) Tunnen itseni melko uupuneeksi, väsyneeksi tai voimattomaksi.
( ) Tunnen itseni hyvin uupuneeksi, väsyneeksi tai voimattomaksi.
( ) Tunnen itseni äärimmäisen uupuneeksi, väsyneeksi tai voimattomaksi.

Kysymys 2

( ) Näen lukea lehteä ja TV:n tekstejä vaikeuksitta ilman silmälaseja.
( ) Näen lukea lehteä ja TV:n tekstejä vaikeuksitta silmälasien kanssa.
( ) Näen lukea lehteä ja TV:n tekstejä heikosti silmälasienkin kanssa.
( ) En näe lukea lehteä ja TV:n tekstejä edes silmälasien kanssa, mutta näen (näkisin) kulkea ilman opasta.
( ) En näe (näkisi) kulkea ilman opasta eli olen lähes tai täysin sokea.

Kysymys 3

( ) Minulla ei ole hengenahdistusta eikä muita hengitysvaikeuksia.
( ) Minulla on hengenahdistusta raskaassa työssä tai urheillessa, reippaassa kävelyssä tasamaalla tai loivassa ylämäessä (ei tarkoita hengästymistä).
( ) Minulla on hengenahdistusta kävellessä tasamaalla.
( ) Minulla on hengenahdistusta pienenkin rasituksen jälkeen, esim. peseytyessä tai pukeutuessa.
( ) Minulla on hengenahdistusta lähes koko ajan, myös levossa.

Kysymys 4

( ) En tunne itseäni lainkaan ahdistuneeksi, jännittyneeksi tai hermostuneeksi.
( ) Tunnen itseni hieman ahdistuneeksi, jännittyneeksi tai hermostuneeksi.
( ) Tunnen itseni melko ahdistuneeksi, jännittyneeksi tai hermostuneeksi.
( ) Tunnen itseni erittäin ahdistuneeksi, jännittyneeksi tai hermostuneeksi.
( ) Tunnen itseni äärimmäisen ahdistuneeksi, jännittyneeksi tai hermostuneeksi.

Kysymys 5

( ) Kuulen hyvin normaalia puhetta ilman kuulokojetta.
( ) Kuulen normaalia puhetta pienin vaikeuksin, mutta en tarvitse kuulokojetta.
( ) Tarvitsen kuulokojeen, mutta kuulen sen kanssa hyvin.
( ) Kuulen kuulokojeenkin kanssa heikosti.
( ) Olen täysin kuuro.

Kysymys 6

( ) Minulla ei ole mitään ongelmia unen suhteen.
( ) Minulla on lieviä uniongelmia, esim. nukahtamisvaikeuksia tai heräilen satunnaisesti yöllä.
( ) Minulla on melkoisia uniongelmia, esim. nukun levottomasti, uni ei tunnu riittävältä.
( ) Minulla on suuria uniongelmia, esim. joudun käyttämään usein tai säännöllisesti unilääkettä, herään säännöllisesti yöllä tai aamuisin liian varhain.
( ) Kärsin vaikeasta unettomuudesta, esim. unilääkkeiden runsaasta käytöstä huolimatta nukkuminen on lähes mahdotonta, valvon suurimman osan yöstä.

Kysymys 7

( ) Pystyn syömään itse ilman mitään vaikeuksia.
( ) Pystyn syömään itse pienin vaikeuksin. (esim. hitaasti, kömpelösti tai erityisapuneuvoin).
( ) Tarvitsen hieman toisen apua syömisessä.
( ) En pysty syömään itse lainkaan, vaan minua pitää syöttää.
( ) En pysty syömään itse lainkaan, vaan minua pitää syöttää joko letkulla tai suonensisäisellä ravintoliuoksella.

Kysymys 8

( ) Minulla ei ole mitään vaivoja tai oireita, esim. kipua, särkyä, pahoinvointia, kutinaa jne.
( ) Minulla on lieviä vaivoja tai oireita, esim. lievää kipua, särkyä, pahoinvointia, kutinaa jne.
( ) Minulla on melkoisia vaivoja tai oireita, esim. melkoista kipua, särkyä, pahoinvointia, kutinaa jne.
( ) Minulla on voimakkaita vaivoja tai oireita, esim. voimakasta kipua, särkyä, pahoinvointia, kutinaa, jne.
( ) Minulla on sietämättömiä vaivoja ja oireita, esim. sietämätöntä kipua, särkyä, pahoinvointia, kutinaa, jne.

Kysymys 9

( ) Pystyn puhumaan selvästi, kuuluvasti ja sujuvasti.
( ) Puhuminen tuottaa minulle pieniä vaikeuksia, esim. sanoja on etsittävä tai ääni ei ole riittävän kuuluva tai se vaihtaa korkeutta.
( ) Pystyn puhumaan ymmärrettävästi, mutta katkonaisesti, ääni vavisten, sammaltaen tai änkyttäen.
( ) Muilla on vaikeuksia ymmärtää puhettani.
( ) Pystyn ilmaisemaan itseäni vain elein.

Kysymys 10

( ) Painoni, pituuteni ja ulkonäköni eivät tuota minulle ongelmia.
( ) Koen painoni, pituuteni tai ulkonäköni hieman kiusalliseksi.
( ) Koen painoni, pituuteni tai ulkonäköni melko kiusalliseksi.
( ) Koen painoni, pituuteni tai ulkonäköni hyvin kiusalliseksi.
( ) Koen painoni, pituuteni tai ulkonäköni äärimmäisen kiusalliseksi.

Kysymys 11

( ) Terveydentilani ei vaikuta koulunkäyntiini tai harrastuksiini.
( ) Terveydentilani haittaa vähän koulunkäyntiäni tai harrastuksiani.
( ) Terveydentilani haittaa huomattavasti koulunkäyntiäni tai harrastuksiani.
( ) Terveydentilani estää lähes kokonaan koulunkäyntini tai harrastukseni.
( ) Terveydentilani tekee koulunkäyntini tai harrastukseni mahdottomaksi.

Kysymys 12

( ) Pystyn kävelemään vaikeuksitta ilman apuvälineitä.
( ) Käveleminen on minulle hankalaa, mutta pystyn kävelemään ilman apuvälineitä (esim. kainalosauvoja tai pyörätuolia).
( ) En pysty kävelemään itse, mutta pystyn liikkumaan hyvin apuvälineiden (esim. kainalosauvojen tai pyörätuolin) kanssa.
( ) Liikkuminen tuottaa minulle suuria vaikeuksia apuvälineidenkin (esim. kainalosauvojen tai pyörätuolin) kanssa.
( ) Olen täysin liikuntakyvytön ja vuoteenoma.

Kysymys 13

( ) Terveydentilani ei vaikuta ystävien saamiseen tai ystävien kanssa olemiseen.
( ) Terveydentilani haittaa vähän ystävien saamista tai ystävien kanssa olemista.
( ) Terveydentilani haittaa huomattavasti ystävien saamista tai ystävien kanssa olemista.
( ) Terveydentilani estää lähes kokonaan ystävien saamisen tai ystävien kanssa olemisen.
( ) Terveydentilani tekee ystävien saamisen tai ystävien kanssa olemisen mahdottomaksi.

Kysymys 14

( ) Pystyn ajattelemaan selkeästi ja johdonmukaisesti.
( ) Minulla on lieviä vaikeuksia ajatella selkeästi ja johdonmukaisesti.
( ) Minulla on melkoisia vaikeuksia ajatella selkeästi ja johdonmukaisesti.
( ) Minulla on suuria vaikeuksia ajatella selkeästi ja johdonmukaisesti.
( ) Olen koko ajan sekaisin ja vailla ajan tai paikan tajua.

Kysymys 15

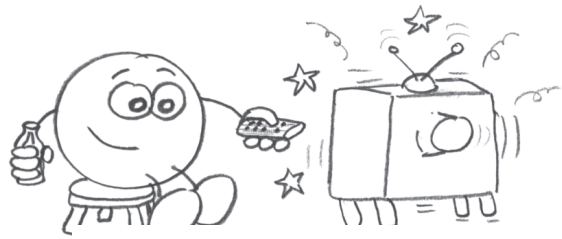
( ) Virtsarakkoni ja suolistoni toimivat ongelmitta.
( ) Virtsarakkoni tai suolistoni toiminnassa on lieviä ongelmia, esim. on virtsaamisvaikeuksia tai kova tai löysä vatsa.
( ) Virtsarakkoni tai suolistoni toiminnassa on melkoisia ongelmia, esim. on satunnaisia virtsanpidätysvaikeuksia tai vaikea ummetus tai ripuli.
( ) Virtsarakkoni tai suolistoni toiminnassa on suuria ongelmia, esim. on

säännöllisesti "vahinkoja" tai peräruiskeiden tai katetroinnin tarvetta.
( ) En hallitse lainkaan virtsaamista tai ulostamista.

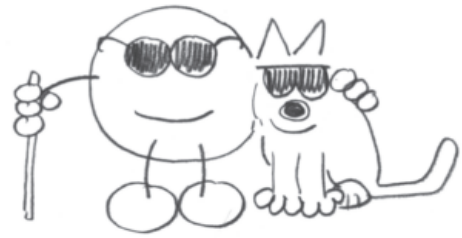
Kysymys 16
( ) En tunne itseäni lainkaan surulliseksi, alakuloiseksi tai masentuneeksi.
( ) Tunnen itseni hieman surulliseksi, alakuloiseksi tai masentuneeksi.
( ) Tunnen itseni melko surulliseksi, alakuloiseksi tai masentuneeksi.
( ) Tunnen itseni erittäin surulliseksi, alakuloiseksi tai masentuneeksi.
( ) Tunnen itseni äärimmäisen surulliseksi, alakuloiseksi tai masentuneeksi.

**English version of the 17D, printed with permission.**

QUALITY OF LIFE QUESTIONNAIRE (17D©)
This questionnaire is all about how you are right now. Please, read the questions carefully. Each question has five answers to choose from. Choose the answer that is closest to the way you are today.

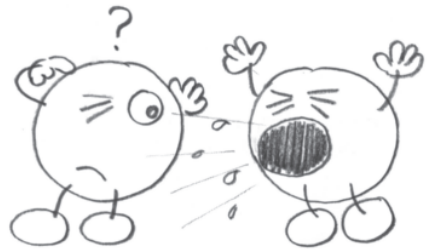


Question 1
How well you can see words in books and on the classroom board?



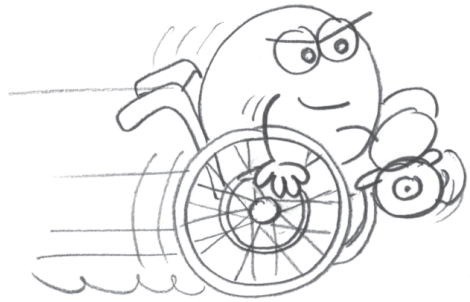
- ☐ Well, without glasses
- ☐ Well, with glasses
- ☐ Poorly, even with glasses
- ☐ I cannot see writing even with glasses, but I can see well enough to walk around without a guide
- ☐ I cannot see enough to walk around without a guide (I am almost or totally blind)

Question 2
How well can you hear?



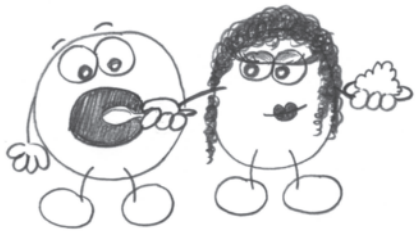
- ☐ I can hear normal speech well without a hearing aid
- ☐ Normal speech is a bit difficult to hear, but I do not need a hearing aid
- ☐ I need a hearing aid, but I can hear well with it
- ☐ I hear poorly even with a hearing aid
- ☐ I am totally deaf

Question 3 is about moving around
Can you walk without using an aid?



- ☐ Yes, without difficulty
- ☐ Yes, but walking is hard without an aid (like crutches or wheelchair)
- ☐ I cannot walk without an aid (like crutches or wheelchair), but with it I can move around well
- ☐ Moving around is hard even with an aid (like crutches or wheelchair)
- ☐ I cannot move around at all

Question 4.
Are you able to feed yourself?



- ☐ Yes, without any difficulty
- ☐ Yes, with a little difficulty (I am a bit slow, or clumsy, or I need a special aid, for example)
- ☐ Yes, if someone helps me a little all the time
- ☐ I cannot feed myself, so I must be fed by someone else
- ☐ I cannot eat at all, so I must be fed by tube or directly into my veins

Question 5
How well do you sleep?


- ☐ I fall asleep easily and I sleep well
- ☐ It is sometimes hard to fall asleep, or I sometimes have nightmares or wake up at night
- ☐ It is often hard to fall sleep, or I often have nightmares or wake up at night
- ☐ It is nearly always hard to fall asleep, or I have nightmares or wake up almost every night
- ☐ I am awake most of the night

Question 6
Do you have any problems going to the toilet?

- ☐ No
- ☐ I have small problems (sometimes it takes a long time in the toilet, or I have to go often)
- ☐ I sometimes have “accidents” (I mess or wet my trousers or bed), or I often get diarrhea, or I can’t go to the toilet for days
- ☐ I often have “accidents”, or I need a catheter or medicine to help me go to the toilet
- ☐ I nearly always mess or wet my trousers

Question 7
Everyone gets out of breath when they run fast, but do you otherwise get breathless or have other breathing problems?

- ☐ No
- ☐ Yes, when running slowly or walking fast
- ☐ Yes, when walking slowly
- ☐ Yes, even after light activity like washing or dressing myself
- ☐ Yes, almost all the time, even when resting

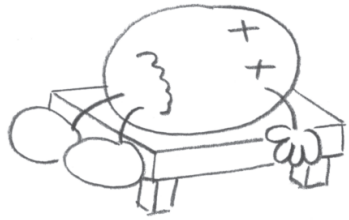
Question 8
Do you have physical troubles or symptoms like pain, ache, feeling sick, or itchy?

- ☐ Not at all
- ☐ A little
- ☐ Quite a lot
- ☐ Very much
- ☐ It is unbearable

Question 9
People can feel healthy and energetic, or they can feel ill, tired and weak. Do you feel

- ☐ Healthy and energetic
- ☐ A little ill, tired or weak
- ☐ Quite ill, tired or weak
- ☐ Very ill, tired or weak
- ☐ Extremely ill, tired or weak

Question 10
Do you feel scared or tense?

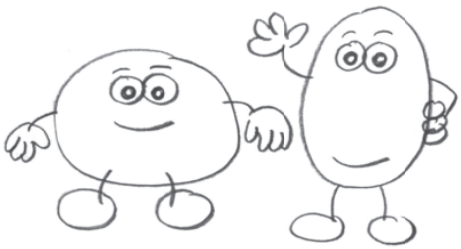


- ☐ Not at all
- ☐ A little scared or tense
- ☐ Quite scared or tense
- ☐ Very scared or tense
- ☐ Extremely scared or tense

Question 11

Are you happy with your weight, your height and how you look?

- ☐ I am completely happy
- ☐ I am quite happy
- ☐ I am rather unhappy
- ☐ I am very unhappy
- ☐ I am extremely unhappy



Question 12

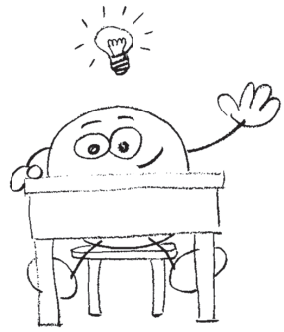
Does your state of health make it difficult to go to school or have hobbies?

- ☐ Not at all
- ☐ A little (like not being able to do sports classes)
- ☐ Quite a lot (like I have difficulty walking or I miss school often because of sickness, or I am not able to have some hobbies)
- ☐ My state of health makes it almost impossible to go to school or have hobbies
- ☐ My state of health makes it impossible to go to school or have hobbies

Question 13

Does your state of health make it difficult to make friends or be with them?

- ☐ Not at all
- ☐ A little
- ☐ Quite a lot
- ☐ My state of health makes it almost impossible to make friends or be with them
- ☐ My state of health makes it impossible to make friends or be with them



Question 14

Sometimes it is hard to concentrate on the same thing for long, when thoughts jump from one thing to another

How long can you concentrate on the same thing?

- ☐ A long time
- ☐ Quite a long time
- ☐ Only a short time
- ☐ My thoughts are always jumping from one thing to another, and I can't really concentrate much
- ☐ I'm so restless that I can't concentrate for a moment

Question 15

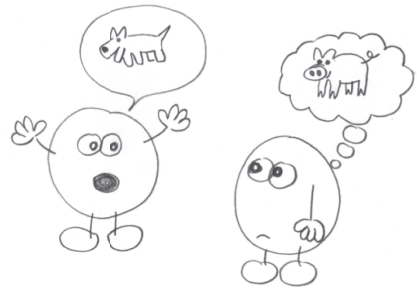
How well can you learn new things and remember them?

- ☐ I learn new things easily and remember them well
- ☐ It is a little hard for me to learn new things or remember them
- ☐ It is quite hard for me to learn new things or remember them
- ☐ It is very hard for me to learn new things or remember them
- ☐ I cannot learn or remember things


Question 16

How clearly can you speak?

- ☐ I can speak clearly
- ☐ It is a little hard for me to speak clearly
- ☐ It is quite hard for me to speak clearly
- ☐ Most people have difficulty understanding me when I speak
- ☐ I can only make myself understood with signing



Question 17

People are not always cheerful and happy. Sometimes they can feel quite sad, unhappy and depressed.
Do you feel

☐ Cheerful and happy
☐ A little sad, unhappy or depressed
☐ Quite sad, unhappy or depressed
☐ Very sad, unhappy or depressed
☐ Extremely sad, unhappy or depressed

Thank you very much!
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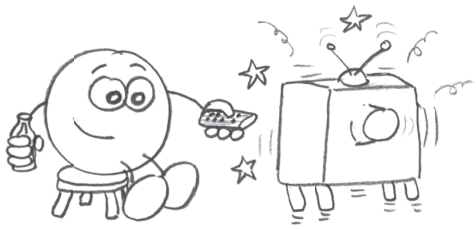
ELÄMÄNLAATUMITTARI 8-11-VUOTIAILLE (17D©)
Tässä lomakkeessa on kysymyksiä siitä, kuinka voit tällä hetkellä. Lue kysymykset tarkkaan. Jokaiseen kysymykseen voi vastata viidellä eri tavalla. Yritä valita vaihtoehdoista se, joka parhaiten kuvaa vointiasi tänään.

Kysymys 1 käsittelee näköäsi.
Näetkö lukea lehteä ja taululle kirjoitettua tekstiä



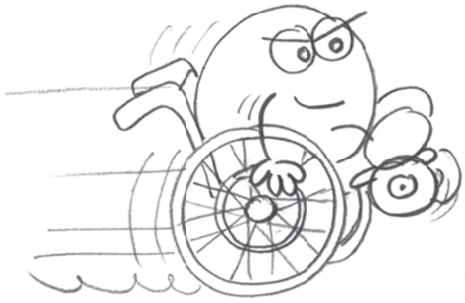
☐ hyvin ilman silmälaseja?
☐ hyvin silmälasien kanssa?
☐ heikosti silmälasienkin kanssa?
☐ en näe lukea lehteä tai taululle kirjoitettua tekstiä edes silmälasien kanssa,
mutta näen kulkea ilman opasta
☐ en näe kulkea edes ilman opasta
(eli olen lähes tai täysin sokea)

Kysymys 2
Kuinka hyvin kuulet?

☐ kuulen normaalia puhetta hyvin ilman kuulolaitetta
☐ kuulen normaalia puhetta pienin vaikeuksin, mutta en tarvitse kuulolaitetta
☐ tarvitsen kuulolaitteen, mutta kuulen sen kanssa hyvin
☐ kuulen kuulolaitteenkin kanssa heikosti

☐ olen täysin kuuro

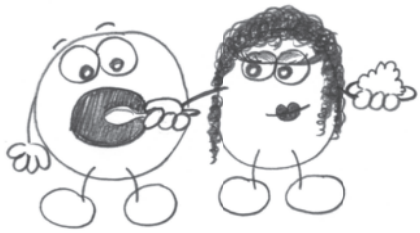
Kysymys 3 käsittelee liikkumista.
Pystytkö kävelemään ilman apuvälineitä?



☐ kyllä, ilman vaikeuksia
☐ kyllä, mutta käveleminen on vaikeaa ilman apuvälineitä (esim. kainalosauvoja tai pyörätuolia)
☐ en pysty kävelemään ilman apuvälineitä (esim. kainalosauvoja tai pyörätuolia), mutta pystyn liikkumaan hyvin apuvälineiden kanssa
☐ liikkuminen on hankalaa apuvälineidenkin (esim. kainalosauvojen tai pyörätuolin) kanssa
☐ en pysty liikkumaan ollenkaan

Kysymys 4
Pystytkö syömään

- ☐ itse ilman mitään vaikeuksia
- ☐ itse pienin vaikeuksin (esim. hitaasti, kömpelösti tai erityisapuvälinein)
- ☐ itse, jos joku vähän auttaa koko ajan
- ☐ en pysty syömään itse, vaan minua pitää syöttää
- ☐ en pysty syömään lainkaan, vaan minua pitää syöttää letkulla tai suonensisäisellä ravintoliuoksella



Kysymys 5
Miten sinä nukut?

- ☐ nukahdan helposti ja nukun hyvin
- ☐ minun on joskus vaikea nukahtaa, näen joskus painajaisunia tai heräilen muuten keskellä yötä
- ☐ minun on usein vaikea nukahtaa, näen usein painajaisunia tai heräilen muuten keskellä yötä
- ☐ minun on vaikea nukahtaa lähes aina, näen painajaisunia lähes joka yö tai heräilen muuten keskellä yötä
- ☐ valvon suurimman osan yöstä


Kysymys 6
Onko sinulla virtsaamis- tai ulostamisvaikeuksia?

- ☐ ei ole
- ☐ on lieviä (pissa tai kakka ei aina tule tai on käytävä usein vessassa)
- ☐ silloin tällöin tulee "vahinkoja" (pissa tulee housuihin tai sänkyyn) tai on usein ripuli tai kakka ei tule moneen päivään
- ☐ on säännöllisesti "vahinkoja" tai peräruiskeiden tai katetroinnin tarvetta
- ☐ pissa tai kakka tulee melkein joka kerta housuihin

Kysymys 7
Kaikki hengästyvät joskus juostessa tai urheillessa, mutta onko sinulla hengenahdistusta (tuntuu, että ilma loppuu) tai muuten vaikea hengittää?

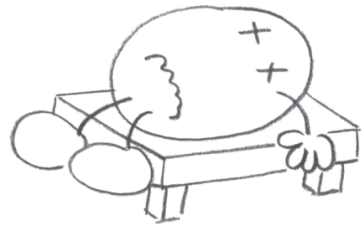
☐ ei ole
☐ on esim. juostessa tai reippaasti kävellessä
☐ on kävellessä hitaasti
☐ on pienenkin rasituksen jälkeen esim. peseytyessä tai pukeutuessa
☐ on lähes koko ajan, myös levossa

Kysymys 8
Onko sinulla sellaisia vaivoja tai oireita kuten kipua, särkyä, pahoinvointia, kutinaa jne.?

☐ ei ollenkaan
☐ vähän
☐ aika paljon
☐ paljon
☐ sietämättömästi

Kysymys 9
Olosi voi tuntua terveeltä ja reippaalta tai sairaalta, väsyneeltä ja voimattomalta.
Tunnetko sinä itsesi

☐ terveeksi ja reippaaksi?
☐ hieman sairaaksi, väsyneeksi tai voimattomaksi?
☐ melko sairaaksi, väsyneeksi tai voimattomaksi?
☐ hyvin sairaaksi, väsyneeksi tai voimattomaksi?
☐ äärimmäisen sairaaksi, väsyneeksi tai voimattomaksi?

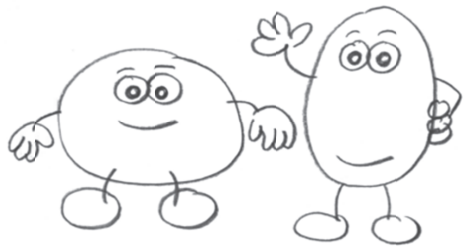


Kysymys 10
Tunnetko itsesi pelokkaaksi tai jännittyneeksi?

☐ en lainkaan
☐ hieman pelokkaaksi tai jännittyneeksi
☐ melko pelokkaaksi tai jännittyneeksi
☐ hyvin pelokkaaksi tai jännittyneeksi
☐ hirveän pelokkaaksi tai jännittyneeksi

Kysymys 11
Oletko tyytyväinen painoosi, pituuteesi ja ulkonäköösi?

☐ olen täysin tyytyväinen
☐ olen melko tyytyväinen
☐ olen melko tyytymätön
☐ olen hyvin tyytymätön
☐ olen äärimmäisen tyytymätön



Kysymys 12
Haittaako terveydentilasi koulunkäyntiäsi tai harrastuksiasi?

☐ ei haittaa ollenkaan
☐ haittaa vähän (esim. ei voi osallistua liikuntatunneille)
☐ haittaa huomattavasti (esim. on liikuntavaikeuksien takia hankala päästä kouluun, on oltava sairauden tai lääkärissä käynnin takia usein poissa koulusta, ei voi harrastaa sitä, mitä haluaisi)
☐ estää lähes kokonaan koulunkäynnin ja harrastukset (esim. joutuu olemaan pitkiä aikoja poissa koulusta tai ei voi harrastaa juuri mitään)
☐ tekee koulunkäynnin tai harrastukset mahdottomaksi

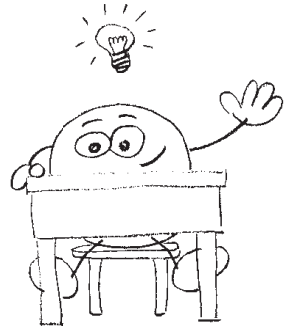
Kysymys 13
Vaikeuttaako terveydentilasi ystävien saamista tai ystävien kanssa olemista?

☐ ei ollenkaan
☐ vähän
☐ aika paljon
☐ terveydentilani estää lähes kokonaan ystävien saamisen tai ystävien kanssa olemisen
☐ terveydentilani tekee ystävien saamisen tai ystävien kanssa olemisen mahdottomaksi

Kysymys 14
Joskus voi olla vaikea keskittyä samaan asiaan pitkäksi aikaa, kun ajatukset hyppelehtivät asiasta toiseen. Jaksatko sinä keskittyä

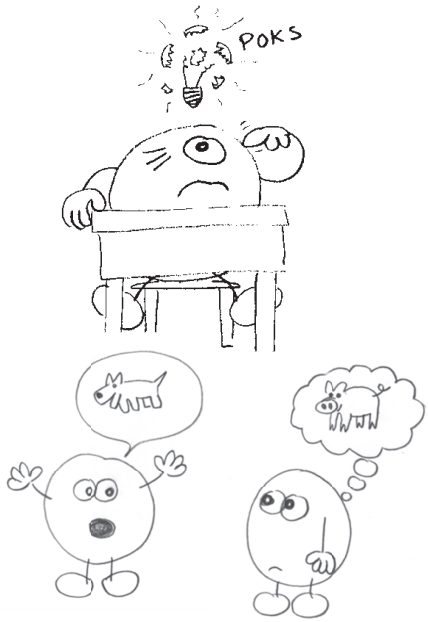
- ☐ pitkäksi aikaa?
- ☐ melko pitkäksi aikaa?
- ☐ vain vähäksi aikaa kerrallaan?
- ☐ ajatukseni hyppelehtivät jatkuvasti enkä oikein jaksa keskittyä ollenkaan
- ☐ olen levoton enkä jaksa keskittyä hetkeksikään

Kysymys 15
Miten hyvin opit uusia asioita ja muistat oppimasi asiat?



- ☐ opin uusia asioita helposti ja muistan oppimani hyvin
- ☐ minulla on pieniä vaikeuksia oppia uusia asioita tai muistaa oppimaani
- ☐ minulla on melkoisia vaikeuksia oppia uusia asioita tai muistaa oppimaani
- ☐ minulla on suuria vaikeuksia oppia uusia asioita tai muistaa oppimaani
- ☐ en pysty oppimaan enkä muistamaan asioita

Kysymys 16
Pystytkö puhumaan hyvin?




- ☐ pystyn puhumaan ihan hyvin
- ☐ puhuminen tuottaa minulle pieniä vaikeuksia
- ☐ puhuminen tuottaa minulle melkoisia vaikeuksia
- ☐ muilla on vaikeuksia ymmärtää puhettani
- ☐ pystyn ilmaisemaan itseäni vain elein

Kysymys 17
Aina ei olo välttämättä tunnu iloiselta ja onnelliselta, vaan joskus voi tuntua hyvinkin surulliselta, onnettomalta ja masentuneelta. Tunnetko sinä itsesi

- ☐ iloiseksi ja onnelliseksi?
- ☐ hieman surulliseksi, onnettomaksi tai masentuneeksi?
- ☐ melko surulliseksi, onnettomaksi tai masentuneeksi?
- ☐ hyvin surulliseksi, onnettomaksi tai masentuneeksi?
- ☐ äärimmäisen surulliseksi, onnettomaksi tai masentuneeksi?

SUURET KIITOKSET!

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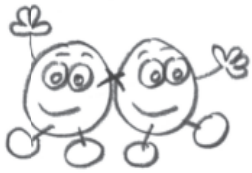

## APPENDIX D

**English version of PVOS. From (89), reprinted with permission.**

1. To what extent does your child's voice limit his or her ability to be understood in a noisy area?
   - ☐ Limited a lot
   - ☐ Limited a little
   - ☐ Not limited at all

2. During the past 2 weeks, to what extent has your child's voice interfered with his or her normal social activities or with his or her school?
   - ☐ Not at all
   - ☐ Slightly
   - ☐ Moderately
   - ☐ Quite a bit
   - ☐ Extremely

3. How often does your child have trouble with food or liquids "going down the wrong pipe" when he or she eats food or drinks liquid and begins to cough after eating or drinking?
   - ☐ All the time
   - ☐ Most of the time
   - ☐ Sometimes
   - ☐ Rarely
   - ☐ Never

4. Do you find your child "straining" when he or she speaks because of his or her voice problem?
   - ☐ Not at all
   - ☐ A little bit
   - ☐ Moderately
   - ☐ Quite a bit
   - ☐ Extremely

**Finnish version of PVOS. From (89), translated with permission.**

1. Missä määrin lapsen ääni rajoittaa hänen kykyään tulla ymmärretyksi meluisassa ympäristössä?

- Rajoittaa paljon
- Rajoittaa vähän
- Ei rajoita

2. Missä määrin lapsen ääni on viimeisen 2 viikon aikana haitannut tavanomaista sosiaalista kanssakäymistä tai koulunkäyntiä?

- Ei lainkaan
- Hieman
- Kohtalaisen paljon
- Varsin paljon
- Äärimmäisen paljon

3. Kuinka usein lapsi saa ruokaa tai juomaa "väärään kurkkuun", eli alkaa yskiä syödessään tai juodessaan?

- Jatkuvasti
- Useimmiten
- Silloin tällöin
- Harvoin
- Ei koskaan

4. Havaitsetko lapsen pinnistelevän puhuessaan ääniongelman takia?

- Ei lainkaan
- Hieman
- Kohtalaisen paljon
- Varsin paljon
- Äärimmäisen paljon

# APPENDIX E

**English version of PVRQOL survey. From (89), reprinted with permission.**

**Please answer these questions based on what your child's voice (your own voice if you are a teenage respondent) has been like over the past 2 weeks. Considering both how severe the problem is when you get it, and how frequently it happens, please rate each item below on how bad it is (that is, the amount of each problem that you have). Use the following rating scale:**

1 = None, not a problem
2 = A small amount
3 = A moderate amount
4 = A lot
5 = Problem is "as bad as it can be"
6 = Not applicable

**Because of my child's voice, how much of a problem is this?**

| | |
|---|---|
| 1. My child has trouble speaking loudly or being heard in noisy situations. | 1 2 3 4 5 6 |
| 2. My child runs out of air and needs to take frequent breaths when talking. | 1 2 3 4 5 6 |
| 3. My child sometimes does not know what will come out when he or she begins speaking. | 1 2 3 4 5 6 |
| 4. My child is sometimes anxious or frustrated (because of his or her voice). | 1 2 3 4 5 6 |
| 5. My child sometimes gets depressed (because of his or her voice). | 1 2 3 4 5 6 |
| 6. My child has trouble using the telephone or speaking with friends in person. | 1 2 3 4 5 6 |
| 7. My child has trouble doing his or her job or schoolwork (because of his or her voice). | 1 2 3 4 5 6 |
| 8. My child avoids going out socially (because of his or her voice). | 1 2 3 4 5 6 |
| 9. My child has to repeat himself or herself to be understood. | 1 2 3 4 5 6 |
| 10. My child has become less outgoing (because of his or her voice). | 1 2 3 4 5 6 |

**Finnish version of PVRQOL survey. From (89), translated with permission.**

**Ole hyvä ja vastaa näihin kysymyksiin sen perusteella millainen lapsesi ääni (oma äänesi mikäli olet teini-ikäinen ja vastaat itse) on ollut viimeisen 2 viikon aikana. Ottaen huomioon ongelman vakavuuden ja sen kuinka usein se ilmenee. Käytä seuraavaa asteikkoa kuvataksesi ongelmaa:**

1 = Ei lainkaan ongelmaa
2 = Hieman
3 = Kohtalaisen paljon
4 = Paljon
5 = Ongelma ei voisi olla pahempi
6 = Ei vastattavissa

**Kuinka suuri ongelma on lapsen äänen takia seuraava asia?**

| | | | | | | |
|---|---|---|---|---|---|---|
| 1. Lapsen on vaikea puhua kovalla äänellä tai tulla tuulluksi meluisissa tilanteissa | 1 | 2 | 3 | 4 | 5 | 6 |
| 2. Lapselta loppuu ilma tai hän joutuu haukkomaan henkeään puhuessaan | 1 | 2 | 3 | 4 | 5 | 6 |
| 3. Ajoittain lapsi ei tiedä millaisen äänen päästää alkaessaan puhua | 1 | 2 | 3 | 4 | 5 | 6 |
| 4. Lapsi on ajoittain ahdistunut tai turhautunut äänensä takia | 1 | 2 | 3 | 4 | 5 | 6 |
| 5. Lapsi on ajoittain masentunut äänensä takia | 1 | 2 | 3 | 4 | 5 | 6 |
| 6. Lapsella on vaikeuksia käyttää puhelinta tai keskustella kasvotusten ystäviensä kanssa | 1 | 2 | 3 | 4 | 5 | 6 |
| 7. Lapsella on vaikeuksia askareissa tai koulussa äänensä takia | 1 | 2 | 3 | 4 | 5 | 6 |
| 8. Lapsi välttää sosiaalisia kontakteja äänensä takia | 1 | 2 | 3 | 4 | 5 | 6 |
| 9. Lapsen täytyy toistaa sanomansa tullakseen ymmärretyksi | 1 | 2 | 3 | 4 | 5 | 6 |
| 10. Lapsesta on tullut vähemmän seurallinen äänensä takia | 1 | 2 | 3 | 4 | 5 | 6 |

# APPENDIX F

## English version of questionnaire used in Article IV

### Personal details

Surname:
Name:
Age:
Social security number:
Gender: □ male □ female
Kindergarten name:
Children group name:
Phone number:
Email address:

### 1. Background information

I graduated as kindergarten teacher in year:
Educational establishment, from which I graduated:
I have worked as kindergarten teacher for ..... years/months.
Employment type:
- □ permanent
- □ temporary
- □ replacement

My employment type changes continuously: □ no □ yes

The age of children in my group is:
- □ less than 3 years
- □ 3-5 years
- □ pre-school education
- □ something else

Different age, what?
The number of the children in my group on average is:

**My common workday include the following:**

Singing times on average: .... (number per day)
Total time of singing on average: .... ( hours per week)
Reading times on average: .... (number per day)
Total reading on average: ... (hours per week)
Total of teaching or playing/activity monitoring on average:... (hours per week)
Outdoor time with children on average: .... (hours per week)
Work-related conversation with other members of your workplace on average:.... (hours per week)
Conversations with children's parents on average:.... (hours per week)
Total of talking on average:.... (hours per day)
My workday length on average: ... (hours)

**Background factors affecting voice**

I have received speech related vocal education
- □ during studying to be a kindergarten teacher
- □ as a course
- □ training in working place
- □ in relation to hobby
- □ I did not receive vocal education

Speech related vocal education lasted for
- □ few hours
- □ few days
- □ weeks
- □ education is continuous and regular

**Voice use related hobbies**

I have the hobby of singing: □ no □ yes
What kind of singing do you practice?
- □ Choral singing
- □ Trained solo singing
- □ For own pleasure, no training
- □ Karaoke singing
- □ Another type

If you practice another type of singing, then what?

I received education in singing
- □ Community college
- □ In a chorus
- □ Music institute
- □ Conservatory of music
- □ University of applied sciences
- □ Sibelius-Academy
- □ Somewhere else

If you received singing education somewhere else, then where?

My singing education lasted for
- □ few hours
- □ few days
- □ weeks
- □ years
- □ education is continuous and regular

At the meantime, the continuous education with certain number of hours per week, e.g. 1 hour/week: ....

I practice acting: □ no □ yes
I practice sports coaching: □ no □ yes

Another voice loading hobby of me or my closed ones (e.g. cheering for a child while practicing sports), what sport?
How many hours go for that per week?
I talk during my leisure time with a strong voice: □ no □ yes

**Illnesses and medications**

I have allergic rhinitis: □ no □ yes
I have asthma: □ no □ yes
I have recurrent flu ( 4 or more times per year): □ no □ yes
I was diagnosed with reflux: □ no □ yes
I often have heartburn, acidic belching, burning feeling behind breastbone, morning pain in my throat and/or voice hoarseness: □ no □ yes
I have a medication for allergy: □ no □ yes
Allergy medication name:
I have a medication for asthma: □ no □ yes
Asthma medication name?
I have a medication for heartburn?: □ no □ yes
Heartburn medication name?
I have a medication for something else: □ no □ yes
For what?

I have been diagnosed with a hearing problem: □ no □ yes
I feel, that I hear less than normal: □ no □ yes
I suffer from tinnitus: □ no □ yes
I grind my teeth together/clench jaws at night/I feel my jaw is stiff in the mornings: □ no □ yes
I often have headache: □ no □ yes
I have recurrent neck-shoulder pains: □ no □ yes
I received voice therapy from a speech therapist before: □ no □ yes
When? ..... How many times? .... times.

**Smoking**

□ I have never smoked tobacco at all
□ I smoked before, but I quit
□ I smoke regularly

When did you quit smoking?
If you smoke regularly, then how many cigarettes/cigars/pipes per day (number)

**2. Self-assessment of voice quality and voice use**

Below are a number of questions related to voice and voice use. Kindly choose the choice that best describes you.

I think my voice is:

□ very bad
□ bad
□ quite bad
□ quite good
□ good
□ very good
□ do not know

In general, I am able to project my voice:

□ very poorly
□ poorly
□ somewhat poorly
□ somewhat well
□ well
□ very well
□ do not know

My voice withstands work-related voice loading (e.g. speaking and singing)

□ very poorly
□ poorly
□ somewhat poorly
□ somewhat well
□ well
□ very well
□ do not know

When my voice is fatigued, it recovers by the next morning:

□ very poorly
□ poorly
□ somewhat poorly
□ somewhat well
□ well
□ very well
□ do not know

**3. Voice symptoms**

Below are a number of questions regarding voice symptoms.
In the first table, we aim to define the prevalence of the voice symptoms, while the second table is about their severity. Kindly fill in both tables with the choices that best describes your voice symptoms.

Please mark the prevalence of your voice symptom/feeling in the following table.
0 = no symptoms, 1 and 2 = few times per year, 3 and 4 = monthly, 5 and 6 = weekly symptoms

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| 1. My voice gets strained | □ | □ | □ | □ | □ | □ | □ |
| 2. My voice is hoarse without infection | □ | □ | □ | □ | □ | □ | □ |
| 3. I have a lump or mucus in my throat | □ | □ | □ | □ | □ | □ | □ |
| 4. I have irritation or tickle in my throat | □ | □ | □ | □ | □ | □ | □ |
| 5. I have tiredness and/or pain in my throat or neck after speaking | □ | □ | □ | □ | □ | □ | □ |
| 6. I have tiredness and/or pain in my throat or neck after singing | □ | □ | □ | □ | □ | □ | □ |
| 7. I have voice breaks when I am talking | □ | □ | □ | □ | □ | □ | □ |
| 8. I have had aphonia without infection | □ | □ | □ | □ | □ | □ | □ |
| 9. After a workday my voice is so fatigued that it causes trouble in social life (trouble in family life and/or other social interaction or restricts participation in vocally demanding activities | □ | □ | □ | □ | □ | □ | □ |

Please mark the severity of your voice symptom/feeling in the following table.
0=No symptoms, 2= mild symptoms, 4=moderate symptoms, 6=severe symptoms

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| 1. My voice gets strained | □ | □ | □ | □ | □ | □ | □ |
| 2. My voice is hoarse without infection | □ | □ | □ | □ | □ | □ | □ |
| 3. I have a lump or mucus in my throat | □ | □ | □ | □ | □ | □ | □ |
| 4. I have irritation or tickle in my throat | □ | □ | □ | □ | □ | □ | □ |
| 5. I have tiredness and/or pain in my throat or neck after speaking | □ | □ | □ | □ | □ | □ | □ |
| 6. I have tiredness and/or pain in my throat or neck after singing | □ | □ | □ | □ | □ | □ | □ |
| 7. I have voice breaks when I am talking | □ | □ | □ | □ | □ | □ | □ |
| 8. I have had aphonia without infection | □ | □ | □ | □ | □ | □ | □ |
| 9. After a workday my voice is so fatigued that it causes trouble in social life (trouble in family life and/or other social interaction or restricts participation in vocally demanding activities | □ | □ | □ | □ | □ | □ | □ |

**4. Working conditions with negative effect on the voice.**

Do the following conditions harm your voice use (in the place, where you work most)?

| CLASSROOM | not at all | a little | moderately | much | very much |
|---|---|---|---|---|---|
| Too large | □ | □ | □ | □ | □ |
| Too cramped | □ | □ | □ | □ | □ |
| Too much echo | □ | □ | □ | □ | □ |
| Noisy | □ | □ | □ | □ | □ |
| Teaching in the open | □ | □ | □ | □ | □ |
| Other, what? | □ | □ | □ | □ | □ |

Other classroom related condition (if yes, then what?)

| BACKGROUND NOISE | not at all | a little | moderately | much | very much |
|---|---|---|---|---|---|
| Noise from peripheral equipment (e.g. air conditioning, teaching equipment and laundry) | □ | □ | □ | □ | □ |
| Children's noise | □ | □ | □ | □ | □ |
| Noise from furniture | □ | □ | □ | □ | □ |
| Noise from outside one's own group | □ | □ | □ | □ | □ |
| Noise from outside | □ | □ | □ | □ | □ |
| Other, what? | □ | □ | □ | □ | □ |

Other background noise related condition (if yes, then what?)

| ROOM AIR | not at all | a little | moderately | much | very much |
|---|---|---|---|---|---|
| Excessive dryness | □ | □ | □ | □ | □ |
| Excessive humidity | □ | □ | □ | □ | □ |
| Inappropriate temperature | □ | □ | □ | □ | □ |
| Dusty | □ | □ | □ | □ | □ |
| Smells and odors | □ | □ | □ | □ | □ |
| Other, what? | □ | □ | □ | □ | □ |

Other room air related condition (if yes, then what?)

| ERGONOMICS | not at all | a little | moderately | much | very much |
|---|---|---|---|---|---|
| Inappropriate furniture/equipment (i.e. unsuitable for own dimensions) | □ | □ | □ | □ | □ |
| Picking up | □ | □ | □ | □ | □ |
| Bending | □ | □ | □ | □ | □ |
| Static postures for example (i.e. standing in same position for too long). | □ | □ | □ | □ | □ |
| Other postures unfavorable for Voice production (e.g. head rotation or bending down) | □ | □ | □ | □ | □ |
| Other, what? | □ | □ | □ | □ | □ |

Other ergonomics related condition (if yes, then what?)

| GROUP | not at all | a little | moderately | much | very much |
|---|---|---|---|---|---|
| Too many children in the group | □ | □ | □ | □ | □ |
| Wide age range | □ | □ | □ | □ | □ |
| Heterogeneous group | □ | □ | □ | □ | □ |
| Restlessness in the group | □ | □ | □ | □ | □ |
| Children who need special attention in the group | □ | □ | □ | □ | □ |
| Other, what? | □ | □ | □ | □ | □ |

Other group related condition (if yes, then what?)

| VOCALIZING TIME | not at all | a little | moderately | much | very much |
|---|---|---|---|---|---|
| Total of singing at work | □ | □ | □ | □ | □ |
| Total of reading loud | □ | □ | □ | □ | □ |
| Total of oral teaching | □ | □ | □ | □ | □ |
| Loud voice use (e.g. to demand order in class) | □ | □ | □ | □ | □ |
| Total speaking time during the workday | □ | □ | □ | □ | □ |
| Other, what? | □ | □ | □ | □ | □ |

Other vocalizing time related condition (if yes, then what?)

| PSYCHOSOCIAL- ELEMENTS | not at all | a little | moderately | much | very much |
|---|---|---|---|---|---|
| Pressure from the work organization (e.g. work load.) | □ | □ | □ | □ | □ |
| Pressure from the work community/ human relationships | □ | □ | □ | □ | □ |
| Haste at work | □ | □ | □ | □ | □ |
| Mental pressure of work | □ | □ | □ | □ | □ |
| Pressure from outside of work | □ | □ | □ | □ | □ |
| Other, what? | □ | □ | □ | □ | □ |

Other psychosocial-elements related condition (if yes, then what?)

Thanks, your answers will be handled confidentially.

**Finnish version of questionnaire used in Article IV**

**Henkilötiedot**

Sukunimi:
Etunimi:
Ikä:
Henkilötunnus:
Sukupuoli: □ mies □ nainen
Päiväkoti:
Päiväkotiryhmän nimi:
Päiväkodin osoite:
Puhelinnumero:
sähköpostiosoite:

**1. Taustatiedot**

Olen valmistunut lastentarhanopettajaksi vuonna:
Oppilaitos, josta valmistuin:
Olen toiminut lastentarhanopettajana .... vuotta/kuukautta
Työsuhteeni on:
- □ vakituinen
- □ määräaikainen
- □ sijaisuus

Työolosuhteeni vaihtuvat jatkuvasti: □ Ei □ Kyllä

Opettamanani ryhmän ikä
- □ alle 3 vuotta
- □ 3-5 vuotta
- □ esiopetusryhmä
- □ jokin muu

Jokin muu ikä, mikä?
Päiväkotiryhmäni lasten lukumäärä keskimäärin:
**Tavallisimpana työpäivänäni työhöni kuuluu**

Lauluhetkiä keskimäärin: .... (kertaa päivässä)
Lauluhetkiä yhteensä keskimäärin noin: .... ( tuntia viikossa)
Lukuhetkiä keskimäärin: .... (kertaa päivässä)
Lukuhetkiä yhteensä keskimäärin noin: ... (tuntia viikossa)
Opettamista tai leikin/askartelun ohjausta yhteensä keskimäärin noin: ... (tuntia viikossa)
Ulkona oloa lasten kanssa keskimäärin: .... (tuntia viikossa)
Työhön kuuluva keskustelu työtiimin/työyhteisön jäsenten kanssa työnteon lomassa keskimäärin:.... (tuntia viikossa)
Perheiden kanssa keskustelua keskimäärin:.... (tuntia viikossa)
Puhumista kokonaisuudessaan keskimäärin:.... (tuntia päivässä)
Työpäiväni kestää keskimäärin:... (tuntia)

**Ääneen vaikuttavia taustatekijöitä**

Olen saanut äänenkäytön koulutusta puheessa
- □ lastentarhanopettajaksi opiskelun yhteydessä
- □ kurssiluontoisesti
- □ työpaikkakoulutuksena
- □ harrastukseen liittyen
- □ en ole saanut koulutusta

Puheeseen liittyvä äänenkäytön koulutus on kestänyt
- □ muutaman tunnin
- □ muutaman päivän
- □ yhteensä viikkoja
- □ koulutus on jatkuvaa ja säännöllistä

**Äänenkäyttöön liittyvät harrastukset**

Harrastan laulamista: □ ei □ kyllä

Millaista laulamista harrastat?
- □ kuorolaulua
- □ ohjattua yksinlaulua
- □ omaksi iloksi laulamista, ilman ohjausta
- □ karaoke-laulua
- □ muuta

Jos harrastat muuta laulamista, mitä?

Olen saanut koulutusta laulussa
- □ kansalaisopistossa
- □ kuorossa
- □ musiikkiopistossa
- □ konservatoriossa
- □ ammattikorkeakoulussa
- □ Sibelius-Akatemiassa
- □ jossain muualla

Jos olet saanut koulutusta laulussa muualla, missä?

Laulukoulutukseni on kestänyt
□ muutaman tunnin
□ muutaman päivän
□ yhteensä viikkoja
□ yhteensä vuosia
□ koulutus on jatkuvaa ja säännöllistä

Tällä hetkellä jatkuvan koulutuksen viikkotuntimäärä, esim. 1 tunti/viikko:...
Harrastan näyttelemistä: □ en □ kyllä
Harrastan urheiluvalmennusta: □ en □ kyllä
Jokin muu äänellisesti kuormittava oma tai läheiseni harrastus (esim. lapsen urheilusuorituksen kannustus), mikä?

Montako tuntia näihin kuluu viikossa?
Puhun vapaa-aikanani paljon voimakkaalla äänellä: □ en □ kyllä

**Sairaudet ja lääkkeet**

Sairastan allergista nuhaa: □ ei □ kyllä
Sairastan astmaa: □ ei □ kyllä
Sairastan toistuvia flunssia (4 tai useamman kerran vuodessa): □ ei □ kyllä
Minulla on todettu refluksisairaus: □ ei □ kyllä
Minulla on usein närästystä, happamia röyhtäyksiä, rintalastan takana poltetta, aamulla kurkku kipeä ja/tai ääni käheä: □ ei □ kyllä
Minulla on lääkitys allergiaan: □ ei □ kyllä
Allergialääkkeen nimi?
Minulla on lääkitys astmaan: □ ei □ kyllä
Astmalääkkeen nimi?
Minulla on lääkitys närästykseen: □ ei □ kyllä
Närästyslääkkeen nimi?:
Minulla on lääkitys johonkin muuhun: □ ei □ kyllä
Mihin?
Minulla on todettu kuulovika: □ ei □ kyllä
Minusta tuntuu, että kuulen normaalia huonommin: □ ei □ kyllä
Kärsin tinnituksesta: □ ei □ kyllä
Puren hampaita yhteen/narskuttelen öisin/tunnen leuassani jäykkyyttä aamuisin: □ ei □ kyllä
Minulla on usein päänsärkyä: □ ei □ kyllä
Minulla on säännöllisesti niska-hartiavaivoja: □ ei □ kyllä
Olen saanut puheterapeutin antamaa ääniterapiaa: □ ei □ kyllä
Milloin?..... Kuinka paljon? .... kertaa.

**Tupakointi**
□ En ole koskaan polttanut tupakkaa
□ Olen polttanut aiemmin, mutta lopettanut
□ Tupakoin säännöllisesti
Milloin olet lopettanut tupakoinnin?
Jos tupakoit säännöllisesti, montako savuketta/sikaria/piipullista päivässä (l

**2. Oma arvio äänestä**

Alla on esitetty joukko ääntä ja äänenkäyttöä koskevia kysymyksiä. Olen hyvä ja valitse se vaihtoehto, joka kuvaa Sinua parhaiten.

Ääneni on omasta mielestäni

□ erittäin huono
□ huono
□ melko huono
□ melko hyvä
□ hyvä
□ erittäin hyvä
□ en tiedä

Ääneni kantaa mielestäni yleensä

□ erittäin huonosti
□ huonosti
□ melko huonosti
□ melko hyvin
□ hyvin
□ erittäin hyvin
□ en tiedä

Ääneni kestää työhön liittyvää kuormitusta (puhumista, laulamista)

□ erittäin huonosti
□ huonosti
□ melko huonosti
□ melko hyvin
□ hyvin
□ erittäin hyvin
□ en tiedä

Kun ääneni väsyy, se palautuu seuraavaan aamuun mennessä

□ erittäin huonosti
□ huonosti
□ melko huonosti
□ melko hyvin
□ hyvin
□ erittäin hyvin
□ en tiedä

## 3. Äänioiretuntemusten yleisyys ja vaikeusaste

Alla on joukko äänioireita koskevia kysymyksiä. Ensimmäisessä taulukossa pyydetään määrittelemään äänioireentuntemuksen yleisyys ja toisessa taulukossa äänioireentuntemuksen vaikeusaste. Ole hyvä ja valitse molemmista taulukoista kustakin kysymyksestä se vaihtoehto, joka kuvaa Sinua parhaiten.

Merkitse tähän taulukkoon äänioireesi/tuntemuksesi yleisyys
0=Ei koskaan, 2=Joskus/muutaman kerran vuodessa, 4=Melko usein/kerran kuukaudessa, 6=Hyvin usein/lähes joka viikko

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| 1. Ääneni rasittuu | □ | □ | □ | □ | □ | □ | □ |
| 2. Ääneni on käheä ilman että olen vilustunut | □ | □ | □ | □ | □ | □ | □ |
| 3. Minulla on palan ja/tai liman tunnetta kurkussa | □ | □ | □ | □ | □ | □ | □ |
| 4. Tunnen kurkussani ärsytystä tai kutinaa | □ | □ | □ | □ | □ | □ | □ |
| 5. Tunnen kurkussani ja kaulan alueella väsymystä ja/tai kipua puhumisen jälkeen | □ | □ | □ | □ | □ | □ | □ |
| 6. Tunnen kurkussani ja kaulan alueella väsymystä ja/tai kipua laulamisen jälkeen | □ | □ | □ | □ | □ | □ | □ |
| 7. Ääneni katkeilee tai pettää puhuessani | □ | □ | □ | □ | □ | □ | □ |
| 8. Ääneni katoaa kokonaan ilman että olen vilustunut | □ | □ | □ | □ | □ | □ | □ |
| 9. Työpäivän jälkeen ääneni on niin väsynyt, että se haittaa sosiaalista kanssakäymistä/ perheen parissa olemista/osallistumista äänellisesti vaativiin harrastuksiin | □ | □ | □ | □ | □ | □ | □ |

Merkitse tähän taulukkoon äänioireesi/tuntemuksesi vaikeusaste.
0=ei oireita, 2=oireet leviä, 4=oireet kohtalaisia, 6=oireet voimakkaita

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| 1. Ääneni rasittuu | □ | □ | □ | □ | □ | □ | □ |
| 2. Ääneni on käheä ilman että olen vilustunut | □ | □ | □ | □ | □ | □ | □ |
| 3. Minulla on palan ja/tai liman tunnetta kurkussa | □ | □ | □ | □ | □ | □ | □ |
| 4. Tunnen kurkussani ärsytystä tai kutinaa | □ | □ | □ | □ | □ | □ | □ |
| 5. Tunnen kurkussani ja kaulan alueella väsymystä ja/tai kipua puhumisen jälkeen | □ | □ | □ | □ | □ | □ | □ |
| 6. Tunnen kurkussani ja kaulan alueella väsymystä ja/tai kipua laulamisen jälkeen | □ | □ | □ | □ | □ | □ | □ |
| 7. Ääneni katkeilee tai pettää puhuessani | □ | □ | □ | □ | □ | □ | □ |
| 8. Ääneni katoaa kokonaan ilman että olen vilustunut | □ | □ | □ | □ | □ | □ | □ |
| 9. Työpäivän jälkeen ääneni on niin väsynyt, että se haittaa sosiaalista kanssakäymistä/perheen parissa olemista/osallistumista äänellisesti vaativiin harrastuksiin | □ | □ | □ | □ | □ | □ | □ |

## 4. Työseikat jotka vaikuttavat ääneen

Haittaavatko seuraavat seikat äänenkäyttöäsi (siinä tilassa, jossa yleensä työskentelet)?

| TYÖSKENTELYTILA | Ei lainkaan | Melko vähän | Kohtalaisesti | Melko paljon | Erittäin paljon |
|---|---|---|---|---|---|
| Liian suuri tila | □ | □ | □ | □ | □ |
| Liian ahdas tila | □ | □ | □ | □ | □ |
| Kaikuisuus | □ | □ | □ | □ | □ |
| Meluisuus | □ | □ | □ | □ | □ |
| Ulkona tapahtuva ohjaus | □ | □ | □ | □ | □ |
| Muu, mikä? | □ | □ | □ | □ | □ |

Muu työskentelytilaan liittyvä seikka (jos vastasit muu, mikä?)

| TAUSTAMELU | Ei lainkaan | Melko vähän | Kohtalaisesti | Melko paljon | Erittäin paljon |
|---|---|---|---|---|---|
| Oheislaitteiden taustamelu (ilmastointi, opetusvälineet, vaatehuolto jne.) | □ | □ | □ | □ | □ |
| Lasten aiheuttama taustamelu | □ | □ | □ | □ | □ |
| Kalusteiden aiheuttama taustamelu | □ | □ | □ | □ | □ |
| Oman ryhmän ulkopuolelta tuleva melu | □ | □ | □ | □ | □ |
| Ulkoa tuleva taustamelu | □ | □ | □ | □ | □ |
| Muu, mikä? | □ | □ | □ | □ | □ |

Muu taustameluun liittyvä seikka (jos vastasit muu, mikä?):

| HUONEILMA | Ei lainkaan | Melko vähän | Kohtalaisesti | Melko paljon | Erittäin paljon |
|---|---|---|---|---|---|
| Kuivuus | □ | □ | □ | □ | □ |
| Kosteus | □ | □ | □ | □ | □ |
| Sopimaton lämpötila | □ | □ | □ | □ | □ |
| Ilman epäpuhtaudet ja pöly | □ | □ | □ | □ | □ |
| Hajut ja tuoksut | □ | □ | □ | □ | □ |
| Muu, mikä? | □ | □ | □ | □ | □ |

Muu huoneilmaan liittyvä seikka (jos vastasit muu, mikä?):

| ERGONOMIA | Ei lainkaan | Melko vähän | Kohtalaisesti | Melko paljon | Erittäin paljon |
|---|---|---|---|---|---|
| Epätarkoituksenmukaiset kalusteet/laitteet (omiin mittasuhteisiin sopimattomat) | □ | □ | □ | □ | □ |
| Nostelu | □ | □ | □ | □ | □ |
| Kumartelu | □ | □ | □ | □ | □ |
| Pitkäkestoinen asentoa ylläpitävä (staattinen) jännitys, esim. käsien kannattelu, pitkällinen samassa jännittyneessä asennossa työskentely | □ | □ | □ | □ | □ |
| Muut puhumisen kannalta hankalat työasennot (esim. pään kierto tai eteen taivutus) | □ | □ | □ | □ | □ |
| Muu, mikä? | □ | □ | □ | □ | □ |

Muu ergonomiaan liittyvä seikka (jos vastasit muu, mikä?):

| RYHMÄ | Ei lainkaan | Melko vähän | Kohtalaisesti | Melko paljon | Erittäin paljon |
|---|---|---|---|---|---|
| Liian suuri lapsimäärä ohjaustilanteessa | □ | □ | □ | □ | □ |
| Liian suuri lasten ikäero ryhmässä | □ | □ | □ | □ | □ |
| Muuten epäyhtenäinen lapsiryhmä | □ | □ | □ | □ | □ |
| Rauhattomuus ryhmässä | □ | □ | □ | □ | □ |
| Erityishuomiota vaativat lapset | □ | □ | □ | □ | □ |
| Muu, mikä? | □ | □ | □ | □ | □ |

Muu ryhmään liittyvä seikka (jos vastasit muu, mikä?):

| ÄÄNESSÄOLOAIKA | Ei lainkaan | Melko vähän | Kohtalaisesti | Melko paljon | Erittäin paljon |
|---|---|---|---|---|---|
| Työhön kuuluva laulun määrä | □ | □ | □ | □ | □ |
| Työhön kuuluva ääneen lukemisen määrä | □ | □ | □ | □ | □ |
| Työhön kuuluva suullisen opetuksen ja ohjauksen määrä | □ | □ | □ | □ | □ |
| Voimistetun äänenkäytön määrä (esim. järjestyksen ylläpitäminen) | □ | □ | □ | □ | □ |
| Työhön kuuluva kokonaispuhemäärä | □ | □ | □ | □ | □ |
| Muu, mikä? | □ | □ | □ | □ | □ |

Muu äänessäoloaikaan liittyvä seikka (jos vastasit muu, mikä?):

| PSYKOSOSIAALISET TEKIJÄT | Ei lainkaan | Melko vähän | Kohtalaisesti | Melko paljon | Erittäin paljon |
|---|---|---|---|---|---|
| Organisaation aiheuttamat paineet (esim. työn määrä, välilliset työtehtävät jne.) | □ | □ | □ | □ | □ |
| Työyhteisön/ihmissuhteiden aiheuttamat paineet | □ | □ | □ | □ | □ |
| Kiire työssä | □ | □ | □ | □ | □ |
| Työn henkinen kuormittavuus | □ | □ | □ | □ | □ |
| Työn ulkopuoliset tekijät | □ | □ | □ | □ | □ |
| Muu, mikä? | □ | □ | □ | □ | □ |

Muu psykososiaalinen seikka (jos vastasit muu, mikä?):

Kiitos, vastauksesi käsitellään luottamuksellisesti!

## APPENDIX G

**Form used for assessing endoscopic findings.**

| | | | | | |
|---|---|---|---|---|---|
| Interarytenoid edema | | None | Mild | Moderate | Severe |
| | | | | | |
| Degree of redness | Right | | | | |
| | Left | | | | |
| Location of redness | Side | None | Front part | Middle part | Posterior part |
| | Right | | | | |
| | Left | | | | |
| Mucous thickness | | Runny or even | | Moderately thick | Quite thick |
| | | | | | |
| Location of mucus [1] | | Uniform or not visible | On the anterior third or anterior commissure | Between the anterior and middle thirds | On the posterior third |
| | | | | | |
| Type of mucus [2] | | Uniform or even mucus | Rough mucous surface of the vocal folds that may be sticky enough to cause mucus threads between them during abduction | Mucus bubbles along the free margins of the vocal folds, resembling vocal fold nodules | Mucus lumps that act as masses on the vocal folds |
| | | | | | |

[1] Hsiung M. Videolaryngostroboscopic observation of mucus layer during vocal cord vibration in patients with vocal nodules before and after surgery. Acta Otolaryngol. 2004;124:186_91.

[2] Hsiao T, Liu C, Lin K. Videostrobolaryngoscopy of mucus layer during vocal fold vibration in patients with laryngeal tension-fatigue syndrome. Ann Otol Rhinol Laryngol. 2002;111:537_41.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Shape of the glottis and vocal folds during adduction | | Straight vocal folds' edges  | Open posteriorly  | Irregular glottis  | Curved vocal folds  | Anteriorly open  | Vocal fold nodules  | Away from each other during adduction  |
| | | | | | | | | |
| Mucus adhesivity, assessed after throat clearing or coughing | | Hard to decide | Normal | | Moderately sticky | | Very sticky | |
| | | | | | | | | |
| Is there asymmetry of movement? | | No | | | Yes | | | |
| | | | | | | | | |
| If asymmetrical, then in which direction? | Side | Abduction direction | | | Adduction direction | | | |
| | Right | | | | | | | |
| | Left | | | | | | | |
| Other findings: nodules, granuloma, Reinke edema, cyst, polyp, etc. | | Right: | | | Left: | | | |
| Write own description of the findings | | | | | | | | |

Other findings or comments:

# ORIGINAL PUBLICATIONS