

Voice Ergonomics

Voice Ergonomics:

Occupational and Professional Voice Care

Edited by

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INTRODUCTION

Speaking and hearing are part of the job description in several professions. There are professions in which voice is a working tool that must be taken care of. Teachers of different degrees have been recognized as one of the largest groups of occupational voice users. In addition, other professionals speaking to groups or individuals and those working by phone need a well-working voice. Also, children as future occupational and professional voice users are an object of voice ergonomic study and actions.

Voice disorders are frequent among occupational voice users, among those who use their voice a lot in their work. Voice disorders usually occur because of exposure to environmental factors which increase the loading of voice organs when speaking in unfavorable conditions whatever the primary cause of a voice disorder. Because many risk factors for voice disorders are bound to the work environment, it is useful to investigate the work environment in some way in the case of a voice disorder. At its best the work environment should also be planned according to the needs of voice ergonomics.

Voice ergonomics has been developed for improving voice and speech as tools for communication. It consists of all factors and measures that increase the possibilities for good voice and speech production and for hearing (perception). Voice ergonomics contains personal and environmental factors such as taking care of the health of the voice organs and adopting fewer loading activities/working practices. It also includes observing and treating noise sources and acoustics, activity and working practices, postures and the indoor climate properly for voice and speech production in work and other environments.

We are using the term Voice Ergonomics instead of Vocal Ergonomics, since the word 'vocal' points to the singing voice whereas the word 'voice' points to the sound that the vocal organ is producing while speaking and singing and that the auditory system is receiving.

Voice ergonomics is a broader field than the well-known issue of "Vocal hygiene", but the topics include it. When voice ergonomics is understood extensively it also includes in addition to the reduction of risk factors for a voice disorder, the reduction of noise that is important for speech perception and the cognitive functions of listeners such as attention, memory and learning. Thus voice ergonomics is overlapping cognitive ergonomics as

well as several other fields of ergonomics (auditory, physical, organizational and visual ergonomics).

There are many scientific studies and publications on separate voice ergonomic risk factors, but they are scattered in different articles. However, knowledge about voice ergonomics as a whole is missing or has been sparse on a popular level, and before this book very little advice on good voice ergonomics has been available to apply in practice. This book is intended to cover this shortage.

The aim of the book is to give new tools to voice specialists and experts, voice users and occupational health care personnel to minimize risk factors for a voice disorder, since there are several professions/occupations for which voice is a working tool that must be taken care of. Teachers from preschools to universities have been recognized as one of the largest groups of occupational voice users. In addition, other professionals speaking to groups and teleworkers need a well-working voice. It is well-known that voice disorders are frequent among occupational voice users, and they are increasing. A high-quality communication ability is called for more and more. Because many risk factors for voice disorders are bound to the work environment, the work environment should be considered to some extent in the prevention and treatment of voice disorders. This book will give several tools for that.

The book's theoretical part will cover the voice ergonomics background, voice ergonomic risk factors and solutions for how to minimize the risks and prevent voice disorders. Scientific studies on different fields of voice ergonomics are on the increase. The first part of this book contains a review and conclusions of scientific research that is remarkable in the clinical work in voice ergonomics.

The practical part includes a short introduction to each topic and checklists/forms that help in making observations and measurements, and make it easier to problem-solve and plan the next steps. The handbook moves from one ergonomic factor to another: 1 Noise and acoustics, 2 Indoor climate, 3 Working postures, 4 Working practices, and 5 The need for amplifiers. The reliability of the voice ergonomic checklist has been tested in practice and in several scientific studies which are presented in the scientific part.

The number of scientific studies and publications on voice ergonomic risk factors is high nowadays, published frequently during recent decades. However, knowledge about voice ergonomics on a practical and popular level has been sparse, and before this book very little advice on good voice ergonomics has been available to apply in practice. This book is intended to cover this shortage.

There is an increasing need for voice specialists and occupational and professional voice users to have tools for the prevention and treatment of voice disorders to apply in practice. Along with increasing awareness of this possibility, voice ergonomics will be one of the fundamental ways of activity among the voice field in the future.

THEORETICAL APPLICATIONS

1. VOICE DISORDER AND VOICE ERGONOMICS

EEVA SALA, LEENA M. RANTALA,
SUSANNA SIMBERG

Voice as a working tool

Speech (voice) is the most important tool in communication between humans. The voice source is in the larynx that changes aerodynamic energy generated by exhalation into acoustic energy (mechanical waves of pressure). Acoustic energy is worked up and amplified in the supra glottal cavities into words and sentences. Voice propagates through air as mechanical waves of pressure which still is aerodynamic energy and meets the ear where it changes into mechanic and electroacoustic energy. A neural tract starting from the inner ear transfers signals to the brain for interpretation and understanding.

A clear and well-functioning voice is one of the professional skills and the ability to work. Voice should be under control so that the voice user knows the possibilities and restrictions of the voice as well as the risks that may threaten it. The environment where voice is used should be conducive for that purpose. Noise and poor acoustics should not disturb those who are speaking or listening.

Voice problems are an increasing public health and economic challenge. The economy has become dependent on communication-based employment and this trend will increase during the next century. The prevalence rates of communication disorders in the United States indicate that they will be a major public health challenge for the 21st century. Communication disorders have been estimated to cost the United States from \$154 billion to \$186 billion per year, which is equal to 2.5% to 3% of the Gross National Product (Ruben 2000). Voice ergonomic intervention is one tool among others to cure or relieve voice disorders.

A voice disorder

Voice disorders are medical conditions characterized by symptoms and/or abnormal voice quality, pitch, loudness and/or resonance. Voice endurance is under that of subjects with the same age and gender. Thus, a voice disorder is often a state in which the voice does not function according to the needs of a speaker or in which voice quality is considered not proper/adequate for the purpose. A voice disorder causes symptoms of the diseased voice organ or a lack of function or an abnormal voice quality. Whatever is the primary background of a voice disorder, environmental factors influence how the speaker overcomes the speech task.

A voice disorder has been defined from the functional, comparative, and symptom-based viewpoint. According to a functional perspective a voice disorder is simply that the voice does not fulfill the requirements set upon it (Vilkman 2004), or if it at “any time does not work, perform, or sound as it normally should, so that it interferes with communication” (Roy et al. 2004, 283).

A definition of a comparative approach is “an abnormal pitch, loudness and/or vocal quality resulting from disordered laryngeal, respiratory and/or vocal tract functioning” (Olson-Ramig et al. 1998).

A medical viewpoint is a symptom-based definition that is based on a disordered vocal tract, a voice disorder which is present when one experiences vocal and/or laryngeal symptoms (the voice becomes strained or tires, the voice becomes low/hoarse, the voice breaks, there is difficulty in being heard, aphonia, a sensation of pain or a lump in the throat and throat clearing/coughing). Symptoms, of course also include a functional perspective like the “voice becomes low/hoarse” and the “voice breaks”, “difficulty in being heard” and “aphonia” (Sala et al. 2001; Simberg et al. 2005; Simberg et al. 2009).

Speakers often suffer from various symptoms related to a voice disorder. They spring from voice use and/or disease of the voice organs. The symptoms appear for some time and last for a period of time or are connected to a speaking situation. A voice disorder is a complex entity and has several levels to explore, such as subjective symptoms, perceptual voice quality, acoustic quality and strength of voice, endurance of voice and the disease state of the voice organ.

Behind a voice disorder is often an organic pathology, sometimes even more than one (Gregory et al. 2012; Van Houtte et al. 2010). Nonetheless, not all of the organic changes in vocal folds cause a voice disorder. In the study on preschool (day care center) teachers by Sala et al. (2001), all participants underwent a laryngeal examination. The results

revealed that those who reported two or more frequently occurring vocal symptoms often had an organic voice disorder. The most frequent finding was laryngitis diagnosed in 17% of the preschool teachers compared to 6% of the nurses (Sala et al. 2001). In a quite recent Chinese study there was a very high prevalence of voice disorders among teachers, and also a high prevalence of organic findings: laryngitis was the most frequent laryngeal finding followed by polyps and nodules (Lu et al. 2017).

Organic voice disorders are disorders caused by structural or neurologic abnormality of the larynx.

Structural pathologies may be vocal fold nodules, polyps, cysts, laryngeal papillomatosis, premalignant and malignancies. Neurological abnormality may be vocal fold paresis or paralysis.

Functional voice disorders are characterized by an abnormal voice quality and/or reduced vocal capacity in the absence of causal structural or neurological laryngeal pathology (Van Houtte et al. 2010).

To treat a voice disorder successfully, underlying causes need to be examined carefully because the treatment is not the same for all voice disorders and a serious underlying condition may be present. There are several kinds of voice disorders: functional, organic and neurologic. A physician (voice specialist) has the responsibility to assess and define (diagnose) a voice disorder, to explore a voice disorder type and the causes of it, as well as offer and outline the treatment.

The treatment of a voice disorder usually includes the remedy of a disease, the elimination or decrement of risk and loading factors, checking the voice production manner and if necessary, correcting it.

Voice disorders usually occur because of exposure to external/environmental factors since environmental factors increase the loading of voice organs when speaking in unfavorable conditions. Various environmental factors are affecting simultaneously or successively, and people are exposed to them for long periods (from daily to yearly). They may have additive or even cumulative effects on the vocal organs and thus, on the voice. It has been found that voice symptoms are mainly due to external factors (Nybacka et al. 2012; Simberg et al. 2009). But, of course causes of voice disorders are also due to other than environmental factors. External factors are noise and acoustics, indoor climate, the possibility to keep good postures and access to an amplifier if needed.

It is possible to prevent a voice disorder to a certain level at least. **The prevention of a voice disorder** is based on the knowledge of the physiology of voice production and the mechanisms of risk factors that interfere with

voice production. Ways to prevent a voice disorder **at a personal level** are to acquire good or excellent skills in voice production, to take care of the health of the vocal organs, to adopt light loading activity and working practices and to keep good postures. To keep voice production in a good state, exercises for healthy and economic voice use habits are taught and voice exercises are recommended as a regular habit. In addition, voice ergonomic information is given. Environmental risk factors are checked and removed or decreased as effectively as possible.

Prevalence of voice disorders in various occupational groups

The importance of the voice as an occupational tool in a number of occupations today is unambiguous. Voice disorders are a common problem among occupational voice users. The results of studies concerning voice disorders and occupations vary depending on how the voice disorder has been defined (functional, for instance how the voice is functioning, comparative, for instance the voice quality, or the symptom-based viewpoint, for instance if there are voice or laryngeal symptoms present), the study populations and the methods (the prevalence period, symptom words and phrases, etc.) used in the studies.

In the general population the prevalence varies between 6,2% (Roy et al. 2005) and 38,5% (Spantides et al. 2015), whereas among a huge number of subjects (N=114.538) the prevalence of voice disorders was found to be 16,9% (Lyberg-Åhlander et al. 2018).

In teachers, prevalence frequencies have been found between 11% and 81% (Da Costa et al. 2012; de Jong et al. 2006; Kojiiman et al. 2007; Ohlsson et al. 2012). In a recent study of Lyberg Åhlander et al. in 2018 the prevalence of voice disorders among teaching professionals (N=2202) was 19%.

In Finland, **data for several studies on occupation and voice disorders** (see Table 1-1) have been collected with the same questionnaire on vocal symptoms since the 1990s (Pekkarinen (Sala) et al. 1992). The questionnaire has been later named Screen6 by Ohlsson et al. (2012). The symptoms enquired about have been: *The voice get strained or tires, The voice gets low or hoarse, Throat clearing or coughing while talking, Voice breaks while talking, A sensation of tension or a lump in the throat and Difficulty in being heard*. Questions concerning the work environment, such as exposure to noise, questions about room acoustics and air quality and posture while talking have also been included.

Table 1-1. One-year prevalence of voice disorders (Screen6: two or more symptoms occurring weekly or more often without a cold) in various occupational groups, prevalence of individual symptoms. The order of studies is according to the age of the study.

Occupational group	N	Prevalence %	The symptoms occurring weekly or more often	
Teachers Pekkarinen et al. 1992 ¹⁾	478	5	Voice tires easily	9%
			Hoarseness	4%
			Sore throat/globus	4%
			Difficulty in being heard	2%
			Voice breaks	3%
			Aphonia	0%
Hospital nurses Pekkarinen et al. 1992 ¹⁾	95	2	Voice tires easily	4%
			Hoarseness	2%
			Sore throat/globus	2%
			Difficulty in being heard	2%
			Voice breaks	1%
			Aphonia	0%
Teacher students Simberg et al. 2000	226	20	Throat clearing	29%
			Voice tires easily	19%
			Sore throat/globus	14%
			Hoarseness	14%
			Difficulty in being heard	7%
			Voice breaks	6%
			Aphonia	1%
Office workers Sala et al. 2001 ³⁾	79	18	Throat clearing or coughing	29%
			Voice tires easily	14%
			Hoarseness	14%
			Sore throat/globus	11%
			Difficulty in being heard	10%
			Voice breaks	9%
			Aphonia	3%
Preschool (Day care center) teachers Sala et al. 2001; 2002	262	37	Throat clearing or coughing	40%
			Voice tires easily	31%
			Hoarseness	26%
			Sore throat/globus	18%
			Voice breaks	14%
			Difficulty in being heard	11%
			Aphonia	1%

Hospital nurses Sala et al. 2001; 2002	108	17	Throat clearing or coughing 28% Voice tires easily 11% Sore throat/globus 11% Hoarseness 10% Voice breaks 5% Difficulty in being heard 1% Aphonia 0%
Teachers Simberg et al. 2005 ¹⁾	241	20	Voice tires easily 22% Hoarseness without a cold 18% Sore throat/globus 14% Difficulty in being heard 9% Voice breaks 7% Aphonia 2%
Teacher students Ohlsson et al. 2012	1250	17	-
Priests Hagelberg et al. 2015	889	27	Throat clearing or coughing 31% The voice tires easily 23% Hoarseness without a cold 18% Sore throat/globus 14% Difficulty in being heard 7% Voice breaks while talking 7%
Soccer coaches (male) Fellman et al. 2016	109	28	Throat clearing or coughing 30% Voice becomes low or hoarse 23% Voice becomes strained or tires 22% Voice breaks while talking 16% Sore throat/globus 14% Difficulty in being heard 13%
Cruise ship personnel Simberg et al. 2018 ²⁾	196	23	Throat clearing or coughing 22% The voice gets hoarse 15% The voice tires 15% Sore throat/globus 14% Difficulty in being heard 13% Voice breaks while talking 10%
Teacher students Greve et al. 2018	968	14	Throat clearing or coughing 27% The voice tires 8% Sore throat/globus 8% Difficulty in being heard 7% The voice gets hoarse 6% Voice breaks while talking 4%
¹⁾ Two vocal symptoms or more occurring weekly or more often. ²⁾ Two-year prevalence. ³⁾ Not published.			

The results show that **the occupational groups with most voice problems** (two or more symptoms occurring weekly or more often) are preschool (day care center) teachers (37%), soccer coaches (28%), priests (27%), hospital nurses (17%) and teacher students (17%) (See Table 1-1).

The results also revealed that **the prevalence of symptoms** had increased during ten to fifteen years from 2 to 17% in the nurses and from 5 to 20% in the teachers (Simberg et al. 2005). It is also evident that the newer the study the higher is the prevalence of the voice disorder. This may be due to changes in speech communication culture/practices or to poor indoor air quality (regulations favoring tight and energy saving building) but this speculation is lacking scientific evidence so far.

Impact of a voice disorder on work

When the voice does not function according to a user's needs it may lead to the avoidance of voice use, to the selection of practices or work tasks with fewer or no voice demands, to a decrease in the ability to be active or to work, to the drop in outcomes, to be unable to work and absenteeism from work. At worst, a worker may even have to change her or his work and educate herself or himself for a new profession due to a voice problem.

The impact of voice symptoms on work depends on what kind of voice demands and loading factors there are at work. The results of Sala et al. (2001) showed that the impact of vocal symptoms on communication at work was much higher among day care center teachers than among hospital nurses (Table 1-2). Ebersole et al. (2018) also showed that performers and people with high occupational voice needs demonstrate sensitivity to subtle voice changes.

So far, there is **no unambiguous method to measure the ability to work with the voice**. Instead, there are questionnaires measuring voice activity and participation or handicap due to voice symptoms. The **Voice Handicap Index (VHI)** measures the handicap due to a voice disorder in everyday life (Jacobson et al. 1997) and the **Voice Activity and Participation Profile (VAPP)** assesses the impact of voice disorders on daily activities (Ma et al. 2001). There is a clear association between voice symptoms and a handicap due to voice symptoms (VHI), the more voice symptoms the greater is the handicap (Ohlsson et al. 2012; Rantala et al. 2012). The **Voice Capability Questionnaire (VCQ)** charts voice quality, laryngeal symptoms and also voice loudness, the effort in voice production and voice projection (Buckley et al. 2015). The impact that the voice disorder is having on the patient's **voice-related quality of life (V-RQOL)** is also available (Hogikyan et al. 1999; Lu et al. 2017). As far as we know,

there is no method to measure the **working ability from the voice point of view**.

Table 1-2. The impact of voice symptoms on communication at work or during leisure time activities. The impact means that voice symptoms are at least moderate, remarkable, cause the need for special arrangements, or inhibit communication totally. Various alternatives given to the respondents were “no impact”, “slight”, “moderate”, “remarkable”, “causes the need for special arrangements”, or “inhibits the communication totally” (Sala et al. 2001).

Communication situation	Frequency (%)			
	Teachers n=249-258	Nurses n=106	X ² (df=1)	p
At leisure activities	4	3	0.50	0.482
At work	38	8	34.40	0.001

Impact of a voice disorder on the listeners

The voice in a voice disorder is hoarse with a varying degree and quality (rough, breathy and/or strained). In a dysphonic voice there is noise present which can be measured as a harmonic-to-noise ratio. Like environmental noise, also noise in the speech voice affects the perception of speech. If a teacher’s voice is dysphonic, it affects the perception of speech in children (Morton et al. 2001), and even a mild dysphonic voice affects speech perception in children (Rogerson et al. 2005, Chui et al. 2018). A teacher with a voice disorder also participates in speech communication in a different way compared to a teacher with a healthy voice.

In a study of Szabo Portela et al. (2018) those with vocal nodules were speaking for longer times and with a higher voice level with a better signal-to-noise ratio than their controls. They thus compensate poor perception of their speech by increasing the signal-to-noise ratio which happens without being aware of it, and when the primary cause for loud-voice use remains open. As there are several kinds of voice disorders, a person with a voice disorder may reduce activity to participate in speech communication and working (Ma et al. 2001).

Occupational, professional and active voice users

There are several groups of voice users whose voice use is essential for managing their work. We differentiate those people into three groups depending on their voice skills, endurance and quality needed and the work situations where they use their voices. Based on this there are three distinct/separate groups.

Occupational voice users are those who need a lot of voice and often must use a loud voice in their work when speaking. They usually speak to groups, at long distances and in the presence of noise. The endurance of voice should be good, or in fact the voice organ should be healthy and in good condition, to tolerate the loading. They have no or only a little guidance in voice use and training for speech production. Typical occupational voice users are teachers.

Professional voice users are those who need much voice and a skillful voice in their work. They are performing to an audience, have natural stress before a performance but can have stage fright or strain. They have various degrees of information concerning the anatomy and physiology of the voice organ and voice use; and have had voice training during their studies. Their voice quality and voice endurance should be perfect or sufficient, or at least fit for the purpose and situation. Typical professional voice users are actors and classical singers. **Artistic voice users, professional vocalists and elite voice performers** are also used as terms which underline the elitist or artistic nature of the profession. Other authors have also given similar descriptions (Titze et al. 1997; Vilkmán 2000; 2004).

Typical occupational voice users are

- teachers,
- military trainers,
- sports coaches,
- clergy/priests,
- physical-education instructors, and
- politicians.

Characteristics of the occupational voice user's work are

- the need for a lot of voice/much voice use,
- having to use a loud voice,
- speaking to groups and at long distances,
- speaking in the presence of noise,
- the speaking environment is often with poor acoustics, and
- they have no or only a little guidance in voice use and training.

Demands of occupational voice users are

- voice endurance needs to be good, and
- voice quality should suit the task.

Typical professional voice users are

- classical singers,
- singers,
- actors, and
- cantors.

Characteristics of the professional voice user's work are

- needing a lot of voice,
- needing preferably a high-quality voice
- needing a skillful voice,
- performing to an audience,
- possibly having stage fright/strain,
- having a lot of information concerning voice, and
- getting voice training during their studies.

Demands of professional voice users are

- voice quality and voice endurance should be perfect or sufficient, or at least be fit for the purpose and situation.

Then there are workers who use much voice during a working day. They usually talk on a phone or a mobile or to people who are nearby. These we call **active voice users**. This group may also be categorized as occupational voice users (Vilkman 2000), but as their speech communication conditions and work environments differ greatly from each other, the authors of this book have separated active voice users from occupational voice users into their own group.

Typical active voice users are

- telemarketers,
- customer call-center workers,
- office workers,
- product demonstrators,
- lawyers,
- nurses,
- physicians,
- speech therapists,
- physiotherapists, and
- TV and radio broadcasters.

Characteristics of an active voice user's work are

- speaking much during a working day,
- speaking on a phone or a mobile,
- speaking to people who are nearby,
- speaking to single persons or small groups,
- speaking on a phone in the car, and
- working in open-plan offices or enclosed office rooms or
- various business environments.

Demands of typical active voice users are

- voice quality and voice endurance should be perfect or sufficient, or at least fit for the purpose and situation.

People who are responsible for voice ergonomics are the planners of the buildings, rooms, furniture and equipment used for work. They ought to consider the special needs of active, occupational and professional voice users. The environment where voice is used should be proper for that purpose. Noise and poor acoustics should not disturb those who are producing a voice and speech or listening to it. Voice users should also have the possibility of using proper postures while speaking, and have access to an amplifier, if needed. A good speech communication environment is quiet with proper acoustics, the air is fresh without harmful pollutants, the environment supports using good postures; and aids like voice amplifiers are available, if needed.

Occupational, professional and work-related voice disorders

Definitions for occupational or professional voice disorders depend on the legislation of a country and the terminology used in the school of a medical or scientific field. The primary causes of voice disorders are often multifactorial. They may be endogenous or due to environmental exposure. Examples of endogenous disuse damages/voice disorders are reflux laryngitis and vocal fold paralysis whereas at least a contributory factor for vocal nodules is environmental. In addition, there are studies that prove the connection between laryngitis and poor environmental climate (Rantala et al. 2012).

An **occupational voice disorder** is often the functional correlation of a disease. In the strictest definition for legal purposes, occupational disease (tissue damage) is considered a disease which is most likely caused primarily by exposure at work. The exposure may be physical (for example

noise) or chemical (for example allergens or toxic substances) by nature. The definition also involves exposure that is found in such an amount that it can cause a disease (tissue damage). Accordingly, an occupational voice disorder is one that is due to tissue damage which is most likely caused primarily by exposure at work. The diagnosis requires a careful laryngeal examination and an investigation of working conditions, to name the exposure factors. A typical occupational voice disorder is due to vocal nodules as the result of high vocal loading. Typical occupations that meet the criteria are teachers and employees working in day care centers.

A **professional voice disorder** has basically the same criteria as an occupational voice disorder but it may be caused by lower exposure to poor ergonomic conditions as the voice organs should function with high quality. Exposure to allergens and pollutants may be more incapacitating to professional voice users than to others. To use the diagnosis of an occupational or professional voice disorder for clinical purposes, such a careful specification is not as necessary as that for legal purposes i.e. to get compensation through insurance for sick leave to avoid exposure during recovery, and to attain treatment and therapy.

A **work-related voice disorder** is a disorder that is due to tissue damage which is most likely caused primarily by **exposure other than work**, for example, tissue damage due to laryngopharyngeal reflux, which causes a disease, increases the risk for laryngitis, vocal fold cysts, polyps, pseudocysts, etc., or if a speaker has vocal fold paresis (for example a viral infection or trauma). People with a work-related voice disorder mainly have symptoms at work because of the higher demands of voice use needed at work than at leisure times. In practice, the disease or the tissue damage is not always found or diagnosed because of the lack of proper know-how and examination methods, or the voice disorder is purely functional.

A **voice disorder often causes a handicap** mainly at work because of the high demands (amount of speech and voice levels) that work sets for communication and vocal performance. The results of a study by Sala et al. (2001) showed differences in vocal demands between work and free time: 38% of the teachers experienced voice symptoms complicating their communication and voice use at work but only 4% of the same teachers reported having similar problems during their leisure time.

Strict criteria of an occupational or a professional voice disorder

To prove a disease (voice disorder) as an occupational disease **the cause-effect relationship must be shown** at the tissue level. It has been proved that using a high voice level causes tissue damage to vocal folds (Grayet et al. 1987). Noise is the exposure that forces the use of high voice levels.

Exposure in the work environment should be shown to be such an amount that it can cause the disease. Noise levels have been shown to be high [over 40 dB(A)] to cause the need to raise the voice, for example in school classrooms (Sala et al. 2002; Sala et al. 2016).

There is also the need to **prove increased risk in the exposed population**. This means that the cause–effect relationship must be shown at the general level (= in a population). That is, with an epidemiological study to show that the named risk factor causes the disease (tissue damage) at a higher probability in the exposed population (for example teachers) than in a non-exposed population. In the exposed population, the risk is higher than in the non-exposed population: the prevalence of voice symptoms is higher and organic findings in vocal folds are more frequent among teachers than in a control group. Vocal nodules, which are typical organic findings (tissue damages) associated with high vocal loading are found in teachers, 6% and nurses, 1% (Sala et al. 2001).

Definition and the development of voice ergonomics

We are using the term **Voice Ergonomics** instead of **Vocal Ergonomics**, since the word vocal points to a singing voice whereas the word voice points to the sound that the vocal organ is producing when speaking and singing and when the auditory system is receiving.

Voice ergonomics contain matters from **Voice/Vocal hygiene** and voice hygiene contains matters from voice ergonomics. What is the difference between voice ergonomics and voice hygiene? The term and the stress are different. In voice ergonomics the focus is on the environment and the interaction and adaptability with human functions and physiology. Voice ergonomics has been gradually, and is now widely, accepted during the last decade.

Voice hygiene is directed towards the subject. It contains guidelines on **how to behave** to minimize the risk for a voice disorder. These instructions include stop smoking, drink lots of water, balance extra vocal demands with voice rest, humidify the environment, use caution with medications and be aware of symptoms of laryngopharyngeal reflux disease. Some of these instructions are nowadays controversial (like drinking lots of water) or partly out of date like medication since new medicines have a less drying effect than before (for example, antihistamines like bilaste, feksofenadiinic or loratadine). The expression of hygiene is actually an old and wide concept. Hygiene refers to conditions and practices that help to maintain health and prevent the spread of infectious diseases.