Connections Between Voice Ergonomic Risk Factors and Voice Symptoms, Voice Handicap, and Respiratory Tract Diseases

***Leena M. Rantala, *Suvi J. Hakala, †Sofia Holmqvist, and ‡Eeva Sala,** **Tampere, †‡Turku, Finland*

Summary: Objectives. The aim of the study was to investigate the connections between voice ergonomic risk factors found in classrooms and voice-related problems in teachers.

Methods. Voice ergonomic assessment was performed in 39 classrooms in 14 elementary schools by means of a *Voice Ergonomic Assessment in Work Environment—Handbook and Checklist*. The voice ergonomic risk factors assessed included working culture, noise, indoor air quality, working posture, stress, and access to a sound amplifier. Teachers from the above-mentioned classrooms reported their voice symptoms, respiratory tract diseases, and completed a Voice Handicap Index (VHI).

Results. The more voice ergonomic risk factors found in the classroom the higher were the teachers' total scores on voice symptoms and VHI. Stress was the factor that correlated most strongly with voice symptoms. Poor indoor air quality increased the occurrence of laryngitis.

Conclusions. Voice ergonomics were poor in the classrooms studied and voice ergonomic risk factors affected the voice. It is important to convey information on voice ergonomics to education administrators and those responsible for school planning and taking care of school buildings.

Key Words: Voice ergonomics–Voice symptoms–Voice risk factors–Classrooms–Teachers.

INTRODUCTION

The causes of dysphonia are more often environmental (65%) than genetic (35%).[1] Thus, it is not surprising that teachers are known to suffer from voice disorders more often than workers in other occupations.[2–5] In spite of this, virtually no remedial measures have been taken—either for voice ergonomics in schools and classrooms or on the level of society and legislation.[6,7]

The risk factors for voice disorders are quite well documented. One of the most obvious is related to working culture, namely the excess of voice use. Indeed, teachers' phonation time at work has been found to be longer (20–40% of working hours[8–12]) than in other professions (under 10% of working hours[8,10,13]). Some teachers, like music teachers, use their voices even more than those teaching other subjects.[14]

In addition to long talking times, teachers' voice levels may be high.[10,12,15] One reason for raising the voice level is long speaking distance. Another reason is background noise: people raise their voices in a noisy environment because of the Lombard effect.[16–18] Loud background noise levels have frequently been measured in schools and kindergartens.[10,19–21] Much noise originates from classroom activities, and the noisiest of these have been measured to be 20 dB louder than the quietest working.[20] Urban schools may also suffer from noise outside the buildings; for instance, 86% of the schools in London were exposed to an average traffic noise level of 57 dB L_{Aeq}.[20]

Poor acoustics increase the harmful effects of noise by making the noise continuous and restricting the noise attenuation.[10,19,22] Furthermore, the speech transmission index, which expresses speech transmission in a space, has been found to be poor in classrooms[19] and kindergartens.[10] Teachers with voice problems are reportedly more prone to suffer from acoustic defects than teachers without them.[23]

The voice is also affected by indoor air quality, which has been shown to be poor in many European schools.[24] Exposure to organic dust may cause voice symptoms,[25] and organic and chemical impurities trigger allergic or inflammatory reactions in the laryngeal mucous membranes.[26,27] Respiratory allergies, in turn, increase the risk for voice symptoms.[28] Moreover, the risks will multiply if ventilation is poor, as has been reported to be in many classrooms.[29] Water damage is one source of poor indoor air, increasing the risk of mold formation. A study conducted in 12 countries reported visible mold in 13.9–39.1% in buildings.[30] Mold emits toxic substances that may cause voice problems[31,32] and upper respiratory symptoms.[31,33,34]

Humidity and temperature are also factors affecting indoor air quality. In a cold climate, the indoor air may be very dry, and the moisture-retaining capacity of the air decreases rapidly as the temperature of the air falls.[35] Low relative humidity affects voice production. It stiffens the cover of vocal folds and increases the viscosity of mucosa,[36] which, in turn, changes the mucosal wave by decreasing its amplitude and frequency.[37,38] As a result, the phonation threshold pressure increases.[39–42]

Some voice ergonomic risk factors, like working posture and emotions, are related to the speaker. Good postural alignment is important in optimizing voice function.[43] Patients with voice disorders have been found to have musculoskeletal abnormalities connected to the voice production structures, such as

Accepted for publication June 1, 2012.

From the *Logopedics, School of Social Sciences and Humanities, University of Tampere, Tampere, Finland; †Department of Logopedics, Åbo Akademi University, Turku, Finland; and the ‡Department of Otorhinolaryngology-Head and Neck Surgery, Turku University Hospital, Turku, Finland.

Address correspondence and reprint requests to Leena M. Rantala, Logopedics, School of Social Sciences and Humanities, FI-33014 University of Tampere, Finland. E-mail: leena.m.rantala@uta.fi

Journal of Voice, Vol. 26, No. 6, pp. 819.e13-819.e20
0892-1997/$36.00

http://dx.doi.org/10.1016/j.jvoice.2012.06.001

a high-held larynx, contraction of the stylohyoid and sternocleidomastoid muscles, and a weak deep flexor mechanism.[44] Of the working postures, sitting and standing have been shown to affect voice production differently.[45]

Emotions have a strong connection to the voice production.[46,47] Stress and anxiety change the acoustic features of the voice[48] and have been found to be associated with voice symptoms in teachers[49,50] and student teachers.[51] Teaching indeed includes numerous stressful factors. Most of the stressing teachers are maintaining discipline, time pressures, and workload.[52] In addition, personal traits may affect how people react to situations. Teachers with functional dysphonia may have temperamental features that elevate their reactivity to stress,[53,54] the level of which may increase to the same intensity as in the people with social anxiety.[55]

Voice disorder as an occupational hazard was reported as early as in the 1950s according to our search of Medline. During the last decade especially, extensive surveys of risks for voice use related to environmental factors[10,23,49,56,57] and studies dealing with workload changes in teachers' voices[58,59] were carried out. Thanks to these and other studies on teachers' voices, the understanding of the voice problems caused by the teaching environment has increased. However, to the best of our knowledge, a systematic voice ergonomic assessment protocol for measuring and inspecting risk factors in a working place has been lacking. The *Voice Ergonomic Assessment in Work Environment—Handbook and Checklist* (VEAW; in Finnish and Swedish) created by Sala et al[60] is such a tool. The publication was originally intended for the clinical use of occupational health care experts, but it can also be used in research.

This study is a part of a larger voice ergonomic research project on elementary schools. The aim of the present study was to assess voice ergonomic risk factors and their connections with teachers' voice symptoms in a real teaching environment by means of the VEAW. In addition, we studied if the teachers suffering from respiratory tract diseases had poorer indoor air quality in their classrooms than those without these diseases. The research also serves as a validating process of the VEAW.

MATERIALS AND METHODS

Schools and teachers

Thirty-nine classrooms in 14 elementary schools situated in five different municipalities were assessed in the study. The number of pupils in the schools ranged from 100 to 650. The head teachers of the schools selected at random from one to eight teachers and their classrooms for the study. According to the school authorities, acoustic improvements had been made to 12 schools; one school did not provide the information and in another school with an old and a new part, acoustic improvements had been made only in the new part. The oldest schools had been built about 100 years ago and the newest ones less than 10 years ago.

Teachers from the above-mentioned classrooms gave information on their voice symptoms. Thirty-one teachers were females and eight males. Mean age of the females was 45 years (range, 27–57 years) and of the males was 39 years (range, 31–45 years). Nine teachers had worked for less than 5 years, seven teachers from 5 to 10 years, and 23 for more than 10 years. Four participants smoked: during a day, one of them smoked less than 15 cigarettes and three less than five cigarettes. One male teacher had a benign mass lesion in the vocal folds in the past 12 months.

Voice ergonomic risk factors

The voice ergonomic assessment was performed with the VEAW. The researcher (S.J.H.) who made the assessment was trained to use the tool and blind to the participants' voice symptoms at the time of the assessment. The researcher assessed the risk factors by measuring, observing, or asking the teacher. The assessment was carried out after the teacher's workday.

The voice ergonomic risk factors consisted of six main domains (called risk fields). They were (1) working culture, (2) noise, (3) indoor air quality, (4) working posture, (5) stress, and (6) access to a sound amplifier as an aid to voice production. Noise from two sources was assessed: noise from equipment and activity noise caused by people. The results of the last one will be reported elsewhere.

Other risk fields except stress (one question) and access to an amplifier (two questions) included numerous risk factors. If a factor carried no risk, the finding was scored zero (0 = no risk to voice), that is, the condition was complied with the recommendation given in the VEAW. If the condition did not comply with the recommendation, a value of one was given in the VEAW (1 = risk of voice disorder). The risk factor stress was rated on a five-point scale (0 = no stress, 1 = only a little, 2 = some, 3 = quite a lot, or 4 = very much stress). The ratings 3 and 4 were considered as a risk for vocal health. The risk factors and their scoring are presented in the Appendix.

For computing the reliability of the VEAW, two researchers of the study group assessed eight classrooms separately. Cronbach's alpha coefficient for the total number of the risk factors was .99 and for the different risk fields, it varied from .95 to 1.

Voice-related variables

The voice-related variables surveyed were the participants' voice symptoms, voice handicap, and respiratory tract diseases. The voice symptoms elicited included (1) voice tires easily, (2) hoarseness, (3) voice breaks, (4) aphonia lasting at least a couple of minutes during speaking, (5) difficulty in being heard, (6) throat clearing, and (7) sore throat or globus in the throat. The participants responded on a five-point scale (4 = daily or almost daily; 3 = weekly or almost weekly; 2 = monthly or almost monthly; 1 = more seldom; and 0 = no symptom during the last 12 months). The voice questionnaire has been found to effectively reveal voice disorders according to a study where a voice screening method was developed to distinguish between normal and abnormal voice.[61] The same questionnaire has been used in other studies,[5,9,62] too.

Voice handicap was assessed by a Finnish-validated version of the Voice Handicap Index (VHI).[63] The VHI is a 30-item questionnaire with three domains: physical (VHI-P), functional