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RĪGAS STRADIŅA UNIVERSITĀTE

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VOICE DISORDERS IN TEACHERS: PREVALENCE, RISK FACTORS, PSYCHO-SOCIAL IMPACT

Summary of the Doctoral Thesis
Speciality – Theoretical Medicine

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The Doctoral Thesis was carried out in Rīga Stradiņš University and in the Speech and Voice Research laboratory of Liepaja University

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The Doctoral Thesis is available at the library of RSU and on the RSU website: www.rsu.lv

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Secretary of the Promotion Council:
Dr. habil. med., Professor **Līga Aberberga-Augškalne**

CONTENT

INTRODUCTION

Human voice – a source of individual and unique sounds that similarly to a mirror reflects our health condition, age, emotions and mood, expresses attitude and behaviour, impacts the course of communication and its outcome. Melodious teacher's voice is one of the corner stones of a successful education process. It characterizes teacher's vitality and adds liveliness to each lesson taught.

Voice disorder proportion in general population balances between 1% to 9.6% (*Roy et al.*, 2004a; *Sliwinska-Kowalska et al*, 2006). According to the data by the National Institute on Deafness and Other Communication Disorders of America voice disorders in teachers are found 32 times more than in representatives of other professions (*NIDCD*, 2008). During the last decade there is a tendency for the number of voice disorders to increase in teachers (*Sliwinska-Kowalska et al.,* 2006; *Orlova et al.*, 2000; *Simberg et al.,* 2005). It is explained by the significant changes in both school environment and socio-economic conditions.

Voice disorder is a multidimensional phenomenon that can be considered from the perspective of a cause as well as consequences. The cause of voice disorders is multifactorial (*Mattiske et al.,* 1998*; De Jong et al.,* 2001). Sometimes the cause for voice disorder is one, very powerful etiological factor yet in most cases the reason for voice disorders is a number of harmful factors. Most often teachers have functional voice disorders conditioned by continuous, loud speaking in stressful situations in classrooms the physical environment of which (acoustics, air quality) is very disadvantageous for the voice (*Mathieson,* 2001). Consequencies of chronic voice function disorders impact every area of individual's life. It impacts their physical, social, emotional, and professional comfort (*Ma, Yiu,* 2001*; Yiu,* 2002*; Xu et al.,* 2010).

In 2006–2007 an extensive pilot study (N = 733) was performed to find out the voice disorder problem urgency in teachers. The results showed that teachers' knowledge about voice, its usage, and professional hygiene was unsatisfactory; many educators were lacking this knowledge all together. Based on this we could provisionally assume that voice disorders could be a problem for a good number of teachers in Latvia and there is a good reason to carry on with this study to find out the prevalence of voice disorders, reasons for voice disorders, and their probable consequences in the population of teachers in Latvia.

Doctoral study is based on the following concepts:

A voice disorder – any time your voice does not work, perform, or sound as you feel it normally should, so that it interferes with communication (*Roy et al.,* 2004a).

Factors impacting voice quality are various factors that create unfavourable conditions for ensuring voice functionality when influencing individual's body; as a result there are vocal tract disorders (*Mattiske et al.,* 1998; *Aronson, Bless*, 2009*; De Jong et al.,* 2001).

As a result of various voice disorders individual's functional, emotional, and physical condition is impacted to various degrees that is considered to be the **direct consequences of voice disorders** (*Jacobson et al.,* 1997).

Objective of the study

The prevalence of voice disorders study in teachers by performing risk factor analysis and describing the impact voice disorders have on an individual.

Tasks of the study

1. To analyse academic resource data, especially the latest studies on the role of voice in teacher's profession, voice disorders, their prevalence and risk factors.

2. To become acquainted with the voice function evaluation methodology, to adapt and approbate the *Voice Handicap Index* into Latvian, to introduce study methodology of factors impacting voice quality.

3. To find out voice disorder prevalence in teacher's profession, especially when analysing the prevalence of voice disorders related to specialization, years worked in profession, and sex.

4. To perform analysis of factors causing voice disorders by determining proportion of their impact on voice disorder etiology.

5. To find out voice disorder impact on teacher's functional, emotional, and physical condition.

6. To perform voice function evaluation in teachers with voice disorders in two control groups – for teachers without voice disorders and non-teachers.

7. To perform statistical data processing, to analyse the acquired data, and to make conclusions.

Hypotheses of the study

1. Psychometric indicators of the *Voice Handicap Index* test in Latvian version correspond to the psychometric indicators of the original collection.

2. The prevalence of voice disorders in the population of teachers in Latvia is as high as in other countries.

3. The teacher's voice quality is impacted by neglecting voice hygiene, physical environment of the classrooms, medical factors, and psycho-social factors.

4. Voice disorders impact teacher's functional, physical, and emotional condition.

5. Objective voice measurements differ in teachers with and without voice disorders and in non-teachers.

Academic and practical novelty of the thesis

For the first time in Latvia a research on voice function disorders has been carried out. This research has activated voice disorder problem in a certain group of professions.

The thesis has summed up data about the prevalence of voice disorders in the population of teachers in Latvia. The prevalence of voice disorders has been analysed in teachers of various subjects and education periods, as well as a correlation between the voice disorders and teacher's age, sex, and years worked in profession.

Risk factors causing voice disorders have been analysed in the research. By using statistical analysis methods, an impact proportion of various risk factors in voice disorder etiology has been discovered, which allows to forecast the probability of voice disorders in individuals working as teachers.

The research analyses an impact of voice disorders on teacher's emotional, physical, and functional condition. The acquired data confirm that voice disorders impact teachers working capacity, their mental and physical comfort.

During the research objective voice parameter measurements have been performed by using voice function examination methods recognised throughout the world. Academically trustworthy data have been gathered during the course of research that confirms objective differences in voice quality among the teachers with and without voice disorders. The gathered data indicate statistically reliable differences in the number of voice parameters among the teachers and non-teachers allowing affirmation that profession can impact the overall voice qualities.

During the research a questionnaire on voice disorder risk factors has been developed and approbated, and a measurement instrument the *Voice Handicap Index* (VHI) for potential voice disorder impact has been adapted and

approbated from English. In Latvia up till now no statistically approbated voice function evaluation instrument has been developed that would have some academic or practical application. Instruments developed during the course of research can serve as points of reference for all future voice function researches.

In the research the voice evaluation protocol by the European Laryngological Society (ELS) has been practically approbated according to the logopedic competence. The voice function measurements were carried out using modern equipment in the only Speech and Voice research laboratory in Latvia that was opened during the course of developing thesis.

Each teacher involved in the research had a chance to pay attention to their voice as the main tool in their work and to acquire information about voice hygiene. Having the knowledge about saving one's voice and using it correctly is the first step towards application of this knowledge either directly or indirectly, thus there is a chance of reducing the prevalence of voice disorders in teachers.

Personal contribution

The author has personally participated in each step of the research, including design development, selection of academic methods, development of questionnaires and protocols, selection of research participants, and carrying out of the actual measurements. The author has researched and compiled academic resources, as well as processed and analysed the acquired statistical data.

Ethics committee approval

The research has been approved by the Rīga Stradiņs University Ethics Committee on 14 January 2010.

1 MATERIAL AND METHODS

1.1 Subjects

Study I. For approbation of the *Voice Handicap Index* three respondent groups were made. The first group (voice disorder group) includes patients that have been diagnosed with larynx illnesses of various etiologies by indirect laryngoscopy. Laryngoscopy was performed by a certified physician-otorhinolaryngologist. Control group included respondents without voice disorders, representing various professions – physicians, functional specialists, full time students and other. The third group was created to establish the VHI testability over time, i.e., this group included 54 participants without voice problems who could fill out the VHI questionnaire twice with a certain time interval in between.

Voice disorder group included 54 patients with voice disorders of various etiology – 45 (83.3%) women, 9 (16.7%) men, the mean age 49.5 years. Control group included 73 participants without voice pathology where 62 (84.9%) were women and 11 (15.1%) were men, with the mean age of 36.6 years.

Voice patients were selected during an otorhinolaryngological examination. Respondents with voice disorders were represented by four ENT diagnosis groups: structural changes of the vocal folds (vocal nodules, *oedema Reineke plicae vocalis*, papillomatosis, patients with malignant larynx tumours after radiation therapy) N = 14 (26%), functional voice disorders (vocal hypofunction and vocal hyperfunction) N = 20 (37%), voice disorders caused by inflammatory processes (chronic laryngitis, GER) N = 7 (13%) and voice disorder of neurological nature (condition after thyroid gland surgery, *paresis n. recurrens*) N = 13 (24%). 19 (35.2%) of all experimental group participants were representatives of vocal professions (teachers, pastors, conductors),

28 (38.4%) respondents from the control group worked in professions with a heavy voice load on an everyday basis.

Study II–IV. Wide cross-sectional study was organised in the general education schools of Latvia. The schools were selected by using strata methodology. Stratas correspond to the regions of Latvia (Kurzeme, Latgale, Vidzeme, Zemgale and Rīga), urbanization (urban and rural schools), as well as to the school type (primary and secondary schools). After creating stratified layers, a school was selected by a chance within the layer; as a result 24 general education schools were selected. Teachers of the chosen schools were issued with 650 custom-made and approbated questionnaires (*Trinite et al, 2011*). In order to ensure representation of all subject teachers in the study, all teachers teaching in one school were offered to fill out the questionnaires. A prior selection of respondents did not take place. The return ratio of questionnaires was 87.9% of which 522 or 80.3% were acknowledged as valid, and respondents of these questionnaires were included in the study selection. Representatives of school administration and librarians were excluded from participation in the study since their everyday duties did not include teaching lessons; also owners of incomplete or inaccurate questionnaires were excluded.

Participants included in the Study II (N = 522) were ages 21 to 74 (M = 44, SD = 10), the average length of service in teacher profession was one to 53 years (M = 20, SD = 10). 91.8% of the study participants were women. 106 (20.3%) respondents were smokers.

In order to find out factors impacting teachers' voice quality (Study III), two subselections were made from the total study selection. The voice disorder group (N = 235) included teachers who had voice problems at the time of filling out the questionnaires and/or they have had them during the last academic year. Control group (N = 174) included teachers who have never had any voice problems. In the Study IV participant division in groups was the same as in the Study III.

Study V. 168 teachers from schools in Liepaja were asked to fill out modified questionnaires and the Vocal symptom scale questionnaire. 138 (82%) questionnaires were recognised valid, 134 (97%) of which were filled out by women. Due to the fact that male proportion was very small, the study was continued by women only. 77 teachers corresponding to the study criteria were sent an invitation to come to a full voice function examination to the Speech and Voice Research laboratory of Liepaja University. 42 (54.6%) teachers came to examinations. One teacher was excluded from the study because during the audiometric test a slight bilateral hearing impairment was established; her hearing threshold was less than 20 dB. She was sent for a visit to an otorhinolaryngologist.

Two teacher groups were formed: (1) teachers with voice disorders (Voice disorder group, VD), N = 20, the mean age 47, the mean length of service in teacher profession was 24 years, and (2) teachers without voice disorders (control group – teachers, CT), N = 21, the mean age 46, the mean length of service in teacher profession was 24 years.

In order to evaluate the voice quality parameters in non-teacher population, employees of the Liepaja Regional Hospital were involved (physicians, nurses, nurse assistants) N = 20; they did not have any complaints about their voice and they did not have any symptoms marked in their Vocal symptom questionnaires. In non-teacher group (control group – non-teachers, CNT) all participants were women, mean age 45.

Carrying out of the study was coordinated with administrations of both education and medical care institutions in advance, it was voluntary and anonymous.

1.2 Practical methods of study

The following voice evaluation methods were used in the study: (1) instrumental larynx examination methods, (2) electroglottography, (3) aerodynamic voice evaluation methods, (4) auditory-perceptual methods, (5) acoustic methods, (6) questionnaire methods and (7) audiometry. The applied methods in each part of the study conformed to the study objective and content organization.

A number of questionnaires and scales were used in the study: (1) Standardized Voice Risk Factor Questionnaire, (2) Voice Handicap Index, (3) Vocal Symptoms Questionnaire, (4) Perceived Stress Scale, PSS, (5) Visual Analogue Scale, VAS.

Standardized Voice Risk Factor Questionnaire (Studies II, III). In order to evaluate the prevalence of voice disorders in the teacher population and to study factors impacting voice quality, a Standardized Voice Risk Factor Questionnaire was developed. Questionnaire consists of four voice quality impacting risk factor scales: (1) voice using habits scale, (2) environment factor scale, (3) medical factor scale, (4) psycho-social factor scale, as well as the prevalence of voice disorders scale and demographic data scales. All together 34 items make up the questionnaire. The estimated time for filling out the questionnaire is 10-15 minutes.

Voice Handicap Index (Studies I, II, IV, V). The Voice Handicap Index was developed in 1997 (*Jacobson et al.,* 1997). In the Study I adaptation and approbation of this tool into Latvian was performed and in the Studies IV, V the Latvian version of VHI was used. The Voice Handicap Index is made of 30 statements divided into 3 subscales – 10 physical statements, 10 emotional statements, and 10 functional statements. Respondents according to the 5 point Likert scale have to evaluate the extent to which each of these statements relate to their individual experience. The minimum total acquired points – 0,

maximum – 120 points. Allocated time for filling out the Voice Handicap Index is 5-10 minutes.

Vocal Symptoms Scale (Study V). In case of voice disorders, the presence of vocal symptoms is always observed. There are statements on seven vocal symptoms in the Vocal Symptoms Scale that are most often mentioned by teachers when describing their voice problems. Respondents have to answer how often during the last year they have felt each of the stated symptoms. The available options: *every day, once a week or more often, less often, never.* Two and more symptoms that repeat themselves every day or once a week and more often are considered to be the sign of voice disorder (*Simberg,* 2004*).*

Perceived Stress Scale (Study V). The Perceived Stress Scale, PSS was developed in 1983 (*Cohen et al.,* 1983; *Cohen, Williamson,* 1988), adapted into Latvian in 2008 (*Stokenberga*, 2010). The PSS measures the overall perceived stress or the extent to which an individual evaluates and feels the things happening to them as uncontrollable, unpredictable, and overburdening. The scale includes 10 statements. Respondents are asked to evaluate the statements according to the Likert scale 1 (*never*) to 5 (*very often*) and upon summing up all item results, the overall perceived stress indicators are found out (*Stokenberga*, 2010). The PSS indicators significantly predict the long term stress reactions such as depression and negative emotions.

Subjective Voice Self-Evaluation (Study V). Subjective voice self-evaluation was performed according to the Visual Analogue Scale (VAS). According to the ELS recommendations, an individual evaluates their voice quality in a 100 mm scale where a score of '0' means normal voice (no deviance) while '100' means extreme voice deviance (*Dejonckere et al.,* 2001).

Acoustic measurements were performed in the Speech and Voice research laboratory of Liepaja University. The voice and speech samples were recorded into the Computerized Speech Lab (CSL), mod.4500 (*KayPENTAX,* USA). For audio signal recording the professional dynamic *Shure* microphone

was used that according to the instructions was positioned in a 45^0 angle and 15 cm away from the subject. All acoustic measurements were performed by person facing the computer screen which displayed visual graphics of the sound signals. Acoustic measurements were performed in a quiet room (background noise level not exceeding 35 dB (A)) where the test performer and the subject were located.

Acoustic signal analysis in Multi-Dimensional Voice Programme (MDVP), (Study V). In the MDVP programme the following voice parameters were analysed: *F0*[1], *jitter*[2], *PPQ*[3], *shimmer*[4], *APQ*[5], *NHR*[6], *VTI*[7] and *SPI*[8]. 3-5 sound /a/ phonating trials were recorded into the MDVP from which only one was used for analysis, usually the third one. The middle 3 seconds were used for analysis (sampling rate 50 kHz).

Voice Range Profile, VRP (Study V). Voice phonetogram was developed and analysed with the CSL program *Voice Range Profile* mod.4326 (*KayPENTAX,* USA). The following voice parameters were analysed with the phonetogram method: $F0_{max}$, $F0_{min}$, *F0* range (Hz and semitones), Int_{min}, Int_{max}, Intensity range (dB). Voice Range Profile was recorded by phonating the sound /a/.

Speech Range Profile, SRP (Sudy V). Speech range profile was developed and analysed with the CSL programme *Voice Range Profile* mod.4326 (*KayPENTAX,* USA). In the speech sample speech $F0_{max}$, $F0_{min}$, speech *F0* range (Hz and semitones), sound preassure level (Int_{min}, Int_{max}),

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[1] F0 – fundamental frequency
[2] Jitter – a short-term (cycle-to-cycle) variation in the fundamental frequency of a signal (*Titze*, 1994)
[3] PPQ – pitch perturbation quotient
[4] Shimmer – a short-term (cycle-to-cycle) variation in the amplitude of a signal (*Titze*, 1994)
[5] APQ – amplitude perturbation quotient
[6] NHR – noise to harmonic ratio
[7] VTI – voice turbulence index
[8] SPI – soft phonation index

speech intensity range (dB) were analysed. The subject was asked to read Aesop's fable *Mouse and Lion* as if they were reading it in front of the class.

GRBAS scale (Study V). Voice functions auditory-perceptual evaluation was performed by using the GRBAS scale (*Hirano*, 1981). Overall grade (*G*), roughness (*R*), breathiness (*B*), asthenia (*A*) and strain (*S*) of overall voice disorder were evaluated. Each parameter was evaluated in 4 point scale: 0 – normal, 1 – mild, 2 – moderate, 3 – severe. Voice quality was perceptually analysed during the production of sound /a/ and during reading *Mouse and Lion* text.

Electroglottography (Study V). The EGG was performed with the *KayPENTAX* electroglottograph, mod.6103 (*KayPENTAX,* USA). A signal analysis was performed with the CSL, mod.4500 (*KayPENTAX,* USA) with sampling rate 44.1 kHz. Two second sample was analysed from second 2 to 4. Information about vocal folds Contact Quotient (CQ) was acquired with the electroglottography.

Spirometry (Study V). In order to find out lung vital capacity (VC), which is a fundamental component for calculation of Phonation Quotient, method of spirometry was performed. Spirometry was performed with the manual spirometer *Riester Spirotest*, 1-7 l. Each individual had three measurements. The highest VC measurement was used for further calculations.

Maximum phonating time (Study V). After taking a maximum deep breath the subject was asked to produce sound /a/ in a convenient pitch and volume for as long as possible. Sound production time that was the maximum phonating time was fixed by a chronometer. The task had to be performed three times. For further calculations the highest MPT was used.

Audiometry (Study V). Audiometry was performed by using calibrated audiometer AD 226 (*Interacoustic*), standard radio earphones TDH 39 for air directing test, and earphones B71 for bone directing test. Test stimulus 1-2 second long clear tone signals 1000, 1500, 2000, 3000, 4000, 6000, 8000, 125,

250, 500 Hz. Tone intensity decreasing step in each frequency was 5 dB. The subject was put into an audiometric cabin AB 4240 (*Eckel*, Canada) during the test.

Indirect laryngoscopy (Study I). Indirect laryngoscopy was performed by a certified otorhinolaryngologist in the Outpatient Department of P. Stradins Clinical University Hospital. During the laryngoscopy examination vocal folds structure and functionality was performed by patient phonating sound /e/.

In practical part of the research answers to the raised questions were searched for. The practical research consisted of five studies. Summary of the studies can be found in Table 1.1.

Table 1.1

Summary of the studies

Name	Objective	Methods	Participants
Adaptation and approbation of the Voice Handicap Index	To find out psychometric indicators of the VHI Latvian version and their conformity to the psychometric indicators of the original selection	Indirect laryngoscopy, test adaptation test validation	**N = 127,** of which N = 54 patient group N = 73 control group N = 54 test–retest group
II The prevalence of voice disorders in teachers population	To find out the prevalence of voice disorders in teachers population of Latvia	Questionnaires, VHI	**N = 522**
III Factors impacting teachers voice quality	To find out factors impacting teachers voice quality	Questionnaires	**N = 409,** of which N = 235 teachers with voice disorders N = 174 teachers without voice disorders

Table 1.1 (continued)

Name	Objective	Methods	Participants
IV Voice disorder impact on teachers functional, physical and emotional condition	To find out voice disorder impact on teachers functional, physical and emotional condition	VHI	**N = 409**, of which N = 235 teachers with voice disorders N = 174 teachers without voice disorders
V Voice function characterization in teachers with and without voice disorders and in non-teachers	To study differences between qualitative and quantitative parameters in teachers with and without voice disorders and in non-teachers	Questionnaires, VHI, GRBAS, MDVP, VRP, SRP, Spirometry, MPT, EGG, Audiometry	**N = 61**, of which N = 20 teachers with voice disorders N = 21 teachers without voice disorders N = 20 non-teachers

1.3 Data processing methods

The overview of statistical methods used in the research displayed in Table 1.2.

Table 1.2

Overview of statistical methods used in the Studies I – V

Statistical methods	Number of study
Methods of descriptive statistics	I, II, III, IV, V
Kolmogorov–Smirnov test	I, II, III, IV, V
Chi square test	III, IV
Pearson product-moment correlation coefficient	I
Spearman rank-order correlation coefficient	I, III, V
Cronbach's alpha coefficient	I
2 x 2 contingency tables	III
R x C contingency tables	II
Kruskal–Wallis test	II, V
Mann–Whitney test	I, II, IV, V
Binary logistic regression	III

Programmes SPSS 13.0 for Windows, SPSS 16.0 for Windows, MS Excel was used for data statistical processing.

2 RESULTS

2.1 Voice Handicap Index adaptation and validation

In 2008 adaptation and validation of the VHI into Latvian was commenced as a part of the doctoral study. Adaptation process included translation of VHI into Latvian, empirical and statistical validation of the translated material, and VHI was administered in a new culture environment.

VHI translation: (1) translation was performed by three highly qualified Latvian – English language practitioners, (2) symmetrical translation method was used, two-way translation approach, (3) emphasis on the semantic compatibility of the items, (4) local cultural peculiarities were taken into consideration, (5) inclusion of the Voice Disorder Severity scale into the VHI form for validation of the test qualitative indicators, (6) the translated material was tested in a pilot study after which formulation of some items was changed.

Test-retest stability. Since there are no alternative voice disorder measurement tests available in Latvian, the VHI stability over time was determined by using a test-retest method. Each participant of the test-retest group filled out the VHI form twice. The average time between both tests administrations were 28 days. The test – retest stability of VHI was determined by using Pearson's moment correlation coefficient. The results indicated statistically significant ($p < 0.001$) correlation between the first (VHI1) and the second measurement (VHI2). Pearson's moment correlation coefficient for the Functional scale was $r = 0.73$, Emotional scale $r = 0.71$ and Physical scale $r = 0.80$. Pearson's moment correlation coefficient of the VHI total scale was 0.80 (Table 2.1.).

Table 2.1

VHI test – retest stability

Scale	VHI1 *M (SD)*	VHI2 *M (SD)*	VHI1 – VHI2 *M (SD)*	*r*	*p*
Functional	6.65 (4.04)	6.96 (5.35)	–0.32 (3.65)	0.73	< 0.001
Physical	7.46 (5.45)	7.54 (6.51)	–0.07 (3.92)	0.80	< 0.001
Emotional	4.56 (3.91)	5.04 (4.98)	–0.48 (3.55)	0.71	< 0.001
Total	18.67 (11.68)	19.54 (15.5)	–0.87 (9.26)	0.80	< 0.001

The difference in VHI total scale between the mean value of the first and second measurements was –0.87 (9.26). Therefore the significant difference between two VHI results in one individual in the total VHI evaluation is 1.96 x 9.26 = 18 points (where 1.96 – a difference of the standard deviation according to the Bland-Altman), accordingly 7 points in the Functional scale, 8 points in the Physical scale, and 7 points in the Emotional scale.

Internal consistency of items of VHI. Data acquired during the study were analysed by using the Cronbach alpha coefficient. High internal consistency was observed among the VHI total scale (α = 0.96), Functional (α = 0.92), Physical (α = 0.86), and Emotional scale (α = 0.91) in the patient group. In control group a little lower internal consistency results of the VHI test subscales were acquired – 0.70 to 0.72 (Table 2.2). In the control group the internal consistency of the VHI total scale was 0.88.

Table 2.2

Internal consistency of VHI subscales in both the patient and control group

Scale	Number of items	Cronbach alpha (α)	
		Patients	Control
Functional	10	0.92	0.70
Physical	10	0.86	0.79
Emotional	10	0.91	0.72
Total	30	0.96	0.88

In order to determine the ***VHI content validity*** when adapting the test in a new culture environment it was necessary to justify the test scale content conformity to the measured parameters. Therefore by using the Pearson's moment correlation coefficient a correlation among VHI subscales was calculated. Calculations indicate a high correlation among the VHI total scale and subscales ($r > 0.94$), as well as a high correlation among subscales ($r > 0.81$) in the patient group (Table 2.3).

Table 2.3

Pearson's moment correlation coefficients among the VHI total scale and subscale values in the patient group

Scale	Functional	Physical	Emotional	Total
Functional	*	0.81	0.89	0.95
Physical	*	*	0.86	0.94
Emotional	*	*	*	0.96
Total	*	*	*	*

The Pearson's moment correlation coefficient among the VHI total scale and subscale values in control group was 0.84, 0.88, 0.87 (functional, physical, and emotional scale) and in between 0.56 to 0.65 among the subscales.

Convergent validity of the VHI was determined by comparing the VHI results with the Voice Disorder Severity scale results. Spearman's correlation coefficient was used for analysis. Statistically significant correlation ($r = 0.78$, $p < 0.001$) was discovered between the VHI result and the Voice Disorder Severity scale score in the patient group. The control group correlation was statistically significant ($r = 0.58$, $p < 0.001$). Study results demonstrate statistically significant ($p < 0.001$) difference between the mean VHI total scale and subscale results in the patient and control groups. In patient group the VHI total score as well as the subscale scores variate on a wider range than in the control group (Table 2.4).

Table 2.4

Mean values of the VHI scales in patient and control groups

Group	*N*	VHI total		Functional		Physical		Emotional	
		M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Patients	53	59.20	26.21	19.07	10.19	22.07	8.54	18.06	10.12
Control	73	15.82	10.37	5.75	3.75	6.21	4.63	3.85	3.62

2.2 The prevalence of voice disorders in teacher population

The prevalence of voice disorders in teacher population. 348 teachers or 66.7% of all the questioned 522 general education teachers have had voice problems (Figure 2.1). 42 or 8% of all teachers (N =522) noted that they had voice disorders at the moment of performing the study. 193 (36.9%) teachers said they have experienced voice problems during the current academic year and 113 (21.6%) teachers admitted to having voice disorders at some point in past during their carriers in education.

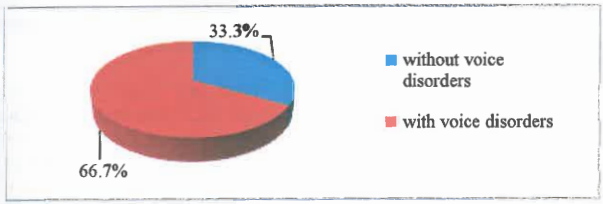

Figure 2.1 The prevalence of voice disorders in teacher population (men, women)

Voice disorders in men and women. Analysis of the acquired data shows that voice disorders are more often found in women teachers than in men

teachers. 328 (68.2%) women teachers noted that they have had voice problems whereas among men teachers 21 (48.8%) teacher admitted to having voice problems, $\chi^2 = 6.87$, $df = 1$, $p = 0.009$ (Figure 2.2).

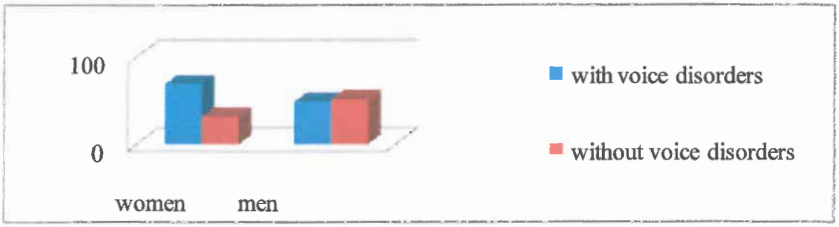

Figure 2.2 The prevalence (%) of voice disorders in women and men

Voice disorders in teachers of various education stages. No statistically significant data were discovered during the study with regards to correlation between the prevalence of voice disorders and education stage of the teacher ($\chi^2 = 10.23$, $df = 5$, $p = 0.069$).

Voice disorders in various subject teachers. Even though in music and sport teacher groups voice disorders are more frequent (respectively 85.2% and 69.7%) when compared to other subject teacher groups, statistically significant differences in the prevalence of voice disorders among various subject teachers was not observed ($\chi^2 = 10.23$, $df = 5$, $p = 0.069$).

The onset of voice disorders. 348 (66.7%) of 522 teachers questioned admitted to having voice problems. Here on only results concerning this group will be considered. 288 (82.8%) of 348 teachers first faced voice problems in their professional carries, i.e., in their job as teachers, 29 (8.3%) – in their childhood and school years and 31 (8.9%) said that they first faced voice problems during their studies. 17.4% of music teachers faced their first voice problems in childhood and during school years, 26.1% during their studies but 56.5% when working as teachers. 100% of all sport teachers had their

first voice disorders during their carrier as educators ($\chi^2 = 24.71$, $df = 12$, $p = 0.016$).

Seeking for help in case of voice disorders. Almost half or 177 (51.0%) teachers in this group (N=348) have been looking for specialist help because of their voice problems. In 113 (32.6%) cases the physician established larynx illnesses yet the most part of the respondents did not remember the exact physician's diagnosis. Women have been seeking for medical help more often – in 52.3% of cases (170/325) than men – 31% (7/22). Specialist involvement in solving voice disorders is greatly related to the severity of voice problem ($\chi^2 = 20.69$, $df = 3$, $p = 0.001$) – the more explicit voice problem is, the more often physician's help is sought after. Teachers who have the knowledge about voice hygiene are more likely to look for physician's help ($\chi^2 = 4.81$, $df = 1$, $p = 0.028$). Teachers who consider their overall state of health to be unsatisfactory and admit to having health problems, more often pay visits to the voice specialists ($\chi^2 = 9.62$, $df = 1$, $p = 0.002$).

Voice disorders and age. Statistically significant correlation between the prevalence of voice disorders and teachers' age has not been established during the sudy ($\chi^2 = 4.94$, $df = 4$, $p = 0.293$).

Voice disorders and years of service in teacher profession. Pearson's chi-square test showed statistically significant correlation between voice problems and years of service in teacher profession ($\chi^2 = 8.93$, $df = 3$, $p = 0.03$). The number of observed cases (frequency) in teachers with years of service above 21 year was higher than in teachers with fewer years of service in education. Voice problems were noted by 60.6% of teachers with years of service one to five, 60.9% of teachers with years of service 6 to 20, 73.5% and 70.6% of teachers with years of service respectively 21 to 40 and above 41.

2.3 Factors impacting voice quality in teachers

Objective of the Study III was to discover factors impacting teacher's voice quality and to find out which of them are more important in the voice disorder etiology.

During the study the answers of four subscales of the Voice risk factors questionnaire were analysed – voice usage habits and vocal load (A), environment factors (B), medical factors (C), and psychosocial factor (D) (Tables 2.5 – 2.8).

Table 2.5

Evaluation of vocal load and voice usage habits impact on the voice quality in the voice disorder group (VD) (N = 235) and the control group (N = 174)

Factors		Control		VD		*p*	*OR*	*95% CI*
		N	%	N	%			
Extra vocal load[9]	no	154	88.5	184	78.3	0.007	2.13	1.22-3.37
	yes	20	11.5	51	21.7			
Teaching hours/ week[10]	< 10	15	8.7	12	5.1	0.006	1.04	1.01-1.07
	11-21	70	41.3	77	32.8			
	22-32	75	43,0	126	53,8			
	33 <	12	7,0	20	8,5			
Total working time / week (h)[10]	< 10	1	0.6	6	2.6	0.003	1.35	1.11-1.64
	11-20	22	12.6	11	4.7			
	21-30	44	25.3	45	19.1			
	31-40	61	35.1	76	32.3			
	41 <	46	26.4	97	41.3			
Average voice loudness during lessons[10]	relaxed	2	1.1	6	2.6	0.002	1.50	1.16-1.94
	normal	105	60.3	88	37.4			
	raised	44	25.3	106	45.1			
	loud	22	12.6	26	11.1			
	very loud	1	0.6	9	3.8			

[9] 2x2 table analysis method has been used in calculations

[10] Binary logistic regression method has been used in calculations.

Table 2.5 (continued)

Factors		Control		VD		*p*	*OR*	*95% CI*
		N	%	N	%			
Shouting[9]	no	119	68.4	125	53.2	0.002	1.90	1.26-2.87
	yes	55	31.6	110	46.8			
Speaking in a noisy environment[9]	no	136	78.2	172	73.2	0.249	1.31	0.83-2.08
	yes	38	21.8	63	26.8			
Knowledge about voice ergonomics[9]	good/ very good	94	54.0	112	47.7	0.203	1.29	0.87-1.91
	bad/ very bad	80	46.0	123	52.3			
Use this knowledge in everyday life[10]	yes	49	28.2	47	20.0	0.061	1.28	0.99-1.66
	no	67	38.5	95	40.4			
	someti mes	58	33.3	93	39.6			
Throat clearing[9]	no	160	92.0	192	81.7	0.003	2.56	1.35-4.85
	yes	14	8.0	43	18.3			
Teaching with a sore throat[9]	no	80	46.0	27	11.5	<0.001	6.56	3.98-10.81
	yes	94	54.0	208	88.5			
Speaking in breaks[9]	no	19	10.9	16	6.8	0.142	1.68	0.84-3.37
	yes	155	89.1	219	93.2			
A volume of water drinking during a day (glasses/ cups)[10]	<3	51	29.3	72	30.7	0.749	1.02	0.93-1.11
	3-4	63	36.2	96	40.7			
	4 <	60	34.5	67	28.6			
A volume of caffine beverages during a day (glasses/ cups)[10]	< 2	43	24.7	66	28.1	0.676	1.03	0.89-1.21
	2-3	112	64.4	131	55.8			
	3 <	19	11.0	38	16.2			

Evaluation of the physical environment impact on the voice quality in the voice disorder group (VD) (N = 235) and the control group (N = 174)

Factors		Control		VD		*p*	*OR*	*95% CI*
		N	%	N	%			
Number of pupils in the class[10]	< 15	44	25.3	38	16.1	0.021	1.04	1.01-1.07
	15-25	102	58.6	153	65.1			
	25 <	28	16.1	44	18.9			
Average noise level in the classroom during the lessons[10]	very quite	1	0.6	1	0.4	0.016	1.50	1.08-2.07
	quite	66	37.9	66	28.1			
	rather load	97	55.7	146	62.1			
	load	10	5.7	19	8.1			
	very load	0	0	3	1.3			
Reverberation in the classroom[9]	no	150	86.2	207	88.1	0.573	0.85	0.47-1.52
	yes	24	13.8	28	11.9			
Background noise in the classroom from outside[9]	no	112	64.4	145	61.7	0.581	1.12	0.75-1.68
	yes	62	35.6	90	38.3			
Background noise from classroom alongside [9]	no	143	82.2	183	77.9	0.284	1.31	0.8-2.15
	yes	31	17.8	52	22.1			
Background noise from corridor[9]	no	107	61.5	144	61.3	0.964	1.01	0.68-1.51
	yes	67	38.5	91	38.7			
Background noise from heating and/or ventilation system[9]	no	165	94.8	219	93.2	0.495	1.34	0.58-3.11
	yes	9	5.2	16	6.8			
Background noise from light fixtures[9]	no	137	78.7	178	75.7	0.477	1.19	0.74-1.9
	yes	37	21.3	57	24.3			
Background noise from technical equipment[9]	no	127	73.0	199	84.7	0.004	0.49	0.3-0.8
	yes	46	26.4	36	15.3			

Table 2.6 (continued)

Background noise from furniture[9]	no	129	74.1	180	76.6	0.567	0.88	0.56-1.38
	yes	45	25.9	55	23.4			
Lack of discipline in the classroom[9]	no	98	56.3	96	40.9	0.002	1.87	1.26-2.78
	yes	76	43.7	139	59.1			
Other sources of background noise[9]*	no	165	94.8	219	93.2	0.495	1.34	0.58-3.11
	yes	9	5.2	16	6.8			
Dust[9]	no	106	60.9	140	59.6	0.784	1.06	0.71-1.58
	yes	68	39.1	95	40.4			
Blackboard chalk[9]	no	65	37.4	55	23.4	0.002	1.95	1.27-3.0
	yes	109	62.6	180	76.6			
Chemical fumes[9]	no	167	96.0	222	94.5	0.484	1.40	0.55-3.58
	yes	7	4.0	13	5.5			
Dry air in the classroom during heating[9]	no	104	59.8	127	54.0	0.248	1.26	0.85-1.88
	yes	70	40.2	108	46.0			
Inadequate temperature in the classroom[9]	no	111	63.8	129	54.9	0.071	1.45	0.97-2.16
	yes	63	36.2	106	45.1			
Other answer related to the quality of air[9]**	no	165	94.8	224	95.3	0.820	0.90	0.37-2.22
	yes	9	5.2	11	4.7			
General quality of air in the classroom[9]	good/ rather good	151	86.8	171	72.8	0.001	2.46	1.45-4.15
	bad/ rather bad	23	13.2	64	27.2			
Humidity of air in the classroom during heating[9]	sufficient	106	60.9	136	57.9	0.535	1.14	0.76-1.69
	insufficient	68	39.1	99	42.1			

* squeaky floor (1 respondent), work noises (2), ball bouncing noise in sport (10), background music in art lessons (2), musical instruments (4).

** excess humidity and dampness (4), mould (10), bad ventilation (5), direct sun light (2).

Evaluation of health problem impact on the voice quality in the voice disorder group (VD) (N = 235) and the control group (N = 174)

Factors		Control		VD		*p*	*OR*	*95% CI*
		N	%	N	%			
General health[9]	very good/ rather good	160	93.0	184	78.3	<0.001	3.74	1.93-7.26
	rather bad/ very bad	12	7.0	51	21.7			
Health problems[9]	no	66	37.9	45	19.1	<0.001	2.58	1.65-4.03
	yes	108	62.1	190	80.9			
Chronic illnesses of upper respiratory tract [9]	no	161	92.5	169	71.9	<0.001	4.84	2.57-9.11
	yes	13	7.5	66	28.1			
Endocrine diseases[9]	no	160	92.0	199	84.7	0.026	2.07	1.08-3.97
	yes	14	8.0	36	15.3			
Respiratory allergies[9]	no	169	97.1	202	86.0	<0.001	5.52	2.11-14.46
	yes	5	2.9	33	14.0			
Oesophageal reflux[9]	no	169	97.1	224	95.3	0.351	1.66	0.57-4.87
	yes	5	2.9	11	4.7			
Lower back pain[9]	no	118	67.8	139	59.1	0.073	1.46	0.97-2.2
	yes	56	32.2	96	40.9			
Shoulders-neck muscles pain[9]	no	116	66.7	114	48.5	<0.001	2.12	1.42-3.19
	yes	58	33.3	121	51.5			
Other health problems[9]	no	162	93.1	217	92.3	0.770	1.12	0.53-2.39
	yes	12	6.9	18	7.7			
Smoking[9]	no	142	81.6	181	77.0	0.260	1.32	0.81-2.16
	yes	32	18.4	54	23.0			

*coronary vessel illnesses (7), head ache, pneumonia (4), tympanitis, joint pain, arthritis, osteochondrosis, gastritis, and other.

Evaluation of psychosocial factor impact on the voice quality in the voice disorder group (VD) (N = 235) and the control group (N = 174)

Factors		Control		VD		*p*	*OR*	*95% CI*
		N	%	N	%			
Stress level at work[9]	insignificant	117	67.2	106	45.1	<0.001	2.50	1.66-3.76
	significant	57	32.8	129	54.9			
Reasons that cause stress:								
Pupils[9]	no	90	51.7	89	37.9	0.005	1.76	1.18-2.62
	yes	84	48.3	146	62.1			
Relationships with colleagues[9]	no	153	88.4	207	88.1	0.896	1.04	0.57-1.92
	yes	20	11.6	28	11.9			
Relationships with administration[9]	no	147	85.0	189	80.4	0.224	1.39	0.82-2.35
	yes	26	15.0	46	19.6			
Heavy workload[9]	no	105	60.7	115	48.9	0.016	1.63	1.09-2.42
	yes	68	39.3	120	51.1			
Salary[9]	no	104	59.8	137	58.3	0.765	1.06	0.71-1.58
	yes	70	40.2	98	41.7			
Family problems[9]	no	140	80.5	185	78.7	0.745	1.09	0.67-1.77
	yes	34	19.5	49	20.9			
Other [9]*	no	155	89.1	199	84.7	0.197	1.48	0.82-2.67
	yes	19	10.9	36	15.3			
Level of tiredness[9]	insignificant	92	52.9	93	39.6	0.008	1.71	1.15-2,55
	significant	82	47.1	142	60.4			
Satisfaction with work[9]	satisfied	170	97.7	213	90.6	0.004	4.39	1.48-12.98
	unsatisfied	4	2.3	22	9.4			

* relationship with pupils' parents (8), studies (2), work organization faults (8), education system faults, school documentation (8), situation in the country, possibility to lose one's job (15) etc.

The results of analysis of domain of sociodemographic factors showed a statistically significant correlation between the voice disorders and respondent's sex ($p = 0.013$).

2.4 Voice disorder impact on teacher's emotional, physical, and functional condition

The study IV objective was to find out to what extent voice disorders impact teacher's emotional and physical comfort, as well as their functionality, i.e., their ability to use their voice. The same participant groups as in the study III were included in this part of the study, i.e., 235 teachers with voice disorders (VD group) and 174 teachers without voice disorders (Control group). The psycho-social handicapping effects of voice disorders in teachers were judged by the scores of Voice Handicap Index total scale and subscales. Since scores to be analysed were not normaly distributed (Kolmogorov–Smirnov test, $p < 0.001$), non-parametric statistical methods were used.

In order to evaluate hypothesis that the VHI total scale and subscale score in the control group are lower than the VHI results in the voice disorder group, the Mann-Whitney test was used. Test results showed statistically significant ($p < 0.001$) difference between the results acquired by both groups (Table 2.9).

Median value of the VHI total scale in the voice disorder group was 23 (12; 33). The range of VHI total scale score was from 0 to 77 in the voice disorder group. Median value in the VHI Functional scale was 7 (4; 10), Physical scale was 10 (6; 15), Emotional scale median value was 5 (2; 10) in the voice disorder group.

Table 2.9

Median values and minimal and maximal score values for the VHI total scale and subscales in the voice disorder and the control group

Scale	Group	N	*Me* (Q_1; Q_3)	*Min, Max*
Functional	Control	174	4 (2; 7)	0; 20
	VD	235	7 (4; 10)	0; 24
Physical	Control	174	4 (2; 7)	0; 20
	VD	235	10 (6;15)	0; 30
Emotional	Control	174	2 (0; 4)	0; 20
	VD	235	5 (2;10)	0; 24
Total	Control	174	10 (5; 17)	0; 60
	VD	235	23 (12; 33)	0; 77

In the voice disorder group 20% of respondents acquired 0 to 10 points, 25% of respondents acquired points between 11 to 20 and almost the same percentage - 24% acquired points between 21 to 30 in the total score of VHI. 68.5% of respondents in the voice disorder group acquired up to 30 points in the VHI total score (Figure 2.3).

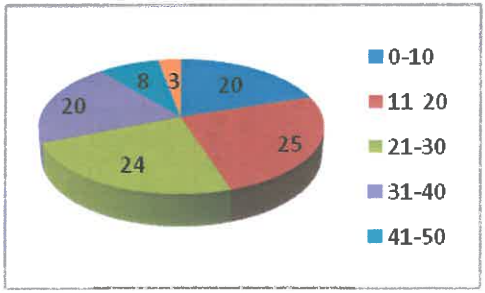

Figure 2.3 Distribution of the VHI scores (%) in the voice disorder group

Each of the three VHI subscales consisted of ten statements that characterise consequencies of voice disorders on a specific area of life – functional, physical, and emotional. Respondents had to evaluate to what extent each statement refers to their experience. In order to check the correlation

between each specific item and voice problems in the teacher group, the Chi square test was used (Tables 2.10, 2.11, 2.12).

Table 2.10

Distribution of the Functional scale answers (%) in the control group (N=174) and the voice disorder group (N=235)

(0 = never, 1 = almost never, 2 = sometimes, 3 = almost always, 4 = always)

Statement	Group	0 %	1 %	2 %	3 %	4 %	χ^2	*df*	*p*
F1. My voice makes it difficult for people to hear me	Control VD	44 31	35 39	21 29	1 2	0 0	8.77	3	0.032
F3. People have difficulty understanding me in a noisy room	Control VD	30 25	35 32	31 38	3 6	1 0	3.71	4	0.447
F5. My family has difficulty hearing me when I call them throughout the house	Control VD	44 32	36 38	16 28	3 3	1 0	11.74	4	0.019
F6. I use the phones less often than I would like to	Control VD	55 42	24 34	19 19	2 3	0 2	10.68	4	0.030
F8. I tend to avoid groups of people because of my voice	Control VD	81 70	14 24	5 6	0 0	0 0	7.33	2	0.026
F11. I speak with friend, neighbours, or relatives less often because of my voice	Control VD	90 68	8 27	2 6	0 0	0 0	27.87	3	<0.001
F12. People ask me to repeat myself when speaking face-to-face	Control VD	60 43	30 42	10 15	0 0	0 0	12.17	2	0.002
F16. My voice difficulties restrict personal and social life	Control VD	84 55	14 30	2 15	1 0	0 0	42.12	3	<0.001
F19. I feel left out of conversation because of my voice	Control VD	76 59	17 31	6 9	0 1	0 0	14.95	3	0.002
F22. My voice problem causes me to lose income	Control VD	84 55	14 27	1 17	1 0	0 0	44.29	3	<0.001

Table 2.11

Distribution of the Physical scale answers (%) in the control group (N=174) and the study group (N=235)

(0 = never, 1 = almost never, 2 = sometimes, 3 = almost always, 4 = always)

Statement	Group	0 %	1 %	2 %	3 %	4 %	χ^2	*df*	*p*
P2. I run out of air when I talk	Control VD	69 43	23 32	8 25	1 0	0 0	32.43	3	<0.001
P4. The sound of my voice varies throughout the day	Control VD	21 7	29 23	38 48	10 19	2 4	26.14	4	<0.001
P10. People ask, "What's wrong with your voice?"	Control VD	70 29	25 32	5 39	1 0	0 0	87.01	4	<0.001
P13. My voice sounds creaky and dry	Control VD	74 43	20 28	6 28	0 1	0 0	45.99	3	<0.001
P14. I feel as though I have to strain to produce voice	Control VD	79 46	16 26	5 26	1 2	0 0	50.85	3	<0.001
P17. The clarity of my voice is unpredictable	Control VD	70 44	23 34	7 20	0 2	0 0	32.32	3	<0.001
P18. I try to change my voice to sound different	Control VD	62 48	25 27	14 24	0 1	0 0	10.88	3	0.012
P20. I use a great deal of effort to speak	Control VD	81 50	16 26	4 23	0 2	0 0	46.73	3	<0.001
P21. My voice is worse in the evening	Control VD	58 26	28 26	14 40	0 7	0 2	62.92	4	<0.001
P26. My voice "gives out" on me in the middle of speaking	Control VD	67 29	28 32	5 39	0 1	0 0	82.10	3	<0.001

Distribution of the Emotional scale answers (%) in the control group (N=174) and the study group (N=235)

(0 = never, 1 = almost never, 2 = sometimes, 3 = almost always, 4 = always)

Statement	Group	0 %	1 %	2 %	3 %	4 %	$\chi 2$	*df*	*p*
E7. I am tense when talking to others because of my voice	Control VD	70 52	21 31	9 16	1 1	0 0	13.69	3	0.003
E9. People seem irritated with my voice	Control VD	67 50	24 37	9 13	1 0	0 0	13.00	3	0.005
E15. I find other people don't understand my voice problems	Control VD	86 58	10 24	4 16	0 2	0 0	36.96	3	<0.001
E23. My voice problems upsets me	Control VD	77 28	17 25	6 39	0 6	1 2	31.11	4	<0.001
E24. I am less outgoing because of my voice problem	Control VD	82 56	14 27	4 16	0 1	0 0	33.82	3	<0.001
E25. My voice makes me feel handicapped	Control VD	87 70	10 21	3 7	0 1	0 0	16.49	4	0.002
E27. I feel annoyed when people ask me to repeat	Control VD	65 49	25 31	9 15	1 3	0 2	13.45	4	0.009
E28. I feel embarrassed when people ask me to repeat	Control VD	72 56	21 30	6 13	0 1	0 0	14.30	4	0.006
E29. My voice makes me feel incompetent	Control VD	86 72	12 23	2 6	0 0	0 0	12.40	2	0.002
E30. I am ashamed of my voice problem	Control VD	92 69	6 26	2 5	0 0	0 0	32.35	3	<0.001

2.5. Voice characteristics in teachers with and without voice disorders and in non-teachers

The study V objective was to find out whether objective voice parameter measurements differ in teachers with and without voice disorders and non-teachers.

138 teachers were asked to answer the question "Have you ever had any voice problems?" - 57 (41.9%) responded negatively, 79 (58.1%) provided a positive answer. Out of all respondents who gave a positive answer, 9 (6.6%) wrote that they had voice problems at the time of filling out the questionnaire, 42 (30.9%) said that voice problems were present during the last nine months but 28 (20.6%) admitted to having had voice problems earlier in their education carrier. Two respondents did not answer this question.

In the Study V Vocal symptom scale was used as an additional tool for participant selection. 75 (54.3%) teachers did not mark any vocal symptoms during the last year. 23 (16.7%) teachers marked one vocal symptom they have observed every day or weekly or more often. 40 (29%) teachers had marked two or more symptoms prevalence of which occurs every day or weekly and more (Table 2.13).

Table 2.13

The number of vocal symptoms in teachers

Number of Vocal symptoms	Teachers N (%)	Females N (%)
0	75 (54.3)	73 (97)
1	23 (16.7)	21 (91)
2	11 (7.8)	10 (91)
3	9 (6.5)	9 (100)
4	10 (7.2)	10 (100)
5	6 (4.3)	6 (100)
6	3 (2.2)	3 (100)
7	1 (0.7)	1 (100)
Total	138 (100)	133

In case of the voice disorders vocal symptoms are always present. Two or more symptoms that repeat themselves every day or weekly and more often are considered to be a sign of functional voice disorder. The prevalence of specific vocal symptoms is displayed in Table 2.14. Most teachers complain about strained and tired voice, as well as about coughing and throat clearing (41 case).

Table 2.14

The Vocal symptom prevalence in teacher population (N=138)

Vocal symptom	Number of cases
My voice gets strained or tires	41
I have to clear my throat or cough while talking	41
My voice gets low or hoarse while talking	35
I have voice-breaks while talking	23
I feel pain or a lump in my throat	15
I lose my voice for at least a couple of minutes while talking	4
I have difficulty in being heard	4

The presence of health problems was marked by 19 (95%) VD[11] group participants, 16 (76.2%) CT[12] group and 15 (75%) CNT[13] group representtatives. The Kruskal–Wallis rank dispersion analysis did not show statistically reliable difference among groups according to the health condition ($p > 0.05$).

Audiometry. On all participants involved in the study hearing audiometry was performed. Based on the acquired audiograms the mean values of 500, 1000, 2000 and 4000 Hz were calculated for each ear. Hearing threshold in 61 participants in 500, 1000, 2000, 4000 Hz frequencies was not lower than 20 dB.

Auditory-perceptual rating of voice quality. Since values to be measured were quantitative and most part of the acquired data did not

[11] VD – teachers with voice disorders
[12] CT – teachers without voice disorders, control group – teachers, CT
[13] CNT – non-teachers, control group – non-teachers, CNT

correspond to the normal distribution, nonparametric methods were used for data analysis. In order to compare all groups involved in the study, the Kruskal–Wallis rank dispersion analysis method was used.

The highest statistically significant mean values of GRBAS scale parameters were found in teachers with voice disorders. There were no differences among groups in voice strain parameter (*S*) (Table 2.15).

Table 2.15

GRBAS scale mean values in the voice disorder group, the teacher control group, and the non-teacher control group

Parameters	VD (N = 20)	CT (N = 21)	CNT (N = 20)	*p*
G_{mean}	0.75	0.10	0.15	0.003
R_{mean}	0.90	0.24	0.40	0.011
B_{mean}	0.60	0.24	0.15	0.014
A_{mean}	0.35	0.29	0.00	0.020
S_{mean}	0.20	0.10	0.05	0.317

When comparing groups in pairs (VD *vs* CT, VD *vs* CNT, CT *vs* CNT) the Mann–Whitney test with Bonferroni correction was used for *p* value of significance level. Statistically significant differences were found in level of overall degree of hoarseness (*G*) and voice roughness (*R*) in the VD group and the CNT group ($p = 0.004$).

Assessment of aerodynamic. A statistically significant difference among the groups was not observed in measurements of vital capacity (VC). The highest median score in measurements of maximum phonating time (MPT) was observed in the group of non-teachers but the lowest in the voice disorder group. Statistically significant differences of MPT ($p = 0.01$) were observed in all groups. Statistically significant differences among all groups had scores of Phonating Quotient (PQ). The highest PQ rank value was observed in the voice disorder group (Table 2.16).

Table 2.16

VC, MPT and PQ median values and values of the first and third quartiles (Kruskal–Wallis test)

Group	N	VC (ml/s)			MPT (s)			PQ (ml/s)		
		Me	Quartile		*Me*	Quartile		*Me*	Quartile	
			25	75		25	75		25	75
VD	20	3050	2625	3700	17.5	13	22.75	201	146.75	238.50
CT	21	3000	2700	3300	18.0	16	21.50	157	137.50	187.00
CNT	20	3500	2700	3950	26.0	22	33.75	128	100.00	156.75
p		0.222			0.010			0.003		

We didn't find statistically significant differences between teachers with voice disorders and teachers without voice disorders in the group of all aerodynamic parameters. Statistically significant ($p = 0.001$) difference was found in MPT parameter between teachers with voice disorders and non-teachers and between the control group teachers and non-teachers. In teachers with and without voice disorders Phonation Quotient score significantly differs from the non-teachers ($p = 0.002$; $p = 0.011$).

Acoustic measurements. Average score of voice fundamental frequencies was lower in the teacher group than in the non-teachers group. Especially low median *F0* was in teachers with voice disorders. Teachers with voice disorders had higher median scores of frequency and amplitude perturbation than teachers without voice disorders. The lowest scores of perturbation (frequency and amplitude) had the group of non-teachers. Statistically significant difference among groups was not found in the median scores of the noise parameters (*NHR, VTI, SPI*) (Table 2.18).

A statistically significant correlation between Jitt and Shim scores and (G) and (R) scores ($r = 0.46$ - 0.59, $p < 0.05$) was found in voice disorder group. A statistically significant correlation appeared between the Jitter and voice roughness (R) ($r = 0.587$, $p = 0.007$) in the non-teachers group.

Table 2.18

Medians and quartile dispersions of acoustic parameters acquired in the MDVP analysis (Kruskal – Wallis test)

Parameter	VD (N = 20)	CT (N = 21)	CNT (N = 20)	*p*
F0 (Hz)	206.22 (196.09; 232.05)	216.39 (197.78; 236.87)	254.16 (229.35; 267.03)	0.001
Jitt (%)	1.18 (0.42; 1.88)	0.89 (0.60; 1.68)	0.53 (0.31; 0.96)	0.013
PPQ (%)	0.70 (0.25; 1.16)	0.53 (0.35; 0.99)	0.31 (0.19; 0.55)	0.011
Shim (%)	3.43 (2.85; 4.32)	3.08 (2.85; 3.63)	2.41 (1.80; 3.41)	0.025
APQ (%)	2.53 (1.96; 2.92)	2.33 (2.03; 2.69)	1.69 (1.32; 2.37)	0.005
NHR	0,12 (0,11; 0,13)	0,11 (0,10; 0,13)	0.11 (0.10; 0.12)	0.137
VTI	0.043 (0.037; 0.054)	0.040 (0.037; 0.046)	0.040 (0.033; 0.050)	0.618
SPI	14.04 (10.27; 17.00)	14.17 (11.31; 17.85)	13.69 (9.99; 18.75)	0.872

The Kruskal – Wallis dispersion analysis did not show statistically significant difference between the groups in scores of VRP and SRP. The widest frequency range as well as the highest voice intensity range was observed in teachers without voice disorders ($F0_{range}$ = 584.43 Hz, Int_{range} = 46 dB). Subsequently the widest boundaries of voice range field were observed in this group as well (S_{VRP} = 1334). The narrowest speech range field was observed in the non-teachers group (S_{SRP} = 256). Not always the speech range field boundaries fitted into the voice range field boundaries. For example, median *VRP* $F0_{min}$ was 146.83 Hz but median *SRP* $F0_{min}$ was 142.71 Hz in the non-teachers group.

Electroglottography. Contact Quotient (CQ) values acquired in the electroglottographic examination did not indicate statistically significant

difference among the groups. Also statistically significant correlation between the CQ and voice intensity was not discovered.

Dysphonia Severity Index (DSI). The calculations of Dysphonia Severity Index were based on objective measurements (MPT, $F0_{max}$, Int_{min}, *Jitt*). The lowest Dysphonia Severity Index value was found in the voice disorder group, it was a little higher in group of teachers without voice disorders and the highest DSI median value was observed in the non-teacher group (Table 2.18). We found statistically significant ($p = 0.001$) difference between groups in scores of DSI.

Table 2.18

Median and quartile dispersions values of the Dysphonia Severity Index

Group	N	Me	Q_1; Q_3	p
VD	20	2.65	1.06; 3.39	0.001
CT	21	3.21	2.09; 4.54	
CNT	20	4.57	3.31; 6.06	

The analysis of results showed statistically significant correlation between the DSI and degree of hoarsenes (G). The Spearman's correlation coefficient value in the voice disorder group ($r = -0.71$, $p < 0.001$), in the CT group ($r = -0.51$, $p = 0.018$), in the CNT group ($r = -0.45$, $p = 0.047$). Negative correlation coefficient indicates increasing of the G score when the DSI score decreases. High G value and low DSI scoree is a stable sign of voice disorders (*Wuyts et al.*, 2000).

Hoarseness level (*G*) corresponded to 0 points and median score of the DSI was 2.96 (2.65; 3.44) in 9 (45%) respondents of the voice disorder group.

The DSI showed statistically significant negative correlation (Spearman's method) with frequency and amplitude perturbation parameters: *Jitt* ($r = -0.44$), *PPQ* ($r = -0.44$), *Shim* ($r = -0.38$), *APQ* ($r = -0.38$), N= 61.

Higher DSI score corresponds to a better voice quality. One of the voice quality characteristic is wide Voice Range Profile. Statistically significant correlation between the DSI scores and the S_{VRP} was found: Spearman's correlation coefficient in teachers with voice disorders (r = 0.55, p = 0.012), in teachers without voice disorders (r = 0.47, p = 0.031) and in non-teachers (r = 0.57, p = 0.009).

During the data analysing process statistically significant negative correlation between the scores of DSI and VHI (r = –0.55, p < 0.01) was found. Upon the increase in the VHI score, the score of DSI decreases. Statistically significant negative correlation was found between the DSI and number of vocal symptoms in all study sample (N=61). Upon the number of vocal symptom increase the DSI decreases.

Subjective voice self-evaluation. During the study respondents were asked to evaluate their voice quality in the Visual analogue scale (VAS) and according to the Voice Handicap Index. The VAS and the VHI scales showed statistically reliable difference among groups (p < 0.001).

Teachers with voice disorders marked significantly more explicit voice deviation from the normal in the VAS scale (Me = 21.0 mm) than participants of both control groups (Me = 1.0 mm, Me = 0.5 mm).

The VHI total scale score in teachers with voice disorders was higher than in teachers with healthy voice and non-teachers yet it did not cross the 25 point mark (respectively Me_{VD} = 25, Me_{CT} = 13, Me_{CNT} = 6). In respondents of all groups the highest were the Physical scale score leaving behind the voice disorder impact on functionality and emotional sphere (Figure 2.4).

Median scores of the Perceived Stress Scale (PSS) have statistically significant (p = 0.021) difference among groups Me_{VD} = 18 (15; 20); Me_{CT} = 13 (9; 17); Me_{CNT} = 16 (12; 21).

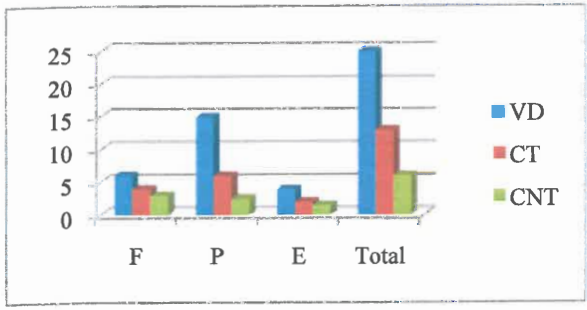

Figure 2.4 The median scores of the Voice Handicap Index subscales and total scale in the VD, CT and CNT groups

In the secondary analysis (comparison between groups) statistically significant difference in perceived stress level was found between the VD group teachers and teachers without voice disorders ($p = 0.009$) as well as between teachers without voice disorders and non-teachers ($p = 0.041$). We didn't find statistically reliable correlation between the scores of PSS and DSI ($r = -0.14$, $p = 0.558$) in the VD, CT, CNT groups. Statistically significant correlation was found between the PSS score and shouting and loud using of voice ($r = -0.49$, $p = 0.027$) as well as the noise level in classroom during the lesson ($r = 0.51$, $p = 0.022$).

3 DISCUSSION

3.1 The Voice Handicap Index adaptation and validation

Latvian version of the VHI demonstrates good test-retest stability. Statistically significant high retest reliablity has been observed in the total and Physical scales of the VHI, in both (r_P = 0.80). A little lower correlation yet also satisfactory has been observed in both the Functional and Emotional scale, r = 0.73, r = 0.71 respectively. Test-retest reliability in all scales lies within r = 0.86 to r = 0.94 in the original version of the VHI (*Jacobson et al.,* 1997). The VHI total scale retest reliability coefficient r = 0.8 is found in Chinese and Spanish version approbations (*Lam et al.,* 2006; *Núñez- Batalla et al.,* 2007).

A difference of 18 points in the VHI total scale score between two measurements was discovered in 95% of respondents. The 18 point difference between pretherapy and post-therapy measurements confirms improvements in patient's voice quality. The acquired results completely correspond to the data of Jacobson's study (*Jacobson et al.,* 1997). Latvian version of the VHI can be used as a method of assessment of speech therapy efficiency in both field practice and research.

Study results indicate high internal consistency of all VHI scales in the patient group, which confirms that the each scale is homogenous and it ensures measurements oriented towards one specific indication. A higher Cronbach's alpha coefficient of the VHI total scale in the patient and the control group when compared to the subscale results can be explained by the number of items in the test scale. The higher is the number of items in the test scale, the higher is α value. Thus tests with higher number of items have a higher potential of higher internal reliability (*Raščevska*, 2005). The VHI total scale is made of 30 items but each subscale consists of 10 items. These findings are in agreement with the previous studies (*Jacobson et al.,* 1997; *Behlau et al.,* 2009; *Schindler et al*, 2010; *Xu et al*, 2010).

The content validity of VHI confirms that the questionnaire measures parameters it is supposed to measure. Pearson's correlation coefficient analysis shows that a tight correlation is observed among the VHI total scale and all subscales ($r = 0.94$ to $r = 0.96$). The results are in concordance with the results by Jacobson et al. study. We found a higher correlation among the subscales ($r > 0.81$) than it was in the study by Jacobson ($r > 0.70$) (*Jacobson et al.,* 1997). The data of our study correspond to the data of other authors (*Hakkesteegt et al.,* 2006; *Ohlsson, Dotevall,* 2009). The high significant correlation confirms that the VHI will operate correspondingly in a new culture environment, i.e., Latvian, and will measure the psycho-social handicap of voice disorders.

Convergent validity shows that the test correlates with other variables or tests that measure the same construct or at least part of it (*Raščevska,* 2005). The convergent validity of VHI was determined by comparing the results of VHI total scale with the results of Voice Disorder Severity scale. Statistically significant correlation ($r_S = 0.78$) was found between both scales. A lower correlation was found between the values of VHI scale and the scale of Voice Disorder Severity in the Jacobson and Helidoni research, $r = 0.6$ (*Jacobson et al.,* 1997), $r = 0.55$ (*Helidoni et al.,* 2010). This observation confirms the tight correlation between the voice problems and the due consequences, i.e., in case of more explicit disorders there will be a higher level of psycho-social and physical limitations.

Statisticaly significant average scores in all scales of the VHI are higher in the patient group than in the control group. Voice problems in the patient and the control group have impacted physical comfort the most. In both study groups voice problems have impacted emotional domain the least. We observed a higher value dispersion of the VHI total scale and all subscales in the patient group when compared to the control group. Other studies haves similar results (*Guimaraes, Abberton,* 2004; *Lam et al.,* 2006; *Núñez-Batalla et al.,* 2007; *Helidoni et al.,* 2010; *Schindler et al.,* 2010). Explicitly higher score in Physical

scale of the VHI can be explained by the fact that people tend to associate physical displays of voice disorders with current voice sounding problems, whereas functional limitations and changes in emotional condition are related to the current voice problems to the lesser extent.

Latvian version of the Voice Handicap Index is a statistically valid and reliable instrument in order to evaluate voice function and psycho-social impact caused by the voice disorders in individual. Hypothesis of the first study has been confirmed since the psychometric indications of the Latvian version of VHI correspond to the psychometric indications of the original study by Jacobson et al., as well as to the results acquired by other authors during test adaptation and approbations. Individual Voice Handicap Index results allow specialists to better understand motives behind looking for help and illustrate limitation variations of activity and participation caused by the voice disorders in individual's life.

3.2 The prevalence of voice disorders in the teacher population of Latvia

Voice disorders are highly spread among teachers (*Smith et al.,* 1998; *Sala et al.,* 2001). The prevalence of voice disorders in the teacher population in Latvia has not been studied so far and this is the first epidemiological study with a goal to find out the prevalence of voice disorders and their risk factors in this profession group.

It has been established that 66.7% of teachers in Latvia have voice disorders (57% *Preciado-Lopez;* 57.72% *Roy;* 59% *Bermudez de Alvear*; 63% *Behlau*; 69% *Sliwinska-Kowalska*) (*Behlau et al.,* 2012; *Preciado-López et al.,* 2008; *Roy et al.,* 2004a; *Sliwinska-Kowalska et al.,* 2006; *Bermúdez de Alvear et al.,* 2010), out of which 36.9% of teachers have suffered from voice disorders

during the past 9 months (31.6% *de Jong;* 37% *Sala*; 41% *Preciado-López*) (*Preciado-López et al.*, 2008; *Sala et al.*, 2001; *De Jong et al.,* 2006) but at the time of filling out questionnaires it was 8% of teachers (11% *Roy*; 11.6% *Behlau*; 13% *Lyberg Ahlander*) (*Behlau et al.*, 2012; *Lyberg Ahlander et al.*, 2011; *Roy et al.,*2004a). 21.6% of the questioned noted that they did not have any voice problems at the time of filling out questionnaires and that they have not had those during the current academic year yet they have faced them earlier in their carriers as educators.

The results acquired by questionnaires related to the lifetime prevalence of voice disorders in teachers of Latvia do not significantly differ from the results acquired by Sliwinska-Kowalska upon using objective laryngoscopy study methods (66.7% *vs* 69%) (*Sliwinska-Kowalska et al.,* 2006). The point prevalence of voice disorders in teacher population of Latvia was significantly lower (8%) when compared to the point prevalence data acquired by Sliwinska-Kowalska and Preciado-López (32.7% & 25%) (*Sliwinska-Kowalska et al.*, 2006; *Preciado-López et al.,* 2008). One should make a conclusion that knowledge about voice quality of teachers in Latvia is possibly insufficient and they are too optimistic when evaluating their current voice condition.

In female teachers voice problems are found 1.4 times more often then in male teachers (68.5% *vs* 48.8%). The acquired results were statistically reliable and completely corresponded to the other studies (46.3% *vs* 36.9%, *Roy*; 38% *vs* 26%, *Smith;* 22% *vs* 12.9%, *Russel*; 46% *vs* 30%, *Smolander*)(*Roy et al.,* 2004a; *Russel et al.,* 1998; *Smith et al.,* 1998; *Smolander, Huttunen,* 2006).

Despite the fact that the prevalence of voice disorders in music and sport teacher groups is the highest (85.2% and 69.7% respectively) when compared to other subject teacher groups, we did not observe statistically reliable difference in the prevalence of voice disorders among different subject teachers. High prevalence of voice disorders were found in chemistry (64.3%),

language (65.4%), visual arts (66.7%), and teachers of other subjects. Preciado-López indicates the high prevalence of voice pathology risk in sport, language, and mathematics teachers yet similarly as in our study they also point out the lack of statistical reliability in terms of relationship among the prevalence of voice disorders, education period, and subject to be taught (*Preciado-López et al.,* 2008). It is possible that the prevalence of similar voice problems in various subject teachers can be explained by similarly bad working conditions and voice hygiene observation conditions. Not only in sport lessons teachers have to raise their voices in order for the pupils to hear them along the sound of bouncing balls; also teachers of other subjects are forced to speak in a loud voice to overcome the continuous background noise of undisciplined pupils. Inadequate room acoustics is characteristic not only to the gyms but also to the most part of classrooms. Upon worsening of the socioeconomic situation even more teachers are forced to work longer working hours thus overloading the voice function.

8.9% of teachers first faced their voice problems during their university years (18.2% *Preciado-López*; 12% *de Jong*) (*Preciado-López et al.,* 2008; *De Jong et al.,* 2006). 82.8% of teachers noted that the time of voice problem occurrence is closely related to their professional activity. Statistically significant correlation was found between the voice problem onset time and subject specialization in teachers. 17.4% of music teachers first faced voice problems in childhood or in school but 26.1% of teachers in university. 56.5% relate beginning of their voice problems with their carrier in teacher profession. High prevalence of voice disorders before commencement of education carrier in music teachers can be explained by the fact that this profession is chosen by people with previous knowledge in music. They are participants of school choirs and other singing groups or they are music school graduates. Not always during the course of education voice apparatus hygiene and proper voice forming techniques are observed therefore voice disorders occur very early

(*Vilson*, 1987). The study confirms that a great number of music teachers do not acquire voice problems but deepen the existing ones during their professional carrier. 100% of all sport teachers involved in the study admitted that voice disorders occurred during their work as teachers. Similarly to music teachers, sport teachers also choose their professional disposition during childhood and school years. They have been active athletes, have trained and participated in competitions emphasising physical accomplishments and voice usage was not a priority. When becoming a teacher the ex-athletes have to become process leaders, activity coordinators where the most important and at times the only instrument is their voice. The extreme work conditions (big gyms, stadiums, bad acoustics, and high background noise level) promote speedy voice problem occurrence in inexperienced voice (*Jónsdottir et al,* 2002).

The study indicates necessity for voice disorder prevention before commencing professional carrier. It is important to perform screening before studies in education programmes and to take care of one's voice during the studies (*De Jong et al.,* 2006). Simberg believes that teachers who have their first voice complaints during the first years of work maybe have chosen wrong profession. In order to avoid these cases she recommends evaluation of voice's physiological capabilities, its capacity and suitability for the chosen profession before beginning studies (*Simberg*, 2004).

51% of teachers due to their voice problems have sought after specialist's help and in 32.6% of cases the physician has established larynx illness. Similar observations in terms of seeking help have been discovered by Russel and Chen (*Russel et al.,* 1998; *Chen et al.,* 2010). Even though half of the questioned teachers have tried to solve their problems in a medical institution, it is very disturbing that in 49% of cases the help has not been sought after. It can be explained by a belief that voice problems in teachers is something normal and part of the profession (*Russel et al.,* 1998), by unwillingness to request a sick leave because of the voice problems or due to

the fear that specialists might suggest reduction in voice load or change of profession all together (*Roy et al.,* 2004b).

It was discovered in the study that women seek for help in case of voice disorders more often than men do. Similar conclusion is drawn by Morton and Roy (*Morton, Watson*, 1998; *Roy et al.,* 2004a). Statistically significant correlation was observed between the decision to seek after specialist's help and the degree of voice problem; between the amount of knowledge about voice hygiene and the overall health condition.

Voice problems are most often found in teachers of 50–59 years of age (73.8%). Nevertheless statistically significant correlation between the teacher's age and the presence of voice problems was not found (*Preciado-López et al.,* 2008; *Bermudez de Alvear et al.,* 2011).

Statistically significant correlation was observed between the voice dysfunction and years of service in education. Mattiske indicates that voice disorders most often are observed in experienced teachers with long years of service (*Mattiske et al.,* 1998). It was established in the study that when years of service increase, the number of teachers complaining about voice problems also increases.

The study confirmed the posed hypothesis that the prevalence of voice disorders in the population of teachers in Latvia is as high as in other countries.

3.3 Factors impacting the voice quality in teachers

The voice disorder etiology is multifactorial. The voice quality is impacted by endogenous and exogenous factors, i.e., larynx illnesses, voice using habits, psycho-emotional factors, overall health condition, environment conditions (*De Jong et al.,* 2001).

During the study factors impacting the voice quality were established and the question of their importance in terms of the voice disorder etiology was answered. Of all 58 factors included in the questionnaire 25 factors have statistically significant impact on the vocal function.

Similarly to Sliwinska-Kowalska (*Sliwinska-Kowalska et al,* 2004) and De Medeiros (*De Medeiros et al.,*2008) studies, our study shows that the voice apparatus load that consists of voice using time and voice using intensity, is one of the main risk factors in the voice using habit group.

In teachers with voice disorders voice using period is longer than in teachers without voice disorders (longer working week, more contact lessons, higher involvement in extra curriculum activities that creates extra vocal load). Voice use during the extra curriculum activities greatly increases the total voice apparatus load and doubles the possibility of voice disorder occurrence.

Another important voice apparatus load component is the voice use intensity. 60% of teachers with voice problems when compared to the 38.5% of teachers in the control group speak in a raised and loud voice. Similar tendency is observed in the Preciado-López study in a teacher population of La Roja (*Preciado-López et al.,* 2008). We established in the study that the habit to raise and use loud voice on every day basis increases the voice disorder risk by 1.5 times.

Voice loudness is directly related to the intensity of background noises. The suggested classroom background noise level in elementary and secondary school education periods is 50-55 dB and 55-65 dB in the primary school period (*Bovo et al.*, 2007). In our study this level of background noise was labelled as 'silent', with an explanation relevant to the working environment '*silent voices, working noises'*).

38.5% of control group teachers work in 'silent' classes and 28.5% of teachers with voice disorders. 71.5% of the voice disorder group teachers work in the classroom on every day basis where the background noise is medium

loud, loud, and very loud. That means that in order to ensure the signal-noise relationship between the background noise and voice optimal for education process (at least 10-15 dB) (*ASHA*, 2005; *Classroom acoustics guidelines,* 2006), a teacher has to speak in a raised and loud voice. It was found in the study that there is a statistically significant correlation between the teacher's voice intensity and the background noise level during the lesson ($r = 0.19$). The acquired results correspond to the De Medeiros study performed in Brazilian teachers (*De Medeiros et al.,* 2008). The voice disorder risk is 1.5 times higher in teachers who have elevated background noise level in their classrooms than in teachers who work in relatively silent classrooms.

The study results showed that a significant background noise level source is undisciplined pupils ($r = 0.33$, $p < 0.001$). Even though both Simberg and Kooijman believe that higher number of students creates bigger noise and the number of pupils is one of the voice disorder risk factors (*Simberg et al.,* 2005; *Kooijman et al.,* 2006), in our study statistically significant correlation between the number of pupils in the classroom and the background noise intensity was not discovered ($r = 0.08$, $p = 0.235$). It could mean that the noise level in the classroom is more related to the discipline and the chosen teaching methods than to the number of pupils (*Shield, Dockrell*, 2008). In classrooms with large number of students the working environment can be silent and appropriate for the work yet in small undisciplined pupil groups the noise level can be high. 59.1% of the voice disorder group teachers indicated undisciplined pupils as a source of background noises (67% *Preciado-López*). In classes with discipline problems teachers are twice more likely to acquire voice disorders when compared to the classrooms where this problem does not exist.

A significant factor impacting the voice is air quality in the classroom. Air quality factors impact vocal cord vibratory abilities (*Vilkman*, 2004; *Thomas et al.*, 2006). 27.2% of the voice disorder group teachers describe the air quality in classrooms as bad and unsatisfactory, 13.2% in the control group

(42% *Simberg,* 2005). 76.6% of the voice disorder group teachers marked the presence of blackboard chalk dust in the classroom (69.2% *Sliwinska-Kowalska*) and it doubles the disorder risk in this group. Blackboard chalk dust can be avoided if to give up the traditional blackboards and purchase whiteboards instead (*Thomas et al.,* 2006).

78.6% of chemistry teachers mark the presence of chemical fumes in their workplace. Statistically significant correlation was discovered between the chemical fumes in physical environment and the presence of voice disorders ($r = 0.27$, $p < 0.001$). That can be explained by the direct irritant impact of chemical fumes on vocal cord mucous membrane. Room ventilation, regular airing can improve the air quality in chemistry labs. The prevalence of voice disorders in chemistry teachers is higher than in the primary school, language, and other subject teachers. It can be related to the presence of two important factors impacting voice quality – bad air quality and increased background noise caused by ventilation system.

42.1% of the voice disorder group teachers noted that during the heating season air humidity in the classroom is insufficient. 45.1% of the teachers in this group pointed to inadequate air temperature in the classroom. Dry air irritates and dehydrates the vocal cord mucous membrane thus impacting the vocal cord vibration cycle regularity and periodicity (*Hemler et al.,* 1997). In order to create optimal conditions for the voice apparatus, the classroom air temperature should be as follows $20\text{-}23^0$ C in winter time and $20\text{-}26^0$ C in summer time (*Sala et al.,* 2009).

Throat clearing is one of the body's reactions to insufficient relative air humidity. Statistically significant correlation between the air humidity and a habit of throat clearing was discovered during the study ($r = 0.15$, $p = 0.019$). Throat clearing itself is considered to be a harmful voice factor since during it powerful aperiodic vocal fold adductions are observed. 18.3% of teachers in the

voice disorders group have a habit of clearing their throat (8% in control group). Throat clearing doubles the voice disorder risk ($OR = 2.56$).

Voice quality is impacted by teachers' habit to draw pupils' attention by crying and shouting out loudly ($OR = 1.9$). Shouting is using the voice in maximum intensity. Data acquired during the study with regards to the habit of shouting correspond to the Smolander's study results. She believes that one of the most prevalent reasons for voice disorders in teachers of Finland is shouting ($OR = 2.8$) (*Smolander, Huttunen,* 2006). Shouting as one of the voice production forms is used by 46.8% of teachers with voice disorders (31.6% in control group). The high result is explained by undisciplined pupils, increased background noise level or the presence of psycho-emotional factors. Psycho-emotional factors are one of the main voice problem reasons (*Kooijman et al*, 2006).

Significant correlation between the teacher's stress and tiredness level and the shouting was discovered during the study. The higher is teacher's stress level, the more often voice strategy used is shouting ($r = 0.14$, $p = 0.027$). It is similar to the tiredness level ($r = 0.15$, $p = 0.023$). Thus shouting, which is a factor negatively impacting voice quality, could be reduced by normalising teacher's psychoemotional condition, by reducing stress, and tiredness. Stress and tiredness positively correlates with the teacher's voice loudness in class. The increased perceived stress level in a teacher positively correlates with the noise level in class ($r = 0.17$, $p = 0.011$). There is a two-fold explanation for this: (1) noise in the classroom increases teacher's stress level (*Simberg et al.,* 2005), (2) teacher's nervousness transfers to pupils and increases the noise level in the class. Statistically significant correlation between the stress and the tiredness level ($r = 0.48$) was discovered in the study. Stress in teachers is created by a significant work load ($r = 0.1$). By reducing the work load, stress and tiredness would decrease and the voice behaviour could be changed.

Significant correlation between the voice problems and the overall health condition was discovered in the study ($p < 0.001$). Similar observations

are found in the study results by Roy, Thomas, Sliwinska-Kowalska, and Preciado-López (*Roy et al.,* 2004a; *Thomas et al.,* 2006; *Sliwinska-Kowalska et al.,* 2006; *Preciado-López et al.,* 2008; *Bermudez de Alvear et al.,* 2011). Teachers suffer from the upper respiratory illnesses more often than representatives of other professions (*Roy et al.,* 2004a). Pathological condition of the vocal folds changes their vibratory model and reduces load tolerance. 28.1% of the voice disorder teachers suffer from chronic upper respiratory illnesses, 7.5% of the teachers in control group (33.3% *vs* 3.3%, *Chen*). Voice disorder risk in teachers who suffer from chronic upper respiratory illnesses is 4.8 times higher than in healthy teachers.

In cases of chronic upper respiratory illnesses voice hoarseness or total loss of voice (aphonia) can be observed. Roy notes that teachers in the USA do not always seek after specialist's help in voice disorder cases instead they choose going to work and continue using their voice in the usual intensity (*Roy et al.,* 2004a). Our study shows similar tendency in Latvia; 54% of teachers in the control group and 88.5% of the voice disorder group representatives continue teaching classes with a hurting throat thus increasing the probability of voice disorders by 6.6 times. This kind of attitude towards one's voice is to be valued as malicious in relation to the health of voice.

In case of a respiratory allergy voice disorders are observed. Vocal fold activity and phonation is impacted by increased secretion in the nose mucous membrane (allergic rhinitis) and bronchial spasms (bothersome breathing, asthma attacks) are observed (*Simberg et al.,* 2009). Teachers suffering from the respiratory allergies are 5.5 times more likely to have voice problems than teachers in whose anamnesis these specific health problems have not been registered. Sliwinska-Kowalska notes that respiratory allergies are encountered in 17.6% of teachers in Poland (*Sliwinska-Kowalska et al.*, 2006). Preciado-López finds theses type of illnesses in 16% of teachers with dysphonia in Portugal (*Preciado-López et al.,* 2008). In our study 14% of teachers noted the

presence of respiratory allergies. It is possible that unsatisfactory classroom air quality in which, as noted by 62.2% of the control group respondents and 76.6% of the study group respondents, there is a blackboard chalk dust combined with continuous psychoemotional strain, are the factors provoking allergy. Study results correspond to Roy's conclusion who believes that voice disorders are more often found in teachers suffering from respiratory allergies, asthma, chronic upper respiratory illnesses (*Roy et al.,* 2004a).

15.3% of teachers in the voice disorder group are suffering from endocrine system illnesses, 8% of the teachers in control group (7.8% *Preciado-López*). Sliwinska-Kowalska and Preciado-López believe that the hormone disorders are equally found in both teachers with the voice disorders and without voice disorders (*Sliwinska-Kowalska et al.,* 2006; *Preciado-López et al.,*2008). Our study demonstrates statistically significant difference between both groups in relation to this illness group. Voice disorder risk in teachers with endocrine system illnesses is twice higher (*OR*=2.1).

The study did not confirm any statistically significant correlation between the consumed water, coffee and other beverages containing caffeine, or smoking, and occurance of voice disorders in teachers. The acquired results correspond to results by other authors (*Miller, Verdolini,* 1995; *Roy et al.,* 2004a; *Chen et al.,* 2010).

Study results confirmed hypothesis about the multifactorial origin of voice disorders that include class physical environment, medical, and psychoemotional factors, as well as disregard for voice hygiene. Specific combinations of various factors impact the quality of voice. When collecting anamnesis in cases of voice disorders, it is important to analyse the different voice problem occurrence aspects.

3.4 Voice disorder impact on psychic, physical and functional condition in teachers

In the part IV of the study it was established how and to what extent voice disorders impact teacher's physical and mental comfort, as well as their functionality. In order to reach this objective Latvian version of the Voice Handicap Index was used. Physical scale of the VHI represents subjective feelings caused by the larynx discomfort, the Emotional subscale characterises the affective reactions caused by voice disorders, and the Functional scale includes statements that describe voice disorder impact on performing every day activities (*Jacobson et al.,* 1997).

Activity and participation limitations caused by voice disorders correlate with the vocal symptom scale, i.e., the extent of voice disorders. Upon the increase of vocal symptoms, the extent of voice disorders and activity and participation limitations caused by voice disorders increase; that is considered to be the direct consequences of voice disorders in physical, functional, and emotional domains.

It was established that the average result of the VHI total scale is higher in teachers with voice disorders than in teachers without voice disorders. There were considerably higher results also in the functional, physical, and emotional subscales in the voice disorder group when compared to the control group. It means that teachers with self-evaluated voice problems feel more limited in their daily activities, they suffer from affective reactions caused by voice disorders more often, and they feel voice discomfort more often. During the study we established that voice disorders in teachers of Latvia have greater impact on their physical comfort and have a smaller impact on their emotional sphere. Teachers in Latvia more often relate their voice disorders to the acoustically detectable changes in their voice sound and unpleasant feelings in the larynx during speech. Teachers with voice disorders believe that they have

fewer job opportunities because of the voice problems, that voice difficulties limit their personal and social life, as well as they limit their communication with friends, neighbours, and relatives. Voice problems are noticable to other people around us. Teachers with voice problems have more often heard a question addressed to them "What is wrong with your voice?" Physical handicapping of voice problems – cracking of voice in the middle of speech, failing of voice in the evening, necessity to strain to produce voice, and use of a great deal of effort to speak – have been marked by teachers in the voice disorder group more often than in the control group. Voice problems impact the psycho-emotional condition of teachers. Teachers in the voice disorder group believe that other people do not understand their voice problems more often, that they are less outgoing due to their voice problems. They are ashamed of their voice problems.

The VHI result provides indications about the degree of voice disorder. The VHI within 0 to 30 points corresponds to light or early voice problems and the resulting minimal participation limitations, 30 to 60 points indicate moderate voice problems and average participation limitations, and 61 to 120 points indicate severe voice problems and significant, severe participation limitations (*Niebudek-Bogusz et al., 2007; Fairfield, Richards, 2007*). Relation between the degree of voice problems and the VHI total scale results is relative. The closer the VHI score gets to 0, the less explicit the voice problem is (*Jacobson et al., 1997*). In the voice disorder group the VHI total scale score has concentrated within 12 to 33 points, i.e., 76.4% of the voice disorder group respondents acquired the total number of points within 12 to 33 points, i.e., 76.4% of the voice disorder group respondents had up to 33 points. In the control group 75.3% of teachers had the VHI score of up to 17 points. The acquired results allow a conclusion that the scores acquired in the control group are closer to 0 mark and can be interpreted as absence of the voice problems,

whereas in the voice disorder group the VHI scores dispersion testify of light voice disorder presence.

The study results show that light voice disorders impacting physical comfort are more often present in teachers. Our study conclusion - that teachers with voice disorders have higher VHI values - corresponds to study results by other author (*Guimarães, Abberton*, 2004; *Kooijman et al.*, 2007; *Thomas et al.*, 2007; *Fairfield, Richards,* 2007; *Kuzanska et al.*, 2009).

The acquired results indicate higher activity and participation limitation in teachers with voice disorders when compared to the teachers not complaining about their voice. The fourth hypothesis of the study that voice disorders impact teacher's physical, functional, and emotional condition has been completely confirmed.

Every daily activity limitation impacts the quality of life (*Ma, Yiu,* 2001). Changes in the quality of life impact the quality of work (*Chen et al.*, 2010). Before filling out the VHI people often do not realise their voice problems. Upon understanding that voice problems impact their daily life people will start changing their habits and externals that impact their voice (*Jacobson et al.*, 1997). Identification of consequences caused by voice problems could allow people to evaluate their attitude towards their voice health.

3.5 Voice function characteristics in teachers with and without voice disorders and non-teachers

Objective of the Study V was to find out whether objective voice parameter measurements differ in teachers with and without voice disorders and non-teachers. Medics as a control group are often used in teacher voice studies (*Ohlsson et al.*, 1987; *Pekkarinen et al.*, 1992; *Sala et al.*, 2001).

Participant selection methodology for the studies II and V was similar. In both studies teacher division in groups was based on the answer to a question: "Have you had problems with your voice?" We found out that regardless of the number of respondents, the prevalence of voice problems was similar. 58.1% of teacher respondents in the Study V (N=138) admitted that they have had voice problems. 6.6% of them had voice problems at the time of examination, 30.9% have had problems during the last nine months or during the last academic year and 20.6% said that they have had problems during their carrier in education. Results in the Study II (N=522) are similar: 66.7% of teachers have had voice disorders, 8% had voice problems at the time of the study, 36.9% have had problems during the past academic year, and 21% have felt voice problems during their carrier in education.

Upon an objective assessment of voice function in small samples of the Study V (voice disorder group, N=20; teacher control group N=21), we came to a conclusion that can be generalized with regards to the Study II sample (N=522).

The vocal symptom scale was used for participant selection as an additional instrument. During the study it was established that 29% of teachers noted the presence of two or more vocal symptoms once a week or more often. Most often teachers complain about voice strain and tiredness during the speech (41/138), throat clearing (41/138), lowering of voice, and hoarseness (35/138). Throat clearing and voice tiredness have been discovered by Simberg as the most frequent vocal symptoms; she considers that two or more symptoms that repeat themselves every day or once a week and more often are a sign of functional voice disorder (*Simberg*, 2004).

Statistically significant difference between the groups according to the GRBAS parameter scores was established in the study. The scores of GRBAS scale parameters are statistically significantly higher in teachers with voice disorders then in teachers without voice disorders. Especially large difference is

observed among the groups in the degree of hoarseness (*G*), voice roughness (*R*), and breathiness (*B*). The acquired results correspond to the Tavares and Martins study results (*Tavares, Martins,* 1997), which confirm that subjectively self-evaluated voice problems perceptually have to be considered as qualitative changes in the voice sound. We established statistically significant strong correlation among the Jitter and Shimmer indications and (*G*) and (*R*) parameters in teachers with voice disorders. As Laver has noted the increased frequency and amplitude perturbation indicators are related to the presence of voice pathology (*Laver et al.,* 1992). Increased median values of voice frequency perturbation are observed in teachers with voice disorders when compared to the norm (*Deliyski,1993*) – *Jitt* = 1.18%, *PPQ* = 0.7%, as well as the decreased median value of voice fundamental frequency *F0* = 206.22 Hz. Decrease of the voice fundamental frequency in teachers with functional dysphonia has been described by Niebudek-Bogusz in her study results (*Niebudek-Bogusz et al.,* 2006).

Even though we also hoped to find more explicit differences in the objective measurements of voice parameters between teachers with and without voice disorders, the study results neither showed statistically significant differences between these groups in aerodynamic and electroglottographic examinations, nor in the biggest part of acoustic measurements.

Yet more explicit differences were marked in various voice parameters when comparing teachers without voice disorders and non-teachers. Reduced Maximum Phonating Time (18 s) and increased Phonating Quotient (157 ml/s) was established in teachers without voice disorders. In non-teachers respectively – 26 s and 128 ml/s. Maximum Phonating Time and Phonating Quotient are related dimensions. Reduced MPT can be explained by reduced vital lung capacity (VC) or inefficient vocal fold closing during the phonating (*Cavallo, 1999*). Increased PQ and reduced MPT are signs of hypofunctional dysphonia (*Baken, Orlikoff, 2000*). Since statistically significant difference

among groups in the VC scores was not observed during the study then aerodynamic parameter changes in teachers in relation to non-teachers can be explained by insufficient vocal fold activity. We didn't find statistically significant differences in the values of aerodynamic parameter in teachers with and without voice disorders. Similar result was accomplished in the Tavares and Martins study (*Tavares, Martins, 1997*). Observations confirm that in teachers regardless of the presence or absence of their voice problems vocal fold working efficiency is lower than in non-teachers. Similar results have been acquired by Sliwinska-Kowalska when comparing voice function of an office employee and a teacher. According to the statistical significance the MPT was higher in the office employees than in teachers (*Sliwinska-Kowalska et al., 2006*). Ineffective coordination of breathing and phonating may create voice tiredness (*Kostyk, Rochet,* 1998). Our study confirmed this statement since one of the most often vocal symptoms in teachers was the voice tiredness. 41 out of 138 teachers mentioned voice tiredness as a continuous, regularly repeating symptom.

As a result of the voice acoustic analysis we established that statistically significant differences between the teacher groups and non-teacher groups are observed in voice acoustic parameters. Increased voice frequency perturbation values (*Jitt* and *PPQ*) are found in teachers without voice disorders when compared to non-teachers. In this teacher group the average value of voice amplitude perturbations (*Shim* and *APQ*) is increased in relation to the norm. Since the Jitter and Shimmer measurements reflect vocal fold vibration stability then changes in these values show phonating instability (*Ferrand, 1998*).

The acquired results suggest a conclusion that voice quality in teachers whose daily profession is characterised by great voice apparatus load, differs from that in the non-teachers. Teacher's profession is a significant voice disorder risk factor.

Our study confirmed statistically significant difference in the Dysphonia Severity Index score among the groups. Teachers with voice disorders have lower median DSI score (2.96) than teachers without voice disorders (3.21). In their turn teachers without voice disorders had lower median DSI score than individuals in the non-teachers group (4.57). The DSI provides evaluation of the voice function based on objective measurements (MPT, $F0_{max}$, Int_{min}, *Jitt*).

Significant negative correlation was established during the study between the DSI and the *G* parameter according to the GRBAS scale, the Vocal Symptom Scale, and the Voice Handicap Index. Upon increasing of the auditory-perceptually detectable changes in the voice quality, the number of vocal symptoms and the VHI score, the DSI score decreased.

In the study we established that perceptual and acoustic analysed voice qualities will not always correspond to the individual's voice self-evaluation. Half of the teachers from the voice disorder group admitted to the presence of voice problems and marked the presence of two or more than two vocal symptoms in every day or once a week or more often yet the voice hoarseness level in them according to the GRBAS scale was marked with 0 points and also the voice acoustic examination did not confirm the presence of voice disorders. These teachers also marked significant limitations in the physical, emotional, and functional areas caused by voice disorders that were reflected in the VHI score.

The acquired results could be explained by the fact that deviations of voice quality are not discovered in a formal examination in a lab yet teachers have other complaints that are mainly related to the voice use in work situations with increased voice apparatus load. Subjective self-evaluation plays a significant role in the voice problem diagnostics because as by Jacobson 'patients with similar voice disorders experience differing levels of handicap and disability' (*Jacobson et al., 1997*).

Similarly to the Study IV (N=409), also the Study V participants (N=61) were asked to perform their voice self-evaluation. The Visual analogue scale method and the VHI method were used. Teachers with voice disorders marked more explicit voice sound quality deviations from the norm mark than the control group participants. The VHI result analysis shows that teachers with voice disorders have more explicit participation limitations in their everyday activities than teachers without voice disorders and non-teachers. The study results correspond to the results acquired by other authors (*Ma, Yiu,* 2001; *Roy et al.,* 2004b; *Kooijman et al.,* 2007). A confirmation was acquired during the study that the presence of voice disorder mostly impacts teachers' physical comfort (*Kuzanska et al.,* 2009).

Qualitative evaluation of different voice function assessment methods shows that the most sensitive voice disorder diagnostics indicator in teacher population is the DSI that provides information on voice function by combining objective aerodynamic and acoustic data. Limitations of everyday life caused by insufficient voice quality played a significant role in teachers' lives therefore the VHI has to be considered as an integral component of the voice assessment process. Study results show that hypothesis of the fifth study has been confirmed. Objective voice parameter measurements differ in teachers with and without voice disorders, as well as in teachers without voice disorders and non-teachers.

CONCLUSIONS

1. The Voice Handicap Index is the first instrument of evaluation of bio-psycho-social consequences of voice disorders in Latvia. Latvian version of the Voice Handicap Index is a psychometrically validated instrument whose indicators correspond to the psychometrical indicators of the original sample.
2. According to our study data 66.7% of teachers in Latvia have voice problems. Voice problem prevalence in teachers is related to the years of service in profession.
3. Music teachers are included into the increased disorder risk group since 43.5% of teachers start their carrier in education with already existing voice problems, which only become more explicit during their education carriers.
4. Teachers' knowledge about voice disorders and their prevention is insufficient, only half of the teachers (51%) have sought after specialists' help because of the voice problems.
5. Our study confirmed data about the multifactorial origin of voice disorders. Voice disorder etiology includes four risk factor groups – increased voice apparatus load and disregard for voice hygiene, disadvantageous physical room environment for the voice, bad health condition, and the presence of psychoemotional factors:
   - Increased voice apparatus load is an important risk factor of causing voice disorders. The habit of using raised and loud voice increases the risk of voice disorder by 1.5 times
   - Teachers are two times more likely to acquire voice disorders in classes with bad discipline than in classes where this problem does not exist.

- Air pollution created by the blackboard chalk dust in the classrooms doubles the risk of acquiring voice disorders
- Teaching classes with a sore throat increases the voice disorder risk by 6.5 times
- Chronic upper respiratory illnesses increase the risk of voice disorders by 4.8 times
- Respiratory allergies increase the risk of voice disorders by 5.5 times
- Increased stress level at work increases the risk of acquiring voice disorders by 2.5 times but dissatisfaction with the profession – four times

6. In teacher population of Latvia light, professionally conditioned voice disorders are encountered more often.
7. Activity and participation in everyday life situations is limited in teachers with voice disorders. Voice disorders mostly impact physical comfort in teachers.
8. 29% of teachers have marked two or more vocal symptoms that are displayed every day or once a week or more often. Teachers often complain about the voice strain, tiredness, throat clearing and coughing during speech.
9. Teachers with voice disorders have objectively justified worse voice acoustic and auditory-perceptual indicators than teachers without voice disorders or non-teachers:
    - More explicit level of voice hoarseness, explicit roughness, and breathiness components in the voice.
    - The average frequency perturbation indicator exceeds the admissible norm threshold (*Jitt* = 1.18%) that proves the presence of voice pathology.
    - Decreased average voice basic frequency *F0* = 206.22 Hz.

10. Voice apparatus load determined by the profession impacts voice quality. Statistically significant differences among the MPT, PQ, F0, *Jitt, PPQ,* and PSS parameters are observed in teachers without subjectively self-evaluated voice disorders when compared to non-teachers:
    - Reduced maximum phonating period (MPT = 18 s)
    - Higher frequency and amplitude perturbation indicators (*Jitt* = 0.89%, *Shim* = 3.08%)
11. Dysphonia Severity Index is the most sensitive voice disorder indicator yet when evaluating voice function in teachers, the Voice Handicap Index results should be taken into account.

RECOMMENDATIONS

1. Voice education course should be included into the new teacher training programme that would provide basic knowledge about normal voice mechanism operation, voice disorders, their possible causes, and prevention.
2. In order to draw teachers' attention towards voice disorder prevention, it is necessary to organise regular informative events, courses, workshops.
3. Each teacher should evaluate their working environment conditions, especially paying attention to the classroom acoustics and air quality. Influence of factors harmful to the voice must be prevented or reduced as much as possible.
4. In case of upper respiratory illnesses like sore throat, teachers would have to avoid using their voice in the class.
5. Individuals working as teachers have to attend speech therapist specialised in voice disorders or otorhinolaryngologist in order to evaluate their larynx and voice function.
6. When evaluating the voice speech therapists and physicians have to use the recommendations by European Laryngological Society that provide varied voice function evaluation.
7. The Voice Handicap Index can be used in speech therapist and physician's work in order to evaluate the biopsychosocial consequences of voice disorders.

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