Voice of elementary school teachers with voice complaints of different educational systems

Voz de professoras do ensino fundamental com queixas vocais de diferentes redes de ensino

Voz de los docentes de primaria con las quejas de voz de los diferentes sistemas educativos

Fernanda dos Santos Pascotini[*]
Vanessa Veis Ribeiro[**]
Carla Aparecida Cielo[***]

Abstract

Objective: *to analyze the voice of elementary school teachers with voice complaints according to the schools they serve.* ***Material and Methods****: cross sectional design, observational, analytical approach of quantitative character, attended by 74 female teachers, aged between 20 and 62 years with a mean of 38,5 years. Data collection was composed by hearing screening and the completion of a protocol, followed by vocal auditory perceptual, acoustic analysis of glottal source and spectrographic of voice. We carried out statistical analysis using ANOVA test, adopting a significance level of 5%.* ***Results****: significant difference in favor of the municipal network in the degree of roughness and the overall degree of change in auditory perceptual voice analysis and the darkening of the trace of the high frequencies and all vocal spectrogram, the presence of noise between the harmonics and definition of harmonics in spectrographic acoustic assessment; there was no significance in the results of the acoustic analysis of glottal source.* ***Conclusions:*** *the group of teachers of the municipal elementary school had a worse voice quality as*

[*]*Master in Human Communication Disorders, Universidade Federal de Santa Maria/UFSM, Santa Maria, RS, Brazil.*
[**] *Master in Human Communication Disorders, Universidade Federal de Santa Maria/UFSM, Santa Maria RS, Brazil.*
[***] *Speech Language Pathologist and Audiologist; Professor of the Undergraduate Program in Speech Language Pathology and Audiology and of the Graduate Program in Human Communication Disorders, Universidade Federal de Santa Maria/UFSM, Santa Maria, RS, Brazil.*

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CorrespondenceAddress: Vanessa Veis Ribeiro. RUniversidade Federal de Santa Maria, Departamento de Fonoaudiologia Av. Roraima, 1000, Prédio 26, 4º andar, Cidade Universitária, Camobi, Santa Maria (RS), Brazil, CEP: 97105-900.
E-mail address:vanessaribeirooo@hotmail.com
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evidenced by the high overall degree of change of voice and hoarseness, although within normal limits, and the increased presence of noise between the harmonics, and probable hyperfunctional vocal compensation evidenced by darker than the spectrographic tracing. Municipal teachers also showed greater definition of harmonics for other school systems, but with low average, suggesting vocal inadequacy.

Keywords: *Attention deficit disorder with hyperactivity; learning disorder; medicalization.*

Resumo

Objetivo: Analisar a voz de professoras do ensino fundamental com queixas vocais de acordo com a rede de ensino. **Material e Método:** Estudo de corte transversal, observacional, analítico, de caráter quantitativo, do qual participaram 74 docentes do sexo feminino, idades entre 20 e 62 anos com média de 38,5 anos. A coleta de dados foi composta pelo preenchimento de questionário, avaliação vocal perceptivoauditiva, análise vocal acústica de fonte glótica e espectrográfica. Realizou-se análise estatística por meio do teste paramétrico ANOVA, adotando-se nível de significância de 5%. **Resultados**: Houve diferença significante a favor da rede municipal quanto ao grau de rugosidade e ao grau geral de alteração vocal na avaliação perceptivoauditiva e quanto ao escurecimento do traçado das altas frequências e de todo o espectrograma vocal, presença do ruído entre os harmônicos e definição de harmônicos na avaliação acústica espectrográfica; não houve significância nos resultados da avaliação acústica de fonte glótica. **Conclusões:** O grupo de professoras do ensino fundamental municipal apresentou pior qualidade vocal evidenciada pelo elevado grau geral de alteração da voz e da rouquidão, ainda que dentro dos padrões de normalidade, e pela maior presença de ruído entre os harmônicos; e prováveis compensações vocais hiperfuncionais evidenciadas pelo maior escurecimento do traçado espectrográfico. As docentes municipais também mostraram maior definição de harmônicos em relação às outras redes de ensino, mas com média baixa, sugerindo inadequação vocal.

Palavras-chave: Docentes; Qualidade da Voz; Saúde do Trabalhador; Voz.

Resumen

Objetivo: *analizar la voz de los docentes de primaria con las quejas de voz de acuerdo a las escuelas a las que sirven.* ***Método:*** *estudio transversal, observacional, el enfoque analítico de carácter cuantitativo, a la que asistieron 74 docentes de sexo femenino, con edades comprendidas entre 20 y 62 años con una media de 38,5 años. La recolección de datos fue compuesta por el cribado y la implementación de un protocolo, seguido de los análisis perceptivo auditivo, acústico de la fuente glotal y espectrográfico de la voz. Se realizó la análisis estadístico mediante la prueba paramétrica de ANOVA, adoptando un nivel de significación del 5%.* ***Resultados:*** *se observó que había diferencia significativa a favor de la red municipal en el grado de rugosidad y el grado general de cambio en la evaluación perceptivo auditivo vocal y el oscurecimiento de la traza de las altas frecuencias y todo el espectrograma vocal, la presencia de ruido entre los armónicos y la definición de los armónicos en evaluación acústica espectrográfico; no hubo significación en los resultados del análisis acústico de la fuente glotal.* ***Conclusiones:*** *el grupo de profesores de la escuela primaria municipal tenía una calidad de voz peor como lo demuestra el alto grado general de cambio de la voz y ronquera, aunque dentro de los límites normales, y la mayor presencia de ruido entre los armónicos; la indemnización vocal hiperfuncional probable evidencia por mayor oscurecimiento del trazado espectrográfico. Maestros municipales también mostraron una mayor definición de los armónicos de otros sistemas escolares, pero con promedio bajo, lo que sugiere insuficiencia vocal*

Palabras clave: *Docentes; Calidad de la Voz; Salud Laboral; Voz.*

Introduction

The professor is the voice professional most at risk for developing vocal disorders of an occupational order, with studies that show a prevalence of some degree of dysphonia in up to 80.7% of teachers[1-6].

The etiology of the vocal deviations in educators is multifaceted and is related to the environmental, emotional, social, and ergonomic conditions of the professor, from lack of preparation to unsatisfactory work conditions and the frequent necessity to speak loudly, loudness, associated with high vocal demand[7,8]. Symptoms such as hoarseness, vocal fatigue, sore throat, aphonia, and dry throat are characteristics of misuse or intense use of the voice, frequently found in professors with dysphonia of the occupational order[2,3,10]. The vocal symptoms normally start slowly and sporadically, developing over time until they become permanent, with the emergence of laryngeal lesions[9].

The necessity to increase the number of work hours, with the goal of improving monthly revenue; the physical tension corresponding with problems in the teacher's environment; the interference of emotional factors and stress on vocal adjustments compose the social factors that may also contribute to these professionals falling ill. In addition to this, they accelerate the wear on the vocal apparatus, making it vulnerable to the development of problems related to the voice[3,11-14]. Despite the large number of research studies about the voice of the professor, studies that analyze the association between the ergonomic factor and the school system, on the teacher's voice, have not been found within the national literature.

Vocal disorders have moved various voice professionals to situations of withdrawal and inability to perform their educational activities, implicating economic and social expenses. In addition to this, the professional in these conditions may experience a situation of re-adaptation, which can cause personal, financial, professional, and functional difficulties for the school9. In Brazil, 20% of professors have needed to miss work in the past for laryngeal problems[9,15], 97% of the re-adaptations to duties within the school derive from vocal disorders and it is estimated that 2% of the professionals will need to withdraw from their duties due to vocal problems, at some point in their career[9,15]. Such data are worrisome and call attention to the need to develop research studies that seek to know in more detail other factors that may influence the occurrence of vocal disorders in professors, making it possible for the phono-audiologist to explore all of the elements in the medical history that, in some way, may modify vocal characteristics. Within these elements, this research study, whose objective it was to analyze the voice of professors with vocal complaints in accordance with the school system in which they worked, highlights the school system to be investigated.

Material and Method

The study was of a cross sectional, observational, analytical, quantitative type character, carried out in accordance with the recommendations of the resolution nº 466/12 of the National Commission of Ethics in Research (Comissão Nacional de ÉticaemPesquisa), and approved by the home institution's Ethics in Research Committee (Comitê de ÉticaemPesquisa) under protocol nº 23081.016945/2010-76. Those responsible for the teaching institutions received the necessary clarifications, being invited to sign the Term of Institutional Authorization (Termo de AutorizaçãoInstitucional (TAI)). In the authorized institutions, the participants received the due clarifications about the research study, and signed the Term of Free and Clarified Consent (Termo de Consentimento Livre e Esclarecido (TCLE)).

The target population of the study was elementary and middle school professors, belonging to state, municipal, and private school systems, from an urban area of a city within the state.

So that the sample would be homogeneous and random, a survey of the municipal schools was carried out, such that there were 36 private, 44 municipal, and 24 state schools found, which went through a process of randomization, in which they were numbered in alphabetical order and later randomly chosen, and made available on a list. With this list, after every two schools one was excluded, leaving 19 state, 31 municipal, and 27 private. The 77 schools that composed the sample were invited to participate in the research study, with 15 joining the TAI. In these schools, all of the professors were invited to participate in the sampling stage, during which a questionnaire was applied, accompanying the auditory screening.

Elementary and middle school teachers were included (1st to 9th grades) from the state, private, and municipal systems, only within the urban area; of ages greater than 19 years old, with the intention of excluding deviations from the period of adolescent voice change; with the presence of vocal complaints; of the female sex. The criteria for exclusion were: reports of allergic, respiratory, or gastric symptoms, or hormonal dysfunction due to pregnancy, pre-menstrual or menstrual period during the evaluations, as they could produce deviations from the vocal parameters; reports of neurological, metabolic, endocrinological, syndromes and/or psychiatric diseases; smokers or alcoholics, as they present aggressive agents and can lead to the formation of laryngeal lesions; presenters of auditory dysfunctions detected in the auditory screening, as they can modify the auto-monitoring of the voice, compromising vocal quality.

The auditory screening was carried out through scanning of pure tones at frequencies of 0.5, 1, 2, and 4kHz at the intensity of 25dB, only via air conduction. The Amplivox audiometer, model A260, 2011, was utilized. For the execution of the procedure, a silent room, courtesy of the school, was utilized, with a noise level less than 50dB, which was verified by the sound pressure level meter Instrutherm, model Dec-480. The subjects that did not respond to the pure tone of 25dB were re-tested and those that failed again were excluded from the research study, and referred for complete auditory evaluation. For the application of the selected criteria, a questionnaire prepared by the authors was utilized, containing identifying data and professional characteristics of general and vocal health.

Of the 208 volunteer professors, the following were excluded in the interview: 47 for incomplete data, 39 for not presenting vocal complaints, 16 for reports of endocrinological disorders, 14 for not passing the auditory screening, seven for having received phono-audiological or otorhinolaryngological vocal treatment, four for being smokers, four for being of the male sex, and three for reporting neurological diseases. This way, the sample consisted of 74 teachers of the female sex, ages between 20 and 62 years old with an average age of 38.5 years. Of the studied group of professors with vocal complaints, 44.59% (n=33) belonged to the private school system, 40.54% (n=30) to the state school system, and 14.87% (n=11) to the municipal school system.

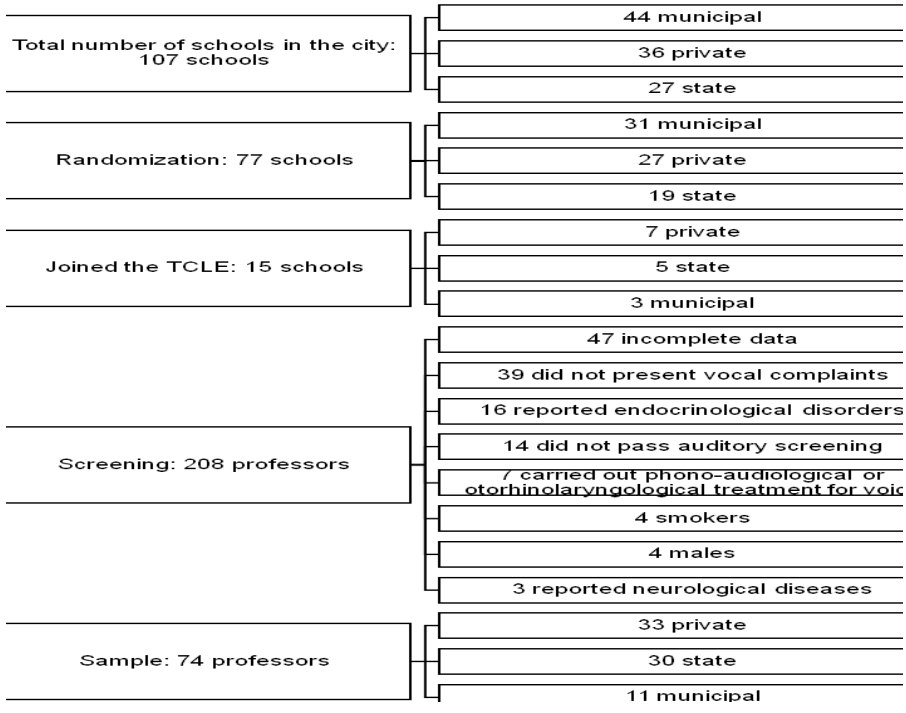

Figure1-Data collection flowchart

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The data collection was composed of auditory--perceptual voice evaluation, acoustic analysis of the glottal source, and spectrographic of the voice. The dada referring to school system were taken out of the questionnaire.

The emissions were captured inside the very school in rooms with environmental noise inferior to 50dB SPL (sound pressure level), measured by a digital sound pressure level meter. For the emissions, the professors were advised to remain in an orthostatic position with arms extended alongside the body, supported by both feet.

For the auditory-perceptual and acoustic analyses, sustained emission samples of the vowel /a:/, a spontaneous speech sample by means of the question "Tell me about the importance of the voice in your profession", and the phrases proposed by the Consensus of the Auditory-Perceptual Evaluation of the Voice (Consenso da AvaliaçãoPerceptivoauditiva da Voz (CAPE-V))[16] protocol. With vowel emission, the professors were advised to perform a sustained pitch and normal loudness, after deep breath, emitting a sound in maximum phonation time, without using the expiratory reserve. Each sample was collected three times, the longest duration being the one considered. For the phrase emissions proposed by the CAPE-V protocol and the spontaneous speech, the professors were advised to utilize normal speech velocity, pitch and loudness. The registration time of each speech situation was not controlled. The emissions were captured by a Zoom, model H4n, professional digital recorder, with a quantization rate of 96kHz and 16bits, recorded at 50% of the input level. The recorder was fixed to a pedestal and positioned at a 90° angle from the subject's mouth, with a Behringer ECM 8000 omni-directional microphone coupled with a flat frequency response range of 15 to 20kHz, maintaining a distance of four centimeters between the microphone and the mouth for vowel emissions and of ten centimeters for the phrases and spontaneous speech emissions.[17]

For the acoustic spectrographic vocal and glottal source analyses, the sustained emissions of the vowel /a:/ were utilized, eliminating the vocal attack and discarding the ending of the emission, in hopes of avoiding the influence of the naturally unstable periods of the voice. The shortest edited time among all of the subjects, discounting the vocal attack and the ending of the emission, was four seconds, making this the standard window of time for acoustic analysis.

For glottal source acoustic analysis, the software Multi Dimension Voice Program Advanced from Kay Pentax®, with a sampling rate of 44kHz and 16bits, was utilized. Because in the literature there is not an exact correspondence between each of the acoustic measurements and the adjacent phenomenon, it is believed that a group analysis of the measurements allows for better understanding. In this way, the extracted measurements were grouped in: (1) Frequency measurements; f0; Highest f0 (fhi); Lowest f0 (flo); f0 Standard Deviation (STD); (2) Disturbance Frequency measurements: Relative Average Perturbation (RAP); Jitter Percentages (Jitt); Absolute Jitter(Jita); Smoothed PitchPerturbation Quotient (sPPQ); PitchPerturbation Quotient (PPQ); Fundamental Frequency Coefficient Variation (vf0); (3) Amplitude Perturbation measurements: Shimmer in dB (ShdB); Shimmer Percentages (Shim); Percentage; Peak Amplitude Variation (vAm); Amplitude Perturbation Quotient (APQ); Smoothed Amplitude Perturbation Quotients (sAPQ); (4) Noise measurements: Noise-Harmonic Ratio (NHR); Soft Phonation Index (SPI); Voice Turbulation Index (VTI); (5) Voice Break measurements: Number of Voice Breaks (NVB); Degree of Voice Break (DVB); (6) Inaudible or Unvoiced Segment measurements: Degree of Unvoiced Segments (DUV); Number of Unvoiced Segments (NUV); (7) Sub-harmonic Segments measurements: Number of Sub-harmonics (NSH); Degree of Sub-harmonic Components (DSH).

The acoustic spectrographic vocal analysis was carried out with a narrowband 1024 point filter (63.09Hz) and a wideband 100 point filter (646Hz), with a sample rate of 11kHz and 16bits at resolution 5kHz, through use of the Real Time Spectrogram (RTS) program of Kay Pentax®.

The following parameters were evaluated with narrowband filter: darkening of the color of the graph (of the high frequencies and of the entire vocal spectrogram); presence of noise (between the harmonics, in the entire vocal spectrogram and in the high frequencies); substitution of harmonics for noise (in the entire vocal spectrogram and in the high frequencies); harmonics definition; uniformity of the graph; number of harmonics and the presence of sub-harmonics. With the wideband filter analysis, the following were evaluated: darkening

of the color of the formant graph (1º formant - F1, 2º Formant - F2, 3º Formant - F3, 4º Formant - F4 of the high frequencies and of the entire vocal spectrogram); formant definition (F1, F2, F3, and F4), and graph uniformity.

The auditory-perceptual analysis was carried out with the visual-analog CAPE-V protocol, composed of a linear analog scale that ranges from 0 to 100mm, whose marking was later transformed into a corresponding number, by direct measurement with a millimeter ruler[18]. For this analysis, the unedited sustained vowel /a:/ emission, the spontaneous speech, and the standard-phrases of the instrument itself, were utilized[18]. The voices were recorded in Digital Versatile Disc (DVD) 52x, 7GB, with PCM audio format; 96kHz; 16bits; mono, converted to waveform extension. Folders with the three samples were made available on the DVD, without subject identification, in random order, with approximately 20% repetition (for analysis of the reliability of the evaluators).

The spectrographs were printed and made available in random order, with approximately 20% repetition (for analysis of the reliability of the evaluators). The spectrograph analysis judges even received model wideband and narrowband spectrographs representing normality for which to base their judgment upon. The material was sent to ten phono-audiologist judges with at least five years experience in the area, not being authors of this study, five for the vocal auditory-perceptual analysis and five for the vocal acoustic spectrograph analysis. The judges were not informed of the objectives of the research study, the sex, the replication of the samples, and the evaluations carried out by the other phono-audiologists, such that they were only informed of the general age group of the subjects.

The judges of the auditory-perceptual evaluation were advised to listen to the voices as many times as necessary, in silent environments and with the computer set to the configurations: 16bits, 96kHz, in accordance with the parameters of the CAPE-V protocol (overall degree of dysphonia, breathiness, roughness, tension, pitch, and loudness)[16].

The five judges responsible for the analysis of the spectrographs were advised to analyze them individually, in accordance with a visual analog scale composed of a ten centimeter ruler, marking the most coherent option on the spectrogram, able to vary its scoring between zero and ten[17].

In the evaluation of the graph color intensity (of the F, the high frequencies and of the entire spectrogram) the degree of graph color intensity was evaluated, which could vary between black (strong intensity), corresponding to ten on the scale, and light gray (weak intensity), corresponding to zero. On the spectrogram, the noise is visualized as a shaded, dashed, or dotted image, where zero corresponded to the total absence of noise and ten to the maximum presence of shading/dotting. The definition of the formants and the harmonics was evaluated in accordance with their visibility, whereas a well-defined, demarcated and symmetric image corresponded with ten and a low-definition, to zero. The graph uniformity was evaluated as ten when it had good stability and continuity, and zero when it was irregular. For the harmonic-substitution-for-noise item, the judges marked zero when there was no substitution and ten when there was total substitution. For the number of harmonics, zero indicated absence-of and ten when the spectrographic image was completely filled by harmonics. For the last item, the presence of sub-harmonics, zero represented their absence and ten the presence of sub-harmonics in the entire spectrogram.

After the evaluation of the voices, a statistical analysis was carried out, to verify the inter-evaluator reliability for the auditory-perceptual and acoustic spectrographic analyses through the coefficient Kappa, considering the following classifications: between 0.8 and 1, reliability almost perfect; 0.6 and 0.79, good; 0.4 and 0.59, moderate; 0.2 and 0.39, regular; between zero and 0.19 poor; between zero and -1, not reliable. The reliability among the judges of the acoustic spectrographic analysis was 0.40 and of the auditory-perceptual evaluation was 0.49. The evaluations of the three phono-audiologists with greatest reliability were considered all together to determine the predominant judgment in each parameter of the CAPE-V scale and of each parameter of the spectrograph analyses for each subject.

The data were statistically analyzed using the ANOVA parametric test, adopting a significance level of 5%.

Results

In Table 1, there was a difference between the mean roughness and the overall degree of voice deviation of the elementary and middle school professors from different school systems (p=0.19;

Table 1 - Relation between the results of auditory-perceptual vocal analysis of professors from different school systems.

	Private	Municipal	State	p-value*
	Average (±SD)	Average (±SD)	Average (±SD)	
Overall degree	13,00 (±1,74)	21,45 (±3,02)	12,10 (±1,83)	0,028*
Roughness	10,84 (±1,82)	20,18 (±3,16)	9,80 (±1,91)	0,019*
Breathiness	12,12 (±1,59)	17,90 (±2,76)	11,70 (±1,67)	0,140
Tension	5,81 (±0,85)	9,54 (±1,48)	6,50 (±0,89)	0,098
Pitch	5,48 (±0,85)	5,81 (±1,48)	5,96 (±0,90)	0,925
Loudness	6,18 (±0,81)	3,54 (±1,41)	6,60 (±0,85)	0,178

*p<0.05; ANOVA Test. Legend - SD: standard-deviation.

Table 2 shows that there was no difference between the average acoustic glottal source measurements of the professors' voices from the state, municipal, and private school systems..

Table 2 – Relation between the results of the acoustic glottal source analysis of professors from different school systems**.**

	Measurements	Normal Range of Measurements	Private Average (±DP)	Municipal Average (±DP)	State Average (±DP)	p-value*
Frequency	f0 (HZ)	243,973	190,68(±4,46)	185,60(±7,73)	185,47(±4,68)	0,691
	fhi (Hz)	252,724	209,37(±5,29)	198,28(±9,16)	201,57(±5,55)	0,456
	flo (Hz)	234,861	168,78(±5,30)	174,77(±9,19)	172,51(±5,56)	0,813
	STD (Hz)	1,349	5,84(±1,00)	3,13(±1,74)	3,50(±1,05)	0,198
Disturbance frequency	Jita (Ms)	83,200	89,58(±11,92)	83,09(±20,65)	83,82(±12,50)	0,932
	Jitt (%)	1,040	1,63(±0,19)	1,52(±0,33)	1,47(±0,20)	0,848
	RAP (%)	0,680	0,99(±0,12)	0,92(±0,21)	0,90(±0,12)	0,863
	PPQ (%)	0,840	0,95(±0,10)	0,87(±0,18)	0,84(±0,11)	0,766
	sPPQ (%)	1,020	1,32(±0,14)	1,07(±0,25)	0,99(±0,15)	0,271
	vf0 (%)	1,100	2,56(±0,33)	1,68(±0,58)	1,88(±0,35)	0,265
Amplitude perturbation	ShdB (dB)	0,350	3,55(±2,04)	0,39(±3,54)	0,43(±2,14)	0,526
	Shim (%)	3,810	5,71(±0,62)	4,43(±1,08)	4,89(±0,65)	0,504
	APQ (%)	3,070	4,09(±0,48)	3,03(±0,84)	3,42(±0,50)	0,460
	sAPQ (%)	4,230	6,12(±0,51)	4,39(±0,89)	5,53(±0,53)	0,246
	vAm (%)	8,200	17,15(±1,33)	12,88(±2,31)	16,80(±1,40)	0,266
Noise	NHR	0,190	0,15(±0,00)	0,15(±0,01)	0,14(±0,00)	0,905
	VTI	0,061	0,04(±0,00)	0,04(±0,00)	0,04(±0,00)	0,382
	SPI	14,120	8,85(±0,71)	7,50(±1,23)	8,72(±0,74)	0,625
Voice Break	DVB (%)	1,000	0,24(±0,16)	0,00(±0,28)	0,00(±0,17)	0,543
	NVB	0,900	0,06(±0,04)	0,00(±0,07)	0,00(±0,04)	0,543

Sub--harmonic segments	DSH (%)	1,000	2,31(±0,75)	2,99(±1,30)	0,86(±0,78)	0,264
	NSH	0,900	3,03(±1,02)	3,90(±1,77)	2,63(±1,07)	0,826
Inaudible segments	DUV (%)	1,000	2,62(±1,54)	2,06(±2,67)	1,87(±1,62)	0,944
	NUV	0,900	3,54(±2,01)	2,72(±3,48)	1,10(±2,11)	0,702

*p<0,05; ANOVA Test. Legend: SD=Standard Deviation; f0=Fundamental Frequency; fhi=Highest Fundamental Frequency; flo=Lowest Fundamental Frequency; STD=Standard Deviation of Fundamental Frequency; RAP=Relative Average Perturbation; Jitt=JitterPercentages; Jita=Absolute Jitter; sPPQ=Smoothed Pitch Perturbation Quotient; PPQ= PitchPerturbation Quotient; vf0=Fundamental Frequency Coefficient Variation; ShdB=Shimmerin dB; Shim=ShimmerPercentage; vAm=Peak Amplitude Variation; APQ=Amplitude Perturbation Quotient; sAPQ=Smoothed Amplitude Perturbation Quotient; NHR=Noise-Harmonic Ratio; SPI=Soft Phonation Index; VTI=Voice Turbulation Index; NVB=Number of Voice Breaks; DVB=Degree of Voice Break; DUV=Degree of Unvoiced Segments; NUV=Number of Unvoiced Segments; NSH=Number of Sub-harmonics; DSH=Degree of Sub-harmonic Components; #=range of normal measurements by sex for the MDVPA program..

In relation to the acoustic spectrographic voice analysis, there was a significant difference between the school systems for graph darkening of high frequencies and of the entire vocal spectrogram, presence of noise among the harmonics and definition of harmonics, all in narrowband, with higher values for the municipal school system (Table 3)..

Table 3 – relation between the results of acoustic vocal spectrografic analysis of professors from differente school systems.

			Private Average (±DP)	Municipal Average (±DP)	Statel Average (±DP)	p-value*
Wide-band	Darkening of graph (0 to 10)	F1	4,36 (±0,20)	5,00 (±0,35)	4,06 (±0,21)	0,087
		F2	4,42 (±0,22)	5,00 (±0,38)	4,00 (±0,23)	0,084
		F3	3,63 (±0,21)	3,54 (±0,37)	3,23 (±0,22)	0,422
		F4	2,57 (±0,20)	2,18 (±0,35)	2,13 (±0,21)	0,295
		At high frequencies	1,72 (±0,20)	2,09 (±0,34)	1,50 (±0,21)	0,344
		Entire spectrogram	4,12 (±0,17)	4,18 (±0,29)	4,03 (±0,17)	0,891
	Presence of noise (0 to 10)	Entire spectrogram	3,78 (±0,14)	4,18 (±0,25)	3,56 (±0,15)	0,130
		At high frequencies	3,81 (±0,15)	4,18 (±0,26)	3,50 (±0,16)	0,082

Wide-band	Definition of formants (0 to 10)	F1	5,96 (±0,24)	6,63 (±0,42)	5,83 (±0,25)	0,276
		F2	5,90 (±0,26)	6,45 (±0,46)	5,60 (±0,28)	0,293
		F3	5,00 (±0,25)	4,90 (±0,44)	4,56 (±0,26)	0,496
		F4	3,81 (±0,28)	3,54 (±0,49)	3,26 (±0,30)	0,420
	Graph uniformity (0 to 10)		5,78 (±0,17)	5,90 (±0,30)	5,80 (±0,18)	0,938
Narrow-band	Darkening of the graph (0 to 10)	At high frequencies	1,72 (±0,32)	3,18 (±0,56)	1,56 (±0,34)	0,011*
		Entire spectrogram	4,45 (±0,22)	5,54 (±0,39)	4,13 (±0,23)	0,028*
	Presence of noise (0 to 10)	In between harmonics	2,54 (±0,25)	3,09 (±0,44)	4,13 (±0,23)	0,028*
		Entire vocal spectrogram	3,06 (±0,25)	4,09 (±0,44)	2,63 (±0,27)	0,113
		In the high frequencies	2,84 (±0,22)	3,09 (±0,39)	3,06 (±0,27)	0,423
	Substitution of harmonics for noise (0 to 10)	Entire spectrogram	2,30 (±0,14)	2,36 (±0,24)	2,16 (±0,14)	0,721
		In the high frequencies	2,90 (±0,18)	2,81 (±0,31)	2,43 (±0,19)	0,189
	Harmonic definition (0 to 10)		5,93 (±0,19)	6,72 (±0,34)	5,36 (±0,20)	0,003*
	Graph uniformity (0 to 10)		6,21 (±0,17)	6,54 (±0,30)	5,93 (±0,18)	0,208
	Number of harmonics (0 to 10)		5,09 (±0,29)	6,09 (±0,50)	4,80 (±0,30)	0,101
	Presence of sub-harmonics (0 to 10)		0,48 (±0,15)	1,00 (±0,27)	0,90 (±0,16)	0,118

*p<0,05;ANOVA Test. Legend: SD=Standard Deviation

p=0.28, respectively), so that the highest average was from the municipal schools.

Discussion

The auditory-perceptual voice analysis showed differences among the averages found for roughness and overall degree of vocal deviation, such that the highest average was from the municipal schools (Table 1). The overall degree of deviation includes a global form of vocal perception, considering all of its components. On this question, the municipal schoolteachers obtained the highest average, with 21.45 points, and despite presenting vocal complaints, they were in accordance with the results of other studies that showed the normal range for vocal quality to be up to 34 points[20] and up to 35.5 points[18].

The roughness parameter evaluated by the CAPE-V protocol includes hoarseness and or asperity[16,21], that correspond with the presence of aperiodic energy generated by mucosal vibration irregularity of the PPVV, or in other words, noise. Hoarseness is generated by low frequency noise and occurs normally in association with the isolated presence of a glottal slit, vocal fold mucosal lesion or association between the two[8,21]. Still, the excessive vocal use can cause inflamatory problems, such as chronic laryngitis, with hoarseness being considered a primary deviation[10]. Symptoms of hoarseness, vocal fatigue and soreness of the throat are signs of vocal abuse or of intense vocal usage in unsuitable conditions and can contribute to the development of an occupational illness[9]. Yet it is important to point out that this symptom, despite its association to the context of intense speech, can also occur due to dehydration, limitation of jaw opening (burdening the laryngeal structure in vocal production), average amount of sleep or lack of rest, according to a national research study[9]. Roughness is generated by high frequency noises associated with mucosal rigidity, which may be associated to laryngeal deviations[21].

Hoarseness stands out as prevalent among vocal quality deviations[1,22]. The highest average observed was that of the municipal schools (21.45 points), though inside the normal range of vocal quality[18,20]. Despite not having found studies that analyze the vocal quality of elementary and middle school professors with the CAPE-V, the results of this investigation corroborate with the findings of research that sought to verify the occurrence of vocal deviations concentrated on the glottal plane in elementary and middle school professors from the municipal system from a survey of complaints and the auditory-perceptual evaluations with the RASAT scale (hoarseness, asperity, breathiness, asthenia, and tension), showing the highest index to be hoarseness (68%)[22]. It was observed that, even when measured by different instruments, hoarseness is one of the auditory-perceptual vocal aspects that appears most in professors[1,22].

This characteristic shows that, in addition to the influence of high daily vocal demands associated with insufficient environmental conditions and incorrect vocal usage [8,13], the municipal elementary and middle school teacher in the group studied could be showing the greatest risk of, in the future, living in limiting situations in relation to her performance of educational activities, re-adaptation of role within the school or even taking leave due to vocal problems at some point in her career, for she also presents vocal complaints[9,15].

In the acoustic glottal source analysis, professors did not present significant vocal deviations among the school systems (Table 2). However, it is important to point out that in the comparison with the normal range proposed by the program for the female sex, the majority of the measurements showed outside of the normal range, suggesting the presence of noise and instability in the glottal signal[17]. The professors from the private school system showed the highest number of measurements and the most deviations in relation to the normal range, followed by the municipal, and lastly, the state system. These findings, though not significant, reinforce the results of the auditory-perceptual analysis, in which the state professors showed the lowest number of vocal quality deviations.

According to the literature, there is a higher rate of vocal complaints among professors[10,11], explaining the deviations with the acoustic glottal source measurements, considering its greater acuity and sensibility for vocal aspects that are not yet detected by the auditory-perceptual vocal evaluation carried out by the human ear. In this way, private school professors may be initiating a vocal disorder process not yet perceptible aurally.

In the acoustic spectrographic analysis, that also analyses the vocal filter, the professors presented significant differences among the school systems, in the narrowband spectrograph, in

relation to the darkening of the graph of the high frequencies and the entire vocal spectrogram, the presence of noise among the harmonics and the harmonic definition, with higher averages for the municipal school system (Table 3).

The significant presence of noise among the harmonics for municipal school system professors reinforces the difference found between them for the presence of the highest overall degree of deviation and roughness in the auditory-perceptual evaluation, relating as well the aperiodicity of vibration of the vocal folds with lower harmonic energy and higher level of noise during phonation[19]. Other studies have also shown a correlation between the presence of noise among the harmonics, and the presence of hoarseness [1,23].

The significant darkening of the spectrographic graph may have occurred due to the increase in sound pressure[23] that is common among professors, considered to be an incorrect use of the voice probably in compensation of the inadequate acoustic conditions of the classrooms and the personality characteristics of the children's age group, that can exceed the standard recommended by the American National Standard Institute (ANSI)[12,24-26.] Such conditions may lead the professor to administer class with elevated sound pressure, without adequate breath support, normally proportional to the loud level of noise in the classroom[6,24,25], generating vocal force that, when carried out frequently, can lead to the development of disorders due to vocal hyperfunction[26,27].

The findings are found in works that highlight the most frequent incorrect uses of the voice among professors, within which are yelling, use of the loud voice – loudness -, hypertension in neck muscles, inadequate posture, speaking for hours on-end, inadequate breathing standards and the lack of vocal rest, as well as anxiety and stres[s8,13,28].

In spite of having a significant difference in the municipal schools for harmonic definition, where the higher the score the better quality the voice, the average was 6.72, a result considerably lower than ten. From this point of view, the result can be interpreted as negative and goes along with the rest of the findings that suggest vocal inadequacy: the increase of roughness and of the overall degree of dysphonia, of noise among the harmonics and of the presence of vocal complaints[19].

A study that characterized and associated work, health and vocal conditions of 165 professors from different municipal schools by way of a questionnaire showed that the mention of the presence of vocal deviation was evaluated as very high and much above the desired, considering that the professor's main work instrument is her voice. The authors also addressed the etiologic factors frequently reported by teachers in relation to vocal deviations: intensive use of the voice, stress, being exposed to noise, allergies, and respiratory infection[29].

In the area of the voice, works comparing vocal characteristics of elementary school teachers from different school systems were not found, however, studies with elementary school professors show that the vocal standardscan be influenced by social, cultural, and demographic characteristics[3,15]. It is worth remembering that there are also occupational risks associated with the work environment that can damage the voice and the health of the teachers, with specifications for each school unit due to its geographic location, architecture and materials used in construction, level of conservation and improvements carried out, as well as the characteristics of work organization[29]. Due to unawareness on the most part of the professors about vocal health, incorrect vocal usage becomes frequent as a compensatory measure when faced with the difficulties found[3,10].

Besides the factors intrinsic to the teaching profession, there are extrinsic factors that can influence a higher occurrence of vocal deviations in municipal schools. Considering that the salary of the educators is proportional to the number of classes administered, these professionals have taken on a large quantity of classes, carrying a weekly workload of up to 60 hours, maintaining full time work at the school and even performing other activities outside the school sector, with the intention of increasing monthly income.

A research study that traced the profiles of ten professors, five from the private and five from the public school systems, showed that while 80% of the public school professors had full time daily work routines of two shifts (40 hours weekly), 80% from the private school worked only one shift (20 hours weekly)14. In addition to this, female professors not only participated actively in the job market but also many times carried out domestic activities, performing a "double shift". Such overload of activities can bring health problems, among them vocal problems, with the consequent need for

leaves or absences [3,11], as well as bringing about physical and psychological exhaustion[12,13].

Another factor that can be related to the results of vocal inadequacy obtained by the group of elementary school professors from the municipal school system is the fact that, in Brazil, only ¼ of professionals are found in the public school system whose state system has been decreasing more and more its number of employees, directing the majority of them to the municipal system. Despite the job as a municipal public server being seen as more stable, the majority of the professors work in this sector directed by the Consolidation of Work Laws (Consolidação das Leis do Trabalho (CLT)), with temporary contracts, without professional stability. The state sector, in turn, provides its teachers with a career plan and the private sector offers better salaries, although theprofessional bond depends on the productivity of the professor[30].

In the case of municipal professors, there is still the anxiety and depression aggravator generated by the fear of unemployment; the majority submit themselves to simplified selective processes and annual contracts, or even still, when they participate in a public exam, the term of experience required is long[30].

Still, it is important to recognize that all of the professors in the study, mainly from the private system, showed deviation in various acoustic measurements of the glottal source, which reinforces the literature about the vocal disorders in professors[10,11,25].

Highlighted in the present work are some of the method limitations that could be implemented in future research studies: stratification according to sex, weekly work load and career length; evaluations of socioeconomics and extracurricular work load.

The realization of research studies that analyze professors of both sexes, seeking to verify whether this is an intrinsic variable that can bring different results, is also recommended as a way of exploring even more the theme addressed in this study.

Conclusion

The group of municipal elementary and middle school professors presented the lowest vocal quality, evidenced by the elevated overall degree of vocal deviation and hoarseness, though still within the standards of normality, and by the greater presence of noise among the harmonics; and probable hyper-functional voice compensations showed by the high darkening of the spectrographic graph. The municipal teachers also showed greater harmonic definition in relation to the other school systems, but with a low average, suggesting vocal inadequacy.

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