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Artigo Original

Vocal warm-up and cool-down in teachers: a quasi-experimental controlled study

Aquecimento e desaquecimento vocal em professores: estudo quase-experimental controlado

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Keywords

Voice
Voice Training
Faculty
Occupational Exposure
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ABSTRACT

Purpose: To verify the effects of vocal warm-up (VWU) and vocal cool-down (VCD) strategies on teachers. **Methods:** A quasi-experimental exploratory blind-evaluator study with control group that included teachers from a public secondary school. Teachers assigned to the experimental group (EG) performed VW prior to classes and VCD after classes. Teachers in the control group (CG) did not perform VWU and simply got voice rest after classes. Intergroup (EG vs. CG) and intragroup (pre-test versus post-test) comparisons were drawn from an auditory-perceptual evaluation, acoustic analysis, and self-reported discomfort. The mean acoustic and discomfort indicators and the percentage of improvement or worsening of vocal quality were calculated with a statistically significance level of p<0.05. **Results:** EG and CG did not differ from each other in the intergroup analysis. The intragroup analysis showed that VWU improved voice quality and decreased the degree of body-related discomfort. VCD decreased both the fundamental frequency (f0) and the degree of discomfort, particularly in relation to the voice aspects. Vocal rest did not show any statistical difference. **Conclusion:** VWU showed positive effects on the auditory-perceptual evaluation and self-reported discomfort (body). VCD impacted f0 and self-reported discomfort (voice). Due to the exploratory nature of the research, the statistical power was not enough to demonstrate a difference in the comparison between EG and CG. However, the results indicate a potential for protecting teachers' voice and may be incorporated into daily work settings. Further controlled studies with random samples and greater numbers of participants should be conducted to confirm these results.

Descritores

Voz
Treinamento da Voz
Docentes
Exposição Ocupacional
Fatores de Proteção
Saúde do Trabalhador

RESUMO

Objetivo: Verificar os efeitos de uma estratégia de aquecimento (AV) e desaquecimento vocal (DV) em professores. **Método:** Estudo exploratório quase-experimental, cego ao avaliador, com grupo controle composto por professores de uma escola pública de ensino médio. Os professores, alocados no grupo experimental (GE), realizaram AV prévio e DV posterior à aula. Os professores do grupo controle (GC) não realizaram AV prévio e ficaram em repouso vocal após a aula. Compararam-se os dados intergrupos (GE vs. GC) e intragrupos (pré vs. pós-teste), segundo avaliação perceptivo-auditiva, análise acústica e desconforto autorreferido. Calcularam-se as médias dos indicadores acústicos e de desconforto; o percentual de melhora ou piora na avaliação perceptivo-auditiva, considerando-se p<0,05 como nível de significância. **Resultados:** GE e GC não diferiram entre si na análise intergrupos em nenhum dos indicadores avaliados. Na análise intragrupos, AV melhorou a qualidade vocal e reduziu o grau de desconforto no corpo; DV diminuiu tanto a frequência fundamental (f0) quanto o grau de desconforto, particularmente nos aspectos relacionados à voz. O repouso vocal não revelou diferença estatística. **Conclusão:** AV demonstrou efeitos positivos na avaliação perceptivo-auditiva e no desconforto autorreferido (corpo). DV impactou f0 e desconforto autorreferido (voz). Devido ao caráter exploratório do estudo, não houve poder suficiente para demonstrar diferença na comparação entre GE e GC. Porém, os resultados obtidos indicam potencial proteção para a voz de professores, podendo ser incorporados no cotidiano de trabalho docente. Novos estudos controlados, com amostra aleatória e maior número de participantes, devem ser realizados para se comprovar tais resultados.

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INTRODUCTION

Teachers are one of the most prominent professional categories that rely on voice as a work tool. According to INEP [National Institute for Education Research], there are 2.2 million teachers in basic education and 519.6 thousand in high school, most of them (68.1%) acting in the 28.3 thousand public schools[1].

Work-related voice disorder (WRVD)[2] is common in teachers and is associated with personal and environmental factors, as well as with factors related to work organization. Teachers with voice disorders are eight times more likely to lose their ability to work, leading to early retirement, compared to teachers without voice disorders[3].

A literature review indicated an average vocal change prevalence in teachers ranging between 20% and 50%. Hoarseness, vocal fatigue and dry throat were the most frequently reported vocal symptoms[4]. Higher indexes (63%) have been found for self-reported voice problems[5], followed by vocal change detected by auditory-perceptual assessment (53.6%)[6] and medical diagnosis of "vocal fold pathology" (18.9%)[7], which reveals a reduction of individual perception and evaluations by speech-language therapists and physicians. The female gender, more than seven years in teaching practice, unfavorable work environment, intensive voice use, respiratory disease, hearing loss and common mental disorders were found to be associated with these indexes[7]. Other associated factors were age above 40 years old, family history of dysphonia, weekly workload above 20 hours and the presence of chalk powder in the classroom[6]. High levels of noise, teaching of Physical Education classes, and habitual use of voice at a high intensity were the most consistent indicators[8].

A study estimated that R$ 150,000 were spent per year from public funds on work absence, medical leaves and rehabilitation of teachers due to WRVD[9]. An up-to-date estimation, considering the number of Basic Education teachers[1] and the minimum wages in this category, would bring expenditures to about R$ 1.66 billion/year. This amount would be useful if employed on public policies to promote and protect teachers' health, such as the vocal health programs for teachers already in place[10,11] in states and municipalities across the country. The proposals for these programs highlight theoretical-practical courses to prevent dysphonia in teachers (83.60%), where vocal warm-up (VWU) and cool-down (VCD)[11] make up an important part of the topics addressed.

VWU consists in a short series (15 to 30 minutes) of progressive exercises[12] that aims to protect the larynx from phonotraumatic lesions. VWU prepares the vocal apparatus for intense voice use by means of respiratory airflow control, head and neck movements and flexibility of the extrinsic and intrinsic muscles of the larynx. Warming them up reduces the elastic and viscous resistance of vocal folds and aids stretching. In addition, it improves vocal projection, raising intensity and reducing vocal effort and fatigue[13-18].

VCD consists in a sequence of short hierarchically organized exercises (5 to 15 minutes)[12] that aim to gradually place the voice back in its habitual muscular adjustment. By stretching the muscles involved, the practice helps to reduce the tension caused by intense voice use, in addition to reducing the fundamental frequency (f0) and intensity, which are key to vocal overload. The fact that this is a gradual process helps to remove lactic acid, responsible for the feeling of pain[13-16], so that it must be done immediately after intensive voice use.

Although VWU/VCD are usually done alongside voice professionals, there is a significant gap in the literature about its immediate effects, especially in teachers during professional activity. This article aims to investigate the immediate effects of a VWU/VCD program as a vocal protection strategy for teachers in their work setting.

METHODS

Study design, location and participants

This is a blind evaluator, prospective, interventional, exploratory and quasi-experimental study, with pre- and post-test control group. Eighteen voluntary teachers from a public secondary school in the city of Salvador took part in the study. When the study was conducted, the institution had 143 teachers and 3,143 students, most of them in High School (2,787) and Education for Adolescents and Adults (1,256). At the time of data collection – between May and August 2008 – 86 teachers were actively working. The research obtained the consent from Secretaria de Educação do Estado da Bahia [the Bahia State Secretary of Education] and was approved by the Research Ethics Committee of Universidade Estadual Paulista [Paulista State University UNESP-Marília], under protocol 1.952/2005, as per the Declaration of Helsinki and Resolution 466/2012 of the National Health Council.

Inclusion and exclusion criteria

The inclusion criteria were: teaching in the morning and demonstrating ability to perform the intervention procedure. Teachers presenting any condition that could compromise vocal quality or resonance – such as a cold, the flu, an allergy, rhinitis, and sinusitis – were excluded, as were those undergoing speech-language therapy due to potentially confounding factors.

Procedures

All teachers in the school were invited to participate in the research. The teachers who agreed signed an informed consent form prior to data collection. After answering the questionnaire, the participants were invited to take part in the second stage of the study, which involved 24 teachers. Participants were divided into two groups: experimental group (EG), with 11 teachers, and control group (CG), with 13 teachers. The teachers allocated to the EG performed vocal warm-up before class and vocal cool-down after class. Teachers allocated to the CG taught their classes without prior vocal warm-up and got vocal rest after class.

Vocal warm-up

The VWU routine proposed was based on a procedure performed with teachers[16,17], lasting approximately 13 minutes, that consisted in a progressive sequence composed by the following exercises: stretching of the body, neck and vocal tract; expansion of the ribcage; exercises aimed at phonoarticulation, directing air, improved flexibility of the mucosa and resonance. A 30-second resting period after each series of exercises was established with a view to allow the vocal tissue to recover. Part of the intervention was conducted standing up and, after the air direction exercises, participants were asked to sit down to prevent hyperventilation (Chart 1).

Vocal cool-down

VCD was also based on a procedure proposed to teachers[16] and lasted seven minutes, on average. The objective was to reduce the effect of overload of classes on their voice by means of gradually returning to its regular adjustment. The proposal consisted in exercises for body and neck stretching, pharyngeal cavity expansion, reduction of f0, laryngeal tension and intensity (Chart 1).

Control group

The teachers allocated to the control group did not perform any prior vocal warm-up and taught their class right after recording the baseline. In order to control VCD, the same time (seven minutes) was used for vocal rest, when participants did not use their voice, but completed crosswords about vocal care.

Sample collection

After answering the questionnaire (stage 1), the second step took place. The ability to perform the exercises proposed for the procedure was verified and the inclusion/exclusion criteria were applied in order to allocate teachers to the experimental (n=11) and control groups (n=13). Altogether, stage 2 included 24 teachers. The teachers using their voice before the class were

Chart 1. Intervention proposal

VOCAL WARM-UP (13 min)
Corporal Exercises
- Stretching out (upward and sideways): 2 times each (30s)
- Shoulder rotation, slowly (backward): 5 times (20s)
- Cervical stretching: 2 times on each side (30s)
- Neck rotation, slowly ("yes", "no", "maybe"): 5 times each (1min)
Articulatory Exercises
- Tongue rotation: 10 times on each side (20s)
- "Beak-smile" 10 times (10s)
- Tongue click: 20 times (20s)
- "Grandma kiss": 10 times (10s)
Expiratory Airflow
- Long exhale SSS... 2 times (20s)
- Long exhale ZZZ... 2 times (20s)
Tongue (or Lip) Trills
-TR... or BR... 15 times (1min) > monopitch > rest (30s)
RR...
RR... RR...
-TR... or BR... RR... 15 times (1min) > ascending/descending > rest (30s)
-TR... or BR…AA…ÉÉ...ÊÊ…II...ÓÓ…ÔÔ…UU... 1 time (30s) > monopitch
RR...
RR... RR...
-TR... or BR... RR...AA...ÉÉ...ÊÊ…II...ÓÓ…ÔÔ...UU...1 time (30s) > ascending/descending > rest (30s)
Nasal Sounds
- Humming... 10 times (1min) > monopitch > rest (30s)
- MM... UAA...UÉÉ...UÊÊ...UUII...UÓÓ...UÔÔ...UUU... 2 times (1min) > monopitch > rest (30s)
UAA... UÉÉ...UÊÊ...UUII...UÓÓ...UÔÔ...UUU... 3 times (1 min) > ascending > rest (30s)
UU...
- MM...

Chart 1. Continued...

VOCAL COOL-DOWN (7 min)
Corporal and Neurovegetative Exercises
- Deep breath (lose everything with "aah"): 3 times (30s)
- Yawning-sigh: 3 times (1min)
- Shoulder rotation, slowly (forward): 5 times (30s)
- Neck rotation, slowly ("yes", "no", "maybe"): 5 times each (1min)
- Cervical stretching: 2 times on each side (30s)
Tongue (or Lip) Trills
-TRR or BRR...
RR...
RR... 15 times (1min) > descending > rest (30s)
Digital Laryngeal Manipulation: 1min > descending
Chant Voice: 1 time (1min) > descending
"My voice is my most precious tool of work
Now I will take care of my voice
Performing warm-up before classes
And cool-down afterward."

excluded. Thus, the experimental group (EG) was composed by VWU (n=8), VCD (n=7), and the control group (CG), by class (n=10) and vocal rest (n=6), amounting to 18 participants in total.

For the baseline, the voices were recorded before any intervention. After the initial recording, the CG participants taught their classes, whereas the EG participants performed a VWU, filled out the discomfort protocol, and had their voice recorded again. At the end of the teaching shift, after recording and filling out the protocol, the EG teachers went on vocal rest (VR), as described in the procedures. The participants of both groups (CG and EG) recorded their voice again and filled out the discomfort protocol. The research stages are summarized in the flowchart below (Figure 1).

Questionnaire

In order to characterize the participants in stage 1, teachers completed a semi-structured and self-administered questionnaire[19]. This instrument encompasses a wide range of variables, where the sociodemographic and functional situation data are of interest for this article.

Recording

The voice samples were recorded in a silent room in the school with 55 dB of noise (maximum value of means calculated) systematically measured before each recording with a Radio Shack Digital Sound Lever Meter decibel meter. A Leson omnidirectional condenser lapel microphone model ML-8 was used on a pedestal at a 45º angle with the mouth and at a pre-fixed distance of 10 cm to record the spontaneous

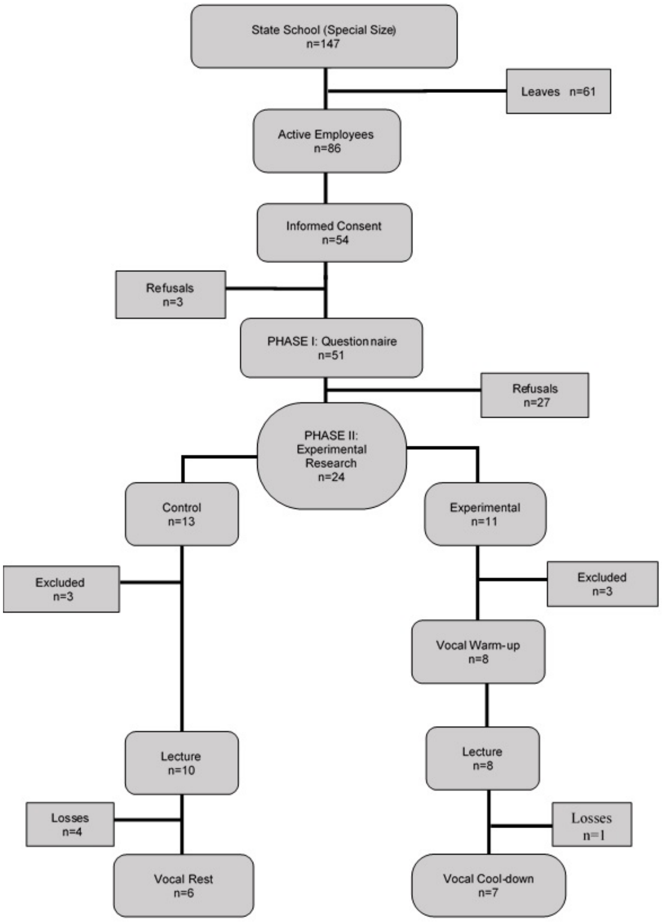

Figure 1. Research flowchart

speech samples – answers to trigger questions “How does your voice feel right now?” and “How was your class?” – and the automatic sequence (counting from 1 to 10). To record the sustained vowel /Ɛ:/ (as pronounced in “help”), the microphone was positioned at a distance of 5 cm, and the participants were asked to make the sound at a comfortable pitch and duration. Two distance indicators were placed perpendicular to the ruler (5 cm to the right, for the vowel; 10 cm to the left, for the running and connected speech), so that participants could bring their mouths closer while keeping the standard distance for the different phonatory tasks. The microphone was connected to a Hewlett-Packard Pavilion ZE 2410 notebook with AMD Sempron 3000 processor and a 16-bit Conexant soundboard. The recordings were done in this computer on software VoxMetria (CTS Informática). The “Voice Analysis” module of the software, which selects a pre-defined sampling rate of 11,025 Hz, was used to record the automatic sequence and spontaneous speech samples. The “Voice Quality” module, with a sampling rate of 44,100 Hz, was used to record the sustained vowel samples. Both recordings were automatically saved on a wave file as per the default configuration of the software.

Auditory-perceptual assessment

The perceptual-auditory assessment is considered the golden standard for vocal analysis and aims to identify how speakers typically use their voice. This research used the GRBASI[20] scale and resonance in the evaluation of the auditory-perceptual quality of the voice.

The GRBASI[20] scale allows for measurement of the degree and type of vocal deviation. Identification of the degree of change follows a four-point mark, ranging from 0-3, where 0 stands for the absence of change; 1, for mild change; 2, for moderate change; and 3, for intense change. As to the type of deviation, we considered: G: *grade* (global vocal change); R: *roughness*; B: *breathiness*; A: *asthenia*; S: *strain*; and I: *instability* (instability in emission, related to fluctuations, both in f0 and in voice quality).

Resonance[21] is known as the amplification of the sound produced by the vocal folds, resulting from reinforcement or buffering of certain frequencies of the sound spectrum in the resonant cavities (larynx, pharynx, mouth and nose). This work considers the balanced (normal) and non-balanced (laryngopharyngeal, hypernasal, hyponasal and laryngopharyngeal with nasal compensation) resonance types.

The auditory-perceptual assessment was carried out by three voice specialists who acted as judges, all three had at least eight years of experience in vocal care activities with teachers. The voice samples were coded, randomized and organized in pairs (pre- and post-test) per teacher. Evaluators were blind as to the activity sequence VWU/class and VCD/vocal rest and the time to which the samples referred (pre-/post-test). This matrix was recorded in compact discs (CDs) and 10% of samples were repeated for the agreement test. Only the connected speech sample was considered for this analysis (counting from 1 to 10).

Acoustic analysis

The acoustic analysis is an important vocal function tool that complements the auditory-perceptual assessment offering numerical values by means of measurements taken from computerized voice labs. Both collection and acoustic analysis were carried out by the first author of this article, and the data were obtained directly from VoxMetria by means of the automatic extraction of indicators. For the sustained vowel parameters, the “Analysis” tab was used with “Vocal Analysis Data” selected in the “Voice Quality” module. This study used the indicators fundamental frequency (f0); jitter (f0 cycle-to-cycle perturbation index, herein referred to as period perturbation quotient – PPQ); shimmer (wavelength cycle-to-cycle perturbation index, herein referred to as energy perturbation quotient — EPQ); noise (aperiodic sound components) and GNE ratio (glottal to noise excitation ratio — noise of a series of pulses produced by the oscillation of vocal folds). The normality values for the VoxMetria software were: *jitter* $< 0.6\%$, *shimmer* $< 6.5\%$, GNE > 0.5 dB and noise < 2.5 dB, as per the manufacturer’s specifications.

Self-reported degree of discomfort

A specific protocol was drawn out for self-evaluation of the degree of discomfort, which considered the most prevalent symptoms in teachers related to the voice (effort to speak, burning throat, voice change, hoarseness, vocal fatigue and the need to often clear the throat), body (general muscle tension and neck and shoulder muscle tension) and global aspects related to the body and voice, analyzed as a whole. Initially proposed as an analog visual scale, it was later reformulated into a numerical scale due to participants’ reported difficulty to use the former during its application in the pilot project[16]. In this work, a 0-5 scale was used, where 0 means the smallest sensation of discomfort and 5, the greatest sensation perceived. The mean reference values used for each set of indicators were: aspects related to the body (7.5), voice (15) and both body/voice (22.5). Low scores represent mild discomfort, while high scores represent high discomfort.

Data analysis

The data were inserted into the EpiData software and analyzed with Statistical Package for the Social Sciences (SPSS). For the acoustic analysis, the means and standard deviations of each indicator studied, taken from the vowel (/Ɛ:/) emission, were calculated. To evaluate the degree of discomfort, means and standard deviations of the scores of variables grouped in aspects related to the body, the voice and body/voice were considered together. The answers to the auditory-perceptual assessment (GRBASI scale), initially presented in terms of the degree of vocal change, were analyzed as to frequency of improvement (P2<P1), worsening (P2>P1) or indifference (P2=P1). The types of resonance were dichotomized in “changed” (laryngopharyngeal, hypernasal and hyponasal) and “not changed” (balanced), where improvement (P2=not changed), worsening (P2=changed) or indifference (P2=P1) were considered. Both types were expressed in number and percentage.

In order to analyze the effects of intervention, intergroup comparisons were drawn considering the EG and CG results in the situations of post-class VWU and post-class without VWU and with VR, by means of the Mann-Whitney test, for all of the indicators assessed. In addition, intragroup analyses were carried out comparing the pre-test (P1) to the post-test (P2) time in each situation (pre- vs. post-VWU; pre- vs. post-VCD; pre- vs. post-class; pre- vs. post-VR). In the intragroup comparison, the acoustic variables, the degree of discomfort and the GRBASI scale were analyzed using the Wilcoxon test. The Sign test was used for resonance. A level of significance of $p<0.05$ was adopted.

The Kappa test was applied to verify interjudge agreement. Interjudge agreement was analyzed by means of Cronbach's alpha test, where values above 0.65 were considered acceptable. Since the values obtained in the interjudge comparisons were below the value established, we chose to use the results of the judge with more internal agreement (Alpha = 0.9702) for this analysis.

RESULTS

The participating teachers were 62.5% female, 37.5% male with an average age of 44.29 (37-56 years old). The mean time in the teaching profession was of 16.71, ranging between 4 and 32 years. All participants had a college degree; 87.5% worked in a single school and 12.5% in two schools.

Table 1 presents the results obtained in the intergroup comparison (EG vs. CG), in the post-class with vocal warm-up vs. post-class without vocal warm-up; post-class with vocal warm-up and cool-down vs. post-class without warm-up and with vocal rest, according to objective acoustic indicators of vocal quality and self-reported discomfort. No statistical difference was found in any of the indicators analyzed ($p>0.05$).

Table 2 compares the percentages of improvement, worsening or indifference resulting from the immediate intragroup effects (pre- vs. post-test), in the situations with vocal warm-up, cool-down, class and vocal rest, as per the auditory-perceptual evaluation (GRBASI scale and type of resonance). Voice improvement was observed in 75% of teachers, whereas indifference was observed in 25% ($p=0.00$) with VWU; voice worsening (57.1%) and indifference (42.9%) close to the statistical significance ($p=0.059$) were observed following VCD. There was no difference in the control group (pre- vs. post-class; pre- vs. post- vocal rest).

Table 3 presents the results of the intragroup comparison (pre- and post-test) of the objective acoustic indicators of vocal quality in the vocal warm-up, class, vocal cool-down and vocal rest; and also of self-reported discomfort in the situations of vocal warm-up, class and vocal cool-down. The experimental group showed a reduction of the degree of discomfort in aspects related to the body (pre-=3.50; post-=0.38; $p=0.0422$), after VWU; reduction of f0 (pre-=181.16; post-=169.84; $p=0.0280$) and the global degree of discomfort (pre-=11.57; post-=3.43; $p=0.0160$), particularly of aspects related to voice (pre-=8.14; post-=2.29; $p=0.0160$), after VCD. The control group presented an increase in f0 (pre-=154.58; post-=169.37; $p=0.0069$) and the global degree of discomfort (pre-=13.40; post-=21.50; $p=0.0109$), particularly in aspects related to voice, when analyzed individually (pre-=8.60; post-=14.90; $p=0.0113$) after class. Vocal rest did not reveal statistical difference in any of the indicators analyzed ($p>0.05$).

Table 1. Comparison between the intervention (post-lecture with vocal warm-up/cool-down) and control (post-lecture without vocal warm-up/vocal rest) groups, according to acoustic indicators and self-reported discomfort

	POST-LECTURE					
Variables	With VWU (n=8)	Without VWU (n=10)	P-value1	VCD (n=7)	VR (n=6)	P-value[1]
	Mean (SD)	Mean (SD)		Mean (SD)	Mean (SD)	
f_0 mean	181.16 (33.76).	169.37 (25.69).	0.5582	169.84 (35.82).	167.45 (29.72).	1.0000
fem. (n=5)	194,14	183.74	---	184.35	184.72	---
male (n=2)	148,71	135.85	---	133.58	132.93	---
Jitter	0.29 (0.34).	0,23 (0.17).	0.8835	0,42 (0.57).	0.35 (0.51).	0.3524
Shimmer	8,43 (4.31).	7.38 (2.80).	0.7696	9,09 (3.55).	11.56 (7.98).	0.7751
GNE	0,81 (0.15).	0.73 (0.20).	0.3789	0,73 (0.18).	0.73 (0.27).	0.8299
Noise	1,19 (0.56).	1.34 (0.81).	0.7697	1,34 (0.72).	1.36 (1.13).	0,8864
Global desc.	11,57 (13.30).	21.50 (10.63).	0.0865	---	---	---
Body desc.	3,43 (5.32).	6.60 (4.03).	0.0828	---	---	---
Voice desc.	8.14 (8.30).	14.90 (7.64).	0.1408	---	---	---

[1]Mann-Whitney test
Caption: VWU = vocal warm-up; VCD = vocal cool-down; VR = vocal rest; Desc = discomfort; fem. = female; n = number of participants; SD = standard deviation; f0 = fundamental frequency; GNE = glotal to noise excitation ratio

Table 2. Comparison between the immediate effects of vocal warm-up, vocal cool-down, lecture, and vocal rest on voice quality, according to perceptual-auditory indicators of degree of vocal alteration (GRBASI scale) and type of resonance

PRE-TEST vs. POST-TEST														
Variables	Experimental Group							Control Group						
	Improved		Worsened		Indifferent		P-value	Improved		Worsened		Indifferent		P-value
	n	%	n	%	n	%		n	%	n	%	n	%	
	VWU (n=8)							Lecture (n=10)						
G[1]	6	75	0	0	2	25	**0.014***	2	20	2	20	6	60	1.000
R[1]	3	37.5	0	0	5	62.5	0.083	2	20	1	10	7	70	0.564
B[1]	3	37.5	0	0	5	62.5	0.102	2	20	3	30	5	50	0.655
A[1]	1	12.5	0	0	7	87.5	0.317	1	10	0	0	9	90	0.317
S[1]	2	25	0	0	6	75	0.157	1	10	2	20	7	70	0.564
I[1]	0	0	0	0	8	100	1.000	0	0	1	10	9	90	0.317
Res.[2]	2	25	2	25	4	50	1.000	3	30	2	20	5	50	1.000
	VCD (n=7)							VR (n=6)						
G[1]	0	0	4	57.1	3	42.9	0.059	0	0	2	33.3	4	66.7	0.157
R[1]	0	0	1	14.3	6	85.7	0.317	0	0	2	33.3	4	66.7	0.157
B[1]	0	0	1	14.3	6	85.7	0.317	0	0	0	0	6	100	1.000
A[1]	0	0	2	28.6	5	71.4	0.157	0	0	0	0	6	100	1.000
S[1]	0	0	0	0	7	100	1.000	2	33.3	2	33.3	2	33.3	1.000
I[1]	0	0	2	28.6	5	71.4	0.157	2	33.3	2	33.3	2	33.3	1.000
Res.[2]	0	0	2	28.6	5	71.4	0.500	0	0	1	16.7	5	83.3	0.500

[1]GRBASI scale: *Wilcoxon test*; [2]Res = Resonance: *Sign test*; *Statistical significance
Caption: VWU = vocal warm-up; VCD = vocal cool-down; VR = vocal rest; n = number of participants

Table 3. Comparison between the immediate effects of vocal warm-up, vocal cool-down, lecture, and vocal rest according to acoustic indicators and self-reported discomfort

Variables	EXPERIMENTAL GROUP					CONTROL GROUP				
	Pre		Post		P-value[1]	Pre		Post		P-value[1]
	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
	VWU (n=8)					Lecture (n=10)				
f0 mean	158.62	35.47	165.59	38.01	0.2626	154.58	30.11	169.37	25.69	**0.0069***
fem. (n=5)	180.04	-----	184.89	-----	-----	172.70	-----	183.74	------	-----
male (n=3)	122.91	-----	133.42	-----	-----	112.30	-----	135.85	-----	-----
Jitter	0.28	0.25	0.26	0.28	0.3428	0.27	0.16	0.23	0.17	0.9527
Shimmer	8.07	4.01	6.95	2.28	0.4008	9.16	3.78	7.38	2.80	0.1260
GNE	0.71	0.17	0.76	0.15	0.4406	0.77	0.10	0.73	0.20	0.8383
Noise	1.46	0.68	1.25	0.65	0.3621	1.21	0.41	1.34	0.81	0.9188
Global desc.	9.50	7.27	4.50	2.56	0.0747	13.40	7.63	21.50	10.63	**0.0109***
Body desc.	3.50	3.74	0.38	1.06	**0.0422***	4.80	3.74	6.60	4.03	0.1700
Voice desc.	6.00	5.50	4.13	1.96	0.2763	8.60	4.79	14.90	7.64	**0.0113***
	VCD (n=7)					VR (n=6)				
f0 mean	181.16	33.76	169.84	35.82	**0.0280***	169.75	24.38	167.45	29.72	0.9165
fem. (n=5)	194.14	-----	184.35	-----	-----	183.76	-----	184.72	-----	-----
male (n=2)	148.71	-----	133.58	-----	-----	141.73	-----	132.93	-----	-----
Jitter	0.29	0.34	0.42	0.57	0.2367	0.25	0.19	0.35	0.51	0.8335
Shimmer	8.43	4.31	9.09	3.55	0.8658	6.99	3.14	11.56	7.98	0.1158
GNE	0.81	0.15	0.73	0.18	0.1763	0.79	0.17	0.73	0.27	0.4982
Noise	1.19	0.56	1.34	0.72	0.4990	1.11	0.71	1.36	1.13	0.3454
Global desc.	11.57	13.30	3.43	2.37	**0.0160***	-----	-----	-----	-----	-----
Body desc.	3.43	5.32	1.14	1.68	0.1088	-----	-----	-----	-----	-----
Voice desc.	8.14	8.30	2.29	2.06	**0.0160***	-----	-----	-----	-----	-----

[1]*Wilcoxon* test; *Statistical significance
Caption: VWU = vocal warm-up; VCD = vocal cool-down; VR = vocal rest; Desc = discomfort; fem. = female; n = number of participants; SD = standard deviation; f0 = fundamental frequency; GNE = glotal to noise excitation ratio

DISCUSSION

This study aimed to evaluate a proposal of VWU/VCD with teachers in their professional context. No statistically significant difference was found in the intergroup comparison (EG vs. CG). However, the intragroup comparison revealed a reduction of the overall severity of voice deviation (G) and self-reported discomfort in the aspects related to the body following VWU. In addition, after VCD, a reduction of f0 and the self-reported global discomfort was observed, particularly with regard to the aspects related to voice, when individually evaluated. The pre-and post-class comparison (without vocal change) revealed an increase of f0 and the global degree of discomfort, particularly in aspects related to the voice. No difference was found upon comparison between the pre- and post-VR. These results pointed to the immediate positive effects of the VWU/VCD proposal.

Control group vs. experimental group

A randomized clinical trial comparing two procedures (vocal warm-up and respiratory exercises) in secondary school teachers of a public school, during six weeks, did not present a significant difference between the groups analyzed either(17), probably due to the reduced number of participants in both research studies.

The literature presents f0 reference values for adult women from 202Hz(22) to 205Hz(21) and for men, values from 113Hz(21) to 125Hz(22). The results found by this work in the group with VWU, at the post-class time for the women participants were close to the values reported in the literature. However, in the case of men, this value was slightly high. The same is observed for the f0 results in the group without VWU.

Although they don't reach statistical significance, the acoustic measures (f0, jitter, shimmer and noise) were higher and the GNE was reduced after VWU compared to the class without VWU, which may suggest worse results for these indicators following the procedure. Although the most plausible explanation is the limited number of participants in this study or chance variation, it is possible to attribute the lower f0 values found in the CG to a response to the negative effects of vocal overload in the teaching profession for teachers who did not perform VWU before classes, which resulted in a potential edema in the vocal folds following intense use in the classroom without proper protection. This edema would increase the weight of vocal folds, reducing f0, just as this potential edema would help in glottal closure, due to an increase in vocal fold mass. This condition would reduce the presence of noise and increase the proportion of GNE, as observed in mild edemas(21). However, it would only be possible to confirm this hypothesis by means of a laryngoscopy, which was not the study's objective. It must be highlighted that, physiologically, both vocal warm-up(18) and the class(23-26) cause an increase in f0 and a forceful increase in f0 due to overload in the classroom without voice preparation with VWU is more harmful to vocal folds.

With regard to the short-term perturbation indexes (jitter and shimmer), the occurrence of a higher standard deviation for the group performing WVU, which indicated differing behaviors among participants, is noteworthy. Another plausible explanation is the reduction of these measures after class(26), especially for individuals without vocal complaint,(25) as a response to vocal hyperfunction.

Immediate effects of vocal warm-up and class

The restricted number of studies on vocal warm-up in teachers found in the literature led us to use unpublished research in this discussion. In line with the results presented, a master degree study with university-admission course teachers showed an improvement in vocal quality in 63.15% of participants after the performance of immediate VWU(18).

The results of EG acoustic analysis did not reveal significant differences in the comparison between the pre-VWU and post-VWU times in this study. A randomized clinical trial with secondary school teachers in a public school showed a reduction in f0 after 6 weeks of intervention (VWU)(17).

On the other hand, upon individual analysis of the CG, a significant increase in f0 is observed upon comparison of pre-class vs. post-class without vocal warm-up. Although VWU did not prove to improve vocal indicators, which would confirm the hypothesis of this study, its performance before class allowed vocal quality to remain intact, which indicates a potential protective effect.

Researchers(24) have shown that, in addition to speaking time, an increase in f0 and intensity may be responsible for vocal overload increase, which favors the occurrence of dysphonia. A rise in these indicators can also be understood as a physiological response to increased muscular activity, revealing a laryngeal impact on vocal production during teaching(25-26) and, therefore, exposing teachers to a risk of voice disorders. This condition proves harmful if intense voice use is not preceded by proper preparation, with a vocal warm-up program that would cause a creeping and gradual increase in f0, less harmful to vocal folds.

Following VWU, the decrease in the degree of discomfort also indicated better vocal production conditions. All scores were below the mean point established and the aspects related to the body presented less discomfort, reaching statistical significance. Considering that vocal production does not result from a single organ, but from a set of coordinating structures, it may be inferred that any compromise in body movement would influence vocal adjustments(27) and, consequently, vocal quality. Therefore, a body presenting harmonic movements with less points of tension may favor free movement of the larynx and, consequently, the production of a healthier voice. In a randomized clinical trial with secondary school teachers of a public state-funded school, lower scores of the Vocal Handicap Index were also found after six weeks of vocal warm-up practice(17). Although using different evaluation instruments and times, both studied showed self-reported improvement after the procedure.

Contrarily, an increase in global discomfort and aspects related to voice was observed after class with scores close to the mean point. An analogous situation was verified in a study with teachers presenting vocal complaints, which induced to vocal fatigue after a working day(25). This situation leads us to understand the evidence of vocal overload imposed on the teaching activity. A study conducted with early childhood and elementary school teachers[28] indicated a progressive increase in the vocal tract discomfort scale after 4 and 8 hours of teaching, especially in teachers under higher vocal risk. The authors state that the effort required by teaching may increase the feeling of discomfort, leading to an additional risk of vocal change[28].

Effects of vocal cool-down and rest

Research on VCD in teachers are even scarcer. No studies were found in the literature about its immediate effects. Therefore, we will discuss the results found more broadly. It must be highlighted that, although vocal rest is used in voice practice as a therapeutic strategy, we set out to consider it as control of the intervention, so as to verify if the potential effects of vocal cool-down would surpass this strategy.

In the auditory-perceptual assessment, most of the judge's answers pointed to worse or indifferent vocal quality, with statistical difference close to significance. This worsening may have occurred by virtue of the voice returning to a more relaxed habitual adjustment and, therefore, with potential vocal instability. On the other hand, as classes require greater intensity, the larynx would be subjected to a more tense muscular adjustment towards vocal hyperfunction, making the system more rigid and, therefore, obtaining a more stable voice as a secondary effect[29], although at the expense of greater vocal effort.

A statistically significant difference was found in the f0 values after VCD, which points to a decrease in the value of this indicator. Given that VCD aims at vocal accommodation for the usual speaking standards, the initial measure (pre-class) of f0 (156.72 Hz) may have cumulatively changed with VWU (160.94 Hz) and even more after voice use in class (181.16 Hz), causing further increase. The protective effect of the procedure is drawn in view of the creeping and gradual increase of f0 after VWU and class, just as its reduction and return to its usual adjustment after VCD. The exercises proposed for VCD aim specifically at deactivating the professional body and voice posture, in addition to allowing for the return to regular intensity and f0[15], reducing cervical and laryngeal tension and activating contraction of the thyroarytenoid muscle, responsible for the production of bass sounds. Thus, VCD causes reduction of vocal attrition, reducing the development of laryngeal lesions.

Reduction of the degree of discomfort after VCD suggests that teachers, worn out after classes, noticed the effects of the procedure on global discomfort more clearly. It probably also adds to the initial perceived reduction of discomfort related to the body after VWU. However, when analyzed in isolation, the effects of VCD are more evident in the aspects related to voice, most impacted by the exercises proposed in the intervention. These results presented mean scores below the average for all variables and point to the positive effects of VWU and VCD, contributing to the reduction of the effects of teaching overload on vocal quality and proprioceptive sensations.

Lastly, it is noteworthy that most of the acoustic indicators analyzed (jitter, GNE and noise) were within normal standards established by the Voxmetria software with lower probability of finding differences in adapted or healthy voice compared to dysphonic ones. In this way, intervention would also be unable to show its effects more strongly in a non-dysphonic population. This situation can be described as the healthy worker bias, usually found in the occupational context, in which unhealthy workers are naturally excluded from work[30]. The only exception was found in the shimmer measure, elevated in the two groups of participants before and after execution of the procedures. It is possible that this noise-sensitive indicator[21] has been affected by the presence of a higher maximum ambient noise level at a particular time of voice recording. Furthermore, it is inferred that the different behavior and reduced number of participants did not allow a statistically significance to be found in the other indicators.

The reduced number of participants constitutes a limitation of this exploratory study that impacted the statistical power of analysis. The non-randomization of samples, as well as the absence of a homogeneity test between the groups, could potentially induce a selection bias. However, it allowed for the organization of a protocol of procedures and analyses that may constitute a starting point for new randomized studies with greater statistical power to be conducted, confirming the hypotheses put forward.

CONCLUSIONS

The results of this exploratory quasi-experimental study conducted with secondary school teachers of a public institution did not show statistically significant difference between the group undertaking vocal warm-up (VWU) before class and vocal cool-down (VCD) after class, compared to the group that did not undertake the first procedure and got vocal rest after class. However, the intragroup analysis showed an improvement in vocal quality and a reduction of the degree of discomfort of the aspects related to the body after VWU. VCD reduced the fundamental frequency and the global degree of discomfort, especially the aspects related to voice, which may be translated into a reduction of vocal attrition caused by the number of glottal cycles.

Both VWU before class and VCD after class are individual strategies that can be incorporated by teachers in their daily work, revealing a potential effect protecting voice from overloading due to the classes. This situation does not exclude collective improvements, both in the environment and in the organization of teaching work. New controlled and randomized studies with a greater number of participants must be carried out to confirm these findings.

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Author contributions

MLVM participated in the data conception, planning, analysis and interpretation, production of the draft and critical review of the content, and approval of the final version of the manuscript; EMGF participated in the data analysis and interpretation, critical review of the content, and approval of the final version of the manuscript; CMLB participated in the data analysis and interpretation, critical review of the content, and approval of the final version of the manuscript.