

Vocal warm-up and cool-down sequences with voice professionals

Programa de aquecimento e desaquecimento vocal para profissionais da voz

Programa de calentamiento y enfriamiento vocal para profesionales de la voz

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Abstract

Introduction: To promote vocal health, the direct approach uses sequences of vocal warm-up and cool-down, which are known, but not valued and improperly performed. **Purpose:** To verify the impact of a vocal warm-up and cool-down program on professional voices. **Methods:** Before and after the study, 26 participants answered an online questionnaire about vocal habits and voice self-assessment protocols Vocal Handicap Index-10 (VHI-10), Vocal Symptoms Scale (VoiSS) and Vocal Performance Questionnaire (VPQ) and had their voices recorded for auditory perceptual assessment (APA) and acoustic analysis. All were instructed to use the warm-up and cool-down sequences for eight consecutive weeks. **Results:** There were differences in the s/z ratio and breathiness in the group, with greater difference between the female participants. After the intervention, the scores of all protocols showed a reduction. In the APA, the values for the breathiness parameter (group: $p = 0.01$; females $p = 0.02$) were different and the general degree parameter (G) increased among men. The mean s/z ratio showed a difference ($p = 0.04$), with a 10% reduction. While the mean maximum phonation time, fundamental frequency and harmonic-to-noise ratio increased, and jitter and shimmer decreased. **Conclusion:** A program of warm-up and cool down is effective, as its use beneficially influences the perception of vocal quality and voice-related quality of life of the professionals who use them, preparing their voices for higher demands of use.

Keywords: Voice; Voice quality; Warm-up exercise; Voice training

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Authors' contributions:

ACRS, HDTM - participated in the collection and interpretation of data and preparation of the manuscript.

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Resumo

Introdução: Na promoção de saúde vocal, a abordagem direta utiliza sequências de aquecimento e desaquecimento vocal, que embora conhecidas, são pouco ou inadequadamente executadas. **Objetivo:** Verificar o impacto de um programa de aquecimento e desaquecimento vocal em profissionais da voz. **Métodos:** Antes e após a realização do estudo 26 participantes responderam questionário *online* sobre hábitos vocais e protocolos de autoavaliação da voz Índice de Desvantagem Vocal-10 (IDV-10), Escala de Sintomas Vocais (ESV) e Questionário de *Performance* Vocal (QPV) e tiveram suas vozes registradas para avaliação perceptivoauditiva (APA) e análise acústica. Todos receberam orientação para uso das sequências de aquecimento e desaquecimento por oito semanas consecutivas. **Resultados:** Houve diferenças na relação s/z e soproisidade no grupo, observando-se maior diferença no grupo feminino. Após a intervenção, houve redução nos escores dos protocolos de autoavaliação da voz. Na APA os valores para o parâmetro soproisidade (grupo: $p = 0,01$; sexo feminino $p = 0,02$) foram diferentes e o parâmetro grau geral (G) aumentou entre os homens. A média da relação s/z apresentou diferença ($p = 0,04$), com redução de 10%. Enquanto as médias de tempo máximo fonatório, frequência fundamental e proporção harmônico-ruído aumentaram e as de *jitter* e *shimmer* diminuíram. **Conclusão:** Um programa básico de aquecimento e desaquecimento é efetivo, pois sua utilização influencia beneficemente na percepção da qualidade vocal e da qualidade de vida relacionada à voz dos profissionais que as utilizam e preparam suas vozes para demandas mais elevadas de uso.

Palavras-chave: Voz; Qualidade da voz; Exercício de aquecimento; Treinamento da voz

Resumen

Introducción: En la promoción de salud vocal, el enfoque directo utiliza secuencias de calentamiento y enfriamiento vocal, que, aunque conocidas, se realizan de forma inadecuada. **Objetivo:** Verificar el impacto de un programa de calentamiento y enfriamiento vocal en profesionales de la voz. **Métodos:** Antes y después del estudio, 26 participantes respondieron un cuestionario *online* sobre hábitos vocales y protocolos de autoevaluación de la voz Índice de Discapacidad Vocal-10 (VHI-10), Escala de Síntomas Vocales (VoiSS) y Cuestionario de Rendimiento Vocal (VPQ) y tenían sus voces grabadas para la evaluación auditiva-perceptiva (EAP) y el análisis acústico. Todos recibieron instrucciones de utilizar las secuencias de calentamiento y enfriamiento durante ocho semanas consecutivas. **Resultados:** Hubo diferencias en la relación s/z y *breathiness* en el grupo, con mayor diferencia en el grupo femenino. Después de la intervención, hubo reducción de puntajes de todos los protocolos. Los valores de *breathiness* (grupo: $p = 0.01$; grupo femenino $p = 0.02$) fueron diferentes y el grado general (G) aumentó entre los hombres. La media de la relación s/z mostró una diferencia ($p = 0.04$) con reducción del 10%. Mientras que las medias del tiempo de fonación máximo, la frecuencia fundamental y la relación armónico-ruído aumentaron y los *jitter* y *shimmer* disminuyeron. **Conclusión:** Un programa básico de calentamiento y enfriamiento es efectivo, ya que su uso influye beneficentemente en la percepción de la calidad vocal y la calidad de vida relacionada a la voz de los profesionales que los usan, preparando sus voces para mayores demandas de uso.

Palabras clave: Voz; Calidad de voz; Ejercicio de calentamiento; Entrenamiento de voz.

Introduction

For several professionals, the voice is the main work tool and its use may differ according to the profession¹. These professionals are more prone to voice changes and, when amateurs, complaints can be considerably more recurrent. The highest risk of voice problems or injuries is present among singers, consultants, teachers, lawyers, church pastors, telemarketing operators, salespeople, and health professionals².

When thinking about promoting vocal health, there are two approaches: the direct and the indirect ones³. The direct approach seeks an adequate and efficient vocal production through training that covers a specific vocal demand and, in general, programs or sequences of vocal warm-up and cool-down. Indirect approach develops actions aimed at raising awareness about vocal health, such as reducing injury risk factors and minimizing the incorrect use of voice⁴.

The vocal warm-up and cool-down sequences are poorly performed or performed inappropriately, even though they are recognized as fundamental in the routine of every disciplined performer, as they are important for the longevity of the voice and the prevention of injuries caused by inappropriate vocal behavior. It happens although the voice care programs are very well known and widespread among the professionals who use the voice⁵⁻⁷.

Vocal warm-up increases blood flow and oxygenation, promotes muscle flexibility, favors the increase of harmonics, improves vocal projection and articulation. On the other hand, cool-down exercises favor the return to the initial speech adjustments, decreases blood flow and promotes the reuptake of lactic acid, decreasing muscle fatigue⁸.

The vocal warm-up exercises can be divided into two groups: technical and physiological exercises. Technical warm-up exercises are generally used by singing teachers and other areas to work on technical aspects such as vocal adjustment, breathing and timbre. The physiological warm-up exercises are usually performed by speech therapists and aims to provide adequate physiological conditions avoiding fatigue during or after vocal performance^{7,9}. It is known that some information disseminated among the population of voice professionals has no scientific origin. Information regarding vocal health is often unknown to most of these professionals and it may cause a negative

impact in the short and long-term. The practice of vocal warm-up and cool-down programs has its importance described in international studies. Speech therapists are considered a reference when it comes to guidance to voice professionals¹⁰.

Thus, the aim of this study was to verify the impact of a vocal warm-up and cool-down program developed and applied to voice professionals.

Methods

Churches, singing and theater teaching institutions and public service were contacted so that lectures on vocal health could be conducted. At the end of each lecture the audience was invited to participate in the study. The interested individuals were exposed to the objectives and to the methodology of the study. They were warned that they could drop out of the study at any time. Those who agreed to participate received an internet link to access the Informed Consent and Authorization Form to the use of the Image and Sound of the Voice for Research Purposes and only after checking the agreement response option they were able to access the following research documents/protocols:

The participant's questionnaire, with 14 questions related to the voice use, vocal health habits and the use of warm-up and cool-down sequences;

The Voice Handicap Index-10 (VHI-10), reduced version of VHI-30, consists of ten questions in order to assess the voice handicap that the individual perceives. It is considered useful for clinical evaluation, reevaluation after treatment and also to researches;

The Vocal Performance Questionnaire (VPQ), with 12 questions, evaluates aspects such as vocal performance and vocal deviation during the use of the voice, in relation to the use of the normal voice. It is directed to the physical symptoms and the socioeconomic impact caused by a vocal problem;

The Voice Symptom Scale (VoiSS) brings 30 questions divided into three domains: impairment, emotional and physical symptoms, evaluates the vocal symptoms perceived by the individual, the impact of dysphonia and which domain is most altered.

During the lectures, 70 individuals were present and, after signing the Informed Consent and Authorization Term for the Use of the Image and Sound of the Voice for Research Purposes and application of the exclusion criteria, 26 participants

were included and composed the final sample of this study. Their age varied from 15 to 52 years old (26.4 ± 12.7), 65.4% (17) were females and 34.6% (9), males. All participants were amateurs distributed among singers (17), theater actors (6), of whom 2 were singing chorus, journalists (2) and church pastor (1), with whom a workshop on vocal health was held, which dealt with the themes of voice production, myths and truths, correct use and care for the voice and the participants were encouraged to interact according to their individual experiences.

The warm-up and cool-down sequences were structured based on the results of the self-assessment protocols, considering the domain(s) with the greatest impact identified by the participants of the group. The sequences were taught and trained personally and individually and sent via WhatsApp, avoiding “loss” or difficulty in execution, since everyone had easy access to this means of communication.

The sequences were prescribed to be performed between five and 30 minutes before continuous/intense use of the voice and for warm-up, the exercises were body stretching, mainly in the cervical region, articulatory, respiratory and resonance exercises, ending the sequence with exercises of glottal competence. And for cool-down there were chosen resonance, breathing and yawning exercises, which should be performed within 10 minutes after continuous/intense use of the voice.

The intervention lasted eight weeks, with group and individual supervision, every two weeks in person and weekly online, to verify the effectiveness of the exercises, to adjust when necessary and to observe/evaluate the conditions of performance.

Individuals who reported using their voice in high demand and participated in all stages of the research project were included in the final sample for analysis. There were excluded for analysis those who: were undergoing speech therapy for speech/voice disorders; presented vocal changes that were considered moderate to severe in the auditory perceptual assessment (APA); did not fully respond to the protocols at any stage of the project or whose voice record had the signal-to-noise ratio higher than 40 dB.

The voices were recorded at the beginning and at the end of the work development period in a silent room, without acoustic treatment, because the participants were not available to go from their

work or study places to LEPO¹. For the records it was used a portable computer, with an onboard sound card in wav format, using an external microphone, positioned 5 cm and 45° from the speaker’s mouth. The APA was carried out by three blind and independent raters, using the GRBASI scale.

The voice samples consisted of the emission of the sound of the Brazilian-Portuguese sustained vowel /a/ and the phonetically balanced sentence used in the Vocal Profile Analysis Scheme-Brazilian Portuguese protocol: “The object of study of Phonetics is this complex variable and powerful sound face of language: the speech”. The acoustic analysis of the voices was performed using the PRAAT software, version 6.0.36, and the maximum phonation times (MPT), the s/z ratio values, the fundamental frequency (F0), the short-term sound disturbance measures, jitter and shimmer, and the harmonic-to-noise ratio (HNR) were extracted.

The data were compared between the pre- and post-intervention moments using the Student’s *t*-test for paired samples, with a significance level of 95%.

In compliance with Resolution No. 466/12-CNS and its complementary, this project was registered at the Research Ethics Committee from Faculdade de Ceilândia/UnB under the CAAE No. 90553418.4.0000.8093 and approved by the report No. 2.757.576. All participants gave their agreement to participate the study and signed electronically the Informed Consent Form and the Authorization Form to the Use of the Image and Sound of the Voice for Research Purposes.

Results

Pre-intervention results. When asked for how long they have used their voices professionally, 34.6% (9) of the participants stated that they did it between one and five years, 30.8% (8), more than 10 years, 19.2% (5) less than a year and 15.4% between five and 10 years. 80.8% (21) said that they performed vocal warm-up and the majority (61.9%, 13) of them reported that they spent between five and 10 minutes with the strategy. Vocal cool-down was only mentioned as usual by 34.6% (9) participants, predominating (88.8%, 8) among them the same time spent for the warm-up.

¹ LEPO: Laboratory of Teaching and Research in Otorhinolaryngology

When they were asked about vocal and laryngeal signs and symptoms related to the professional use of the voice, 61.5% (16) said they did not notice anything, 34.6% (9) reported “dry throat”, 30.8% (8) referred vocal fatigue, 19.2% (5) presence of clearing throat, 7.7% (2) hoarseness and 3.8% (1) pain.

When they were asked about the presence of these same symptoms in their daily lives, 38.5% (10) said they did not notice anything in their voice, 34.6% (9) mentioned “dry throat” and vocal fatigue, 23.1% (6) vocal fatigue, 7.7% (2) hoarseness and 3.8% (1) pain.

Gastroesophageal reflux was reported by 34.6% (9) and 26.9% (7) stated that they did not know if they have it and 38.5% (10) stated that they did not present it. About hearing, 46.2% (12) reported having undergone audiometry examination and did not have any hearing problem, 38.5% (10) said that they hear well, but have never had undergone audiometry examination and 15.4% (4) said that they did not hear well and have never undergone audiometry examination.

When asked about the practice of performing vocal warm-up and these data were descriptively compared to the time of profession, in groups with less than one year, between one and five years and with more than 10 years of experience, 23.1% (6 in each group) stated that they performed warm-up and in the group that worked between five and 10 years, 11.5% (3) did it. The remaining 19.2% (5) stated that they did not perform vocal warm-up.

Regarding the cool-down exercises, in this same context, in the groups with less than one year and with more than 10 years of experience, 11.5% (3) stated that they performed these exercises, in the group between one and five years of activity 7.7% (2) had the habit and none of the participants in the group that worked between five and 10 years did it.

The total mean scores of the protocols VHI-10, VPQ and VoiSS were, respectively, 7.2 ± 6.5 , 20.3 ± 1.5 and 21.5 ± 12.9 points. The impairment, emotional and physical symptoms domains of the VoiSS protocol reached 11.5 ± 8.0 , 2.5 ± 3.8 and 7.8 ± 4.3 points, respectively.

For APA, the mode of the parameters of the GRBASI scale were considered, which suggested voice with a mild degree of alteration ($G = 1$), with the presence of mild breathiness ($B = 1$) and without the presence of the other evaluated noise: roughness ($R = 0$), asthenia ($A = 0$), tension ($S =$

0) and instability ($I = 0$) for the group. And in the female group, these values remained the same, except for the instability parameter, which suggested the presence of a mild degree of alteration ($I = 1$).

As a result for the acoustic parameters, the MPT of the vowel /a/ reached 11.0 ± 4.7 sec, the s/z ratio, 1.1 ± 0.3 , the F0, 191.2 ± 53.9 Hz, jitter, $0.417 \pm 0.166\%$, shimmer, $3.7 \pm 1.9\%$ and HNR, 20.1 ± 3.3 .

Post-intervention results. After carrying out the work, the time of professional use of the voice underwent a small change as some individuals reported longer time of professional use of the voice. 46.2% (12) of the participants stated that they did it between one and five years, 26.9% (7) for more than 10 years, 19.2% (5) between five and 10 years and 7.7% (2) less than a year. All participants (26) said they were performing vocal warm-up and the majority (65.4%, 17) reported that they spent between 5 and 10 minutes doing it, 30.8% (8) spent between 10 and 20 minutes and 3.8% (1) of the participants said they spent between 20 and 30 minutes. Vocal cool-down was mentioned by 53.8% (14) of the participants as usual, with the same time of the warm-up.

When they were asked about vocal and laryngeal signs and symptoms related to the professional use of the voice, 76.9% (20) said they did not notice anything, 19.2% (5) reported voice tiredness, 7.7% (2) “dry throat” and throat clearing, 3.8% (1) hoarseness and there were no reports of pain.

When the participants were questioned about the presence of these same symptoms in their daily lives, 53.8% (14) said that they did not notice anything in their voices, 38.5% (10) cited the presence of throat clearing, 19.2% (5) “dry throat” and 11.5% (3), vocal fatigue, without any reports of hoarseness or pain.

19.2% (5) reported the presence of gastroesophageal reflux and 15.4% (4) said that they did not know if they had it. About hearing, 42.3% (11) reported having undergone audiometry examination and did not have any hearing problems, 53.8% (14) said they heard well, but have never undergone audiometry examination and 3.8% (1) said they did not hear well and have never undergone audiometry examination.

When the participants were asked about the habit of vocal warm-up exercises and these data were descriptively compared to the time of profes-

sion, the professionals who performed the warm-up in the group under one year, between one and five years, between five and 10 years and over 10 years of experience were, respectively, 7.7% (2), 46.1% (12), 41.7% (5) and 26.9% (7) of the participants.

As for the cool-down, in this same context, the professionals who performed it in the group with less than one year, between one and five years, between five and 10 years and with more than 10 years of experience were, respectively, 7.7% (2), 26.9% (7), 7.7% (2) and 11.5% (3) of the participants.

The total mean scores of the VHI-10, VPQ and VoiSS protocols were 4.1 ± 4.8 , 18.3 ± 1.5 and 17.8 ± 11.8 points, respectively. The impairment, emotional and physical symptoms domains of the VoiSS protocol reached 8.9 ± 7.6 , 1.8 ± 3.1 and 7.1 ± 4.4 points, respectively.

The mode values of the APA using the GRBA-SI scale suggested voice with a mild degree of alteration ($G = 1$), without, however, identifying the presence of the other evaluated parameters ($R = 0$, $B = 0$, $A = 0$, $S = 0$ and $I = 0$).

The acoustic parameters results show for the MPT 11.8 ± 2.3 sec for the vowel /a/, a s/z ratio of 1.0 ± 0.2 , a F0 of 193.3 ± 54.7 Hz, jitter of $0.359 \pm 0.134\%$, shimmer of $3.5 \pm 1.7\%$ and HNR of 21.7 ± 4.1 .

Differences between sex. The average total pre- and post-study scores were, respectively, for the female and male, in the VHI-10 protocol of 7.4 ± 6.3 / 4.1 ± 4.8 and 7.4 ± 7.5 / 4.0 ± 7.5 points, in the VPQ protocol of 19.3 ± 2.5 / 18.7 ± 1.1 and 23.0 ± 6.1 / 20.7 ± 4.0 points and in the VoiSS protocol of 23.3 ± 12.6 / 19.0 ± 11.4 and $17, 9 \pm 13.5$ / 15.4 ± 13.1 points. The impairment, emotional and physical symptoms domains of the VoiSS protocol reached, respectively, for the female, pre- and

post-study, 11.8 ± 7.2 / 9.2 ± 6.8 , 3.1 ± 4.4 / 1.8 ± 2.5 and 8.9 ± 4.6 / 8.1 ± 4.8 points; and for male, in the same order, 11.0 ± 9.9 / 8.3 ± 9.2 , 1.2 ± 1.7 / 1.9 ± 4.3 and 5.7 ± 3.0 / 5.3 ± 2.8 points.

The mode values of the APA for the GRBASI scale for female suggested voice with a mild degree of change ($G = 1$), with the presence of breathiness and instability of a mild degree ($B = 1$ and $I = 1$) in the pre- and post-study. For the male, it was observed that the pre-study defined a normal voice and in the post-study a mild general degree ($G = 1$), but without identifying the presence of the other evaluated parameters ($R = 0$, $B = 0$, $A = 0$, $S = 0$ and $I = 0$).

As for the acoustic parameters, in the pre- and post-study, respectively, for the female, the MPT of the vowel /a/ reached 10.2 ± 3.5 / 10.5 ± 2.6 sec, the s/z ratio of 1.2 ± 0.3 / 1.0 ± 0.2 , F0 of 222.8 ± 34.6 / 224.3 ± 39.2 Hz, jitter of 0.449 ± 0.184 / $0.387 \pm 0.143\%$, shimmer of 4.2 ± 2.1 / $3.8 \pm 1.9\%$ and the HNR of 20.1 ± 4.0 / 21.6 ± 4.7 . For male, in the same order, the MPT of the vowel /a/ reached 11.6 ± 6.3 / 14.3 ± 3.1 sec, the s/z ratio of 1.0 ± 0.2 / 0.9 ± 0.2 , F0 of 131.6 ± 23.9 / 134.8 ± 19.7 Hz, jitter of 0.357 ± 0.110 / $0.305 \pm 0.101\%$, shimmer of 2.8 ± 0.9 / $2.8 \pm 0.9\%$ and the HNR of 20.2 ± 1.4 / 21.9 ± 3.0 .

Descriptive and statistical comparison of parametric data between the pre- and post-study.

Table 1 shows the average scores of the voice self-assessment protocols, for the group and compares the sex differences, before and after participating in the study. There was a difference between the total pre- and post-study mean scores in VHI-10 ($p = 0.02$), in VPQ ($p = 0.03$) and in VoiSS ($p = 0.04$) and, the greatest percentage variation observed was in the mean total score of VHI-10 (43.0%) and the lowest was of the VPQ (9.8%).

Table 1. Mean values of the scores of the voice self-assessment protocols (n = 26).

	VHI-10		VPQ		VoiSS							
					Impairment		Emotional		Physical symptoms		Total	
	Pre-	Post	Pre-	Post	Pre-	Post	Pre-	Post	Pre-	Post	Pre-	Post
Group	7.2±6.5	4.1±4.8	20.3±1.5	18.3±1.5	21.5±12.9	17.8±11.8	2.5±3.8	1.8±3.1	7.8±4.3	7.1±4.4	21.6±13.0	17.8±11.8
p*		0.020*		0.029*		0.049*		0.298		0.383		0.049*
Var. %		-43.0		-9.8		-17.2		-28.0		-9.0		-17.6
Male	7.4±7.5	4.0±7.5	23.0±6.1	20.7±4.0	11.0±9.9	8.3±9.2	1.2±1.7	1.9±4.3	5.7±3.0	5.3±2.8	17.9±13.5	15.4±13.1
p*		0.103		0.207		0.229		0.583		0.821		0.433
Var. %		-45.9		-10.0		-24.5		58.3		-7.0		-14.0
Female	7.4±6.3	4.1±4.8	19.3±2.5	18.7±1.1	11.8±7.2	9.2±6.8	3.1±4.4	1.8±2.5	8.9±4.6	8.1±4.8	23.3±12.6	19.0±11.4
p*		0.016*		0.090		0.132		0.062		0.356		0.075
Var. %		-39.2		-3.1		-22.0		-41.9		-9.0		-18.4

LEGENDA: VHI, Voice Handicap Index; VPQ, Vocal Performance Questionnaire; VoiSS, Vocal Symptoms Scale; p*, Student t -test with 95% of significance, Var. %, percentage variation.

When considered by sex, the scores showed no differences between female and male both in the pre- and post-study. And only the VHI-10 mean score for the female presented difference (p = 0.02) between pre- and post-study. The emotional domain mean score was the only parameter among those evaluated that showed an increase, with a variation of 58.3%.

The pre- and post-study mode values of the GRBASI scale parameters for the group and sex are shown in Table 2. There was a difference between the pre- and post-study values for the breathiness parameter (B, p = 0.01), and the asthenia parameter (A) was not observed in any of the participants.

Table 2. Mode values of the auditory perceptual assessment using the GRBSAI scale (n = 26).

	G		R		B		A		S		I	
	Pre-	Post	Pre-	Post	Pre-	Post	Pre-	Post	Pre-	Post	Pre-	Post
Group	1	1	0	0	1	0	0	0	0	0	0	0
p*		0.490		0.057		0.011*		no variation		1.00		0.788
Male	0	1	0	0	0	0	0	0	0	0	0	0
p*		1.000		0.347		0.347		no variation		1.000		0.081
Female	1	0	0	0	1	0	0	0	0	0	1	0
p*		0.332		0.083		0.020*		no variation		1.000		0.543

LEGEND: p*, Student t -test with 95% of significance.

The male group presented an increase in the mode of the general degree parameter (G), while all other parameters remained stable. At the female group all parameters of the scale either remained stable or reduced with a difference only for the breathiness parameter (B, p = 0.02).

For the acoustic parameters, only the mean values of the s/z ratio showed a difference (p = 0.04) between the pre- and post-study, with a reduction of 10%. The mean values for MPT, F0 and HNR

increased while jitter and shimmer decreased in the post-study.

When compared by sex, among the male there was no difference between pre- and post-study for any parameter, and for the female, only the s/z ratio was different (p = 0.03). In both sexes there was an increase in MPT, F0 and HNR, but without difference, following the trend of variation in the studied group (Table 3).

Table 3. Mean values of the acoustic parameters of the voice (n = 26).

	MPT (sec)		s/z ratio		F0 (Hz)		Jitter (%)		Shimmer (%)		HNR	
	Pre-	Post	Pre-	Post	Pre-	Post	Pre-	Post	Pre-	Post	Pre-	Post
Group	11.0±4.7	11.8±3.3	1.1±0.3	1.0±0.2	191.2±53.9	193.3±54.7	0.417±0.167	0.359±0.134	3.7±1.9	3.5±1.7	20.1±3.3	21.7±4.1
p	0.338		0.042*		0.783		0.142		0.671		0.081	
Var. %	7.2		-10		1.1		-13.9		5.4		-8.0	
Male	12.6±6.3	14.3±3.1	1.0±0.2	0.9±0.2	131.6±23.9	134.8±19.7	0.357±0.110	0.306±0.102	2.8±0.9	2.8±1.0	20.2±1.1	21.9±3.0
p	0.373		0.756		0.472		0.296		0.956		0.163	
Var. %	13.5		-10.0		2.4		-14.3		0.0		8.4	
Female	10.2±3.5	10.5±2.6	1.2±0.3	1.0±0.2	222.8±34.6	224.3±39.2	0.449±0.184	0.387±0.143	4.2±2.1	3.8±1.9	20.1±4.0	21.6±4.7
p	0.711		0.026*		0.897		0.271		0.678		0.231	
Var. %	2.9		-16.7		0.7		-13.8		-9.5		7.4	

LEGEND: MPT, maximum phonation time; sec, seconds; F0, fundamental frequency; Hz, hertz; %, percentage; HNR, harmonic-to-noise ratio; p*, Student *t*-test with 95% of significance.

Discussion

This study took into account the effect of a vocal warm-up and cool-down sequence on the voices of different voice professionals and at different age groups, since most studies select specific populations, few propose interventions in different groups and are influenced by cultural and generation differences, also influencing vocal behavior and the search for information about vocal health habits ¹¹.

In the literature, the time used for warm-up varies considerably, bringing results between five and ten minutes ⁶. In this study, we chose to use the same time reference and the results obtained showed that the time used was effective for the proposed objectives.

Research carried out with singers and theater students observed that most participants perform vocal warm-up, but only 25% use vocal cool-down⁶ and this practice is related to the time of profession ¹². It was also observed that singers did not show consensus regarding the form of warm-up, but that they prioritize it and that singing teachers and speech therapists agree that a routine of voice care should be maintained ¹³. Despite the heterogeneity of age and time of profession in the sample of this study, most professionals favored warm-up in comparison to cool-down, which, after the intervention, became more valued and reported. It is noteworthy that even after the workshop/lecture, the number of participants who reported performing vocal warm-up and cool-down increased.

It has been shown in professional actors and theater students that several factors can influence voice quality; among them it can be mentioned vocal adjustments to define or represent the character, harmful habits to the voice, inadequate environ-

ment acoustic conditions, general and psychological health. However, vocal health care is not recognized ¹⁴. In this study, although the participants reports were of gain, there were no differences between the pre- and post-intervention moments.

When the voice is used inappropriately, professionals may note pain and have their performance limited due to the presence of hoarseness, dry throat, cough, throat clearing, vocal tiredness, among other laryngeal and vocal symptoms ^{2,15,16}.

Participants in this study were asked to answer questions regarding vocal symptoms perceived after intense use of the voice, and daily, and reported the occurrence of symptoms found in the literature. After the intervention, there was a reduction in this perception with the exception of the item “is your voice frequently hoarse?”, which was maintained, and in the item “do you clear the throat?”, which increased. However, we question whether this answer could be causally linked to the incorrect use of the voice¹⁷ or if it can be due to the greater perception of the participants in relation to vocal symptoms ¹⁸.

The time of intervention also appears as quite variable in the literature, and it can be adapted according to the evolution of the individual ¹⁹. This work showed that an eight-week intervention is effective for improving the participant’s perception of his/her vocal performance because of the practice of vocal warm-up and cool-down sequences. It suggests that voice health guidance can modify vocal behavior.

A study was carried out to compare the difference between two groups of teachers, one performing vocal warm-up and the other breathing training. It was observed that the group that performed vocal warm-up for six weeks showed

a significant reduction in the vocal indicators of the VHI self-assessment, in addition to reporting greater ease in speaking and general improvement in the voice quality²⁰. The decrease in the mean total score of the VHI-10 in the present study, both in the group and among the female participants, suggests a lower perception of voice handicap when there is intensive use of the voice in professional activities due to the use of the vocal warm-up and cool-down sequences.

The use of the VoiSS protocol allows us to affirm that there was a reduction in the averages of the total and the impairment domain scores, indicating that the participants perceived fewer vocal signs and symptoms, in addition to feeling less limited in relation to the use of the voice.

In a study with teachers using the VoiSS, it was noticed that the group that performed vocal warm-up showed an important reduction, both in the total score and in the impairment domain, which was the most altered. Functionality was the most perceived impact factor by these professionals, followed by physical and emotional symptoms²¹, as well as a reduction in the total scores and in the impairment and emotional domains in individuals with dysphonia¹⁸.

As this work was developed with amateur voice professionals, the assessment of vocal performance is one of the pillars to validate the effect of the intervention, as it would allow us to recognize how the participant perceived its "effect". Thus, the use of VPQ was particularly important to understand the impact of the voice problem on their vocal performance and became a tool for comparison before and after speech therapy intervention. The mean VPQ scores reduced both in the group and by sex, however they approached the maximum possible score, suggesting that the participants had a perception of excellent voice/vocal performance. Interestingly, it was observed that when separating the scores by sex after the intervention for men the mean total score was 20.7 ± 4.0 points, and for female it was 18.3 ± 1.5 points, suggesting that men believe that they have better vocal performance than women.

Thinking of an objective evaluation and to complement the APA, an acoustic analysis of the voices was carried out before and after the proposed intervention.

The *s/z* ratio allows us to verify whether the values found are suggestive of vocal fold hyper or

hypoconstriction²². There was a decrease in the values of this ratio and in the group's breathiness parameter, it suggested improvement or greater stability in the glottal coaptation pattern and a reduction in self-reported vocal fatigue. The female presented the same trend, with a decrease in the values of the *s/z* ratio and the breathiness parameter. The fact that the same does not happen with the male may be due to the low number of participants or the anatomical characteristics of the female vocal tract, which presents greater angulation of the thyroid cartilage compared to the male, interfering in F0 and in the propensity to the presence of posterior triangular gap²³.

The F0 is defined as the number of times a sound wave produced by the vocal folds is repeated in a period of time; it expresses the number of glottic opening and closing cycles and varies due to sex, age, prosody and, it is believed that it depends on the person's state of mind, lifestyle and professional use of the voice²⁴. In the group studied the F0 showed no difference, suggesting higher values to men and lower for women in relation to the reference values for Brazilian Portuguese speakers²⁴.

However, F0 cannot be considered in isolation for the assessment of the vocal fold vibration pattern²⁵, and other parameters for assessing its disturbance should be considered, such as jitter, shimmer and HNR.

The values of jitter and shimmer showed a reduction without difference, which may suggest better control of vocal fold vibration and increased glottic resistance. This reduction may be related to the change in the level of vocal effort²⁶ or to the volume of voice used during the recording of voices²⁷, which may have undergone modification due to the greater vocal proprioception developed during the study.

The statistical comparison of the acoustic analysis does not show differences between the moments pre- and post-warm-up. After vocal warm-up, a negative correlation was observed between the number of harmonics and the level of vocal noise at high frequencies. The warm-up produced greater richness in the acoustic spectrum, indicating a probable improvement in glottic coaptation, or in the adjustments of the vocal tract²⁴.

HNR as a more sensitive index of vocal function quantifies the noise added to the vocal signal²⁵ or objectively evaluates roughness²⁸. In this study, there was a mild increase in this index

with an increase in harmonics which, although not significant, reinforces the idea of improvement in the stability of glottic coaptation and the vibratory pattern of the vocal folds. Vocal warm-up favors speech production that meets greater demands in terms of vocal intensity and flexibility, observed in acoustic analysis the richness of harmonics in the spectrum^{29,30}.

Vocal self-perception shows the real impact of illness on quality of life, since it measures, contributes to clinical practice, directing therapeutic planning, which favors the prognosis, in addition to assisting in the assessment of the effectiveness of interventions, which suggests that, although vocal warm-up and cool-down do not have a therapeutic role, the time of the proposed intervention was sufficient to sensitize participants to its effects.

Conclusion

The use of vocal warm-up and cool-down sequences influences beneficially the voice and voice-related quality of life of the professionals who use them. A warm-up and cool-down program is effective for different professionals, also showing that the sequences prepare the voice for more intense demands of use but have no therapeutic role. And guidance promotes a change in habits and awareness of vocal health.

References

- Putnoki DS, Hara F, Oliveira G, Behlau M. Qualidade de vida em voz: o impacto de uma disfonia de acordo com gênero, idade e uso vocal profissional. *Rev da Soc Bras Fonoaudiol*. 2010; 15(4): 485–90. <http://dx.doi.org/10.1590/S1516-80342010000400003>
- Rosa M, Behlau M. Mapping of Vocal Risk in Amateur Choir. *J Voice*. 2017; 31(1): 118.e1-118.e11. <https://doi.org/10.1016/j.jvoice.2016.03.002>
- Nogueira B de FM, Medeiros AM de. Comportamento vocal e condições de trabalho de professores após fonoterapia para tratamento de disfonia comportamental. *Audiol - Commun Res*. 2018; 23: e 2061. <https://doi.org/10.1590/2317-6431-2018-2061>
- Santos AS dos, Oliveira CT de, Dias ACG. Características das relações dos universitários e seus pares: implicações na adaptação acadêmica. *Psicol. teor. prat*. 2015; 17(1):150-63.
- Moorcroft L, Kenny DT. Singer and Listener Perception of Vocal Warm-Up. *J Voice*. 2013; 27(2): 258.e1-13. <https://doi.org/10.1016/j.jvoice.2012.12.001>
- Gish A, Kunduk M, Sims L, McWhorter AJ. Vocal Warm-Up Practices and Perceptions in Vocalists: A Pilot Survey. *J Voice*. 2012; 26(1): e1–10. <https://doi.org/10.1016/j.jvoice.2010.10.005>
- Masson MLV, Fabbron EMG, Loiola-Barreiro CM. Aquecimento e desaquecimento vocal em professores: estudo quase-experimental controlado. *CoDAS*. 2019; 31(4): e20180143. <https://doi.org/10.1590/2317-1782/20182018143>
- Ribeiro VV, Frigo LF, Bastilha GR, Cielo CA. Aquecimento e desaquecimento vocais: revisão sistemática. *Rev CEFAC*. 2016; 18(6): 1456–65. <https://doi.org/10.1590/1982-0216201618617215>
- Portillo MP, Rojas S, Guzman M, Quezada C. Comparison of Effects Produced by Physiological Versus Traditional Vocal Warm-up in Contemporary Commercial Music Singers. *J Voice*. 2018; 32(2): 200–8. <https://doi.org/10.1016/j.jvoice.2017.03.022>
- Dassie-Leite AP, Duprat A de C, Busch R. Comparação de hábitos de bem estar vocal entre cantores líricos e populares. *Rev CEFAC*. 2010; 13(1): 123–31. <https://doi.org/10.1590/S1516-18462010005000118>
- Moreti F, Zambon F, Behlau M. Conhecimento em cuidados vocais por indivíduos disfônicos e saudáveis de diferentes gerações. *CoDAS*. 2016; 28(4): 463–9. <https://doi.org/10.1590/2317-1782/20162015162>
- Miranda ICC, Ladeira AC, Gouvêia VL, Costa VR. Autoanálise vocal de alunos do curso de teatro. *Distúrb.Comun*. 2012; 24(3): 369–78.
- Araújo ALL, Momensohn S. TM, Giannini SPP, Miguel F, Petian A. Aquecimento Vocal para o Canto Erudito: Teoria e Prática. *Musica Hodie*. 2015; 14(2): 122–37. <http://hdl.handle.net/11449/130324>
- Vilanova JR, Marques JM, Ribeiro VV, Oliveira AG de, Teles L, Silverio KCA. Atores profissionais e estudantes de teatro: aspectos vocais relacionados à prática. *Rev CEFAC*. 2016; 18(4): 897–907. <https://doi.org/10.1590/1982-021620161849315>
- Rocha C, Moraes M, Behlau M. Dor em cantores populares. *J Soc Bras Fonoaudiol*. 2012; 24(4): 374–80. <http://dx.doi.org/10.1590/S2179-64912012000400014>
- Ferreira LP, Gonçalves TAC, Loiola CM, Andrada e Silva MA. Associação entre os sintomas vocais e suas causas referidas em um grupo de coristas da cidade de São Paulo. *Distúrb. Comun*. 2010; 22(1): 47–60.
- Cielo CA, Ribeiro VV, Hoffmann CF. Sintomas vocais de futuros profissionais da voz. *Rev CEFAC*. 2015; 17(1): 34–43. <http://dx.doi.org/10.1590/1982-0216201517013>
- Moreti F, Zambon F, Behlau M. Voice symptoms and vocal deviation self-assessment in different types of dysphonia. *CoDAS*. 2014; 26(4): 331–3. <http://dx.doi.org/10.1590/2317-1782/201420130036>
- Behlau M, Pontes P, Vieira VP, Yamasaki R, Madazio G. Presentation of the Comprehensive Vocal Rehabilitation Program for the treatment of behavioral dysphonia. *CoDAS*. 2013; 25(5): 492–6. <http://dx.doi.org/10.1590/S2317-17822013000500015>
- Pereira LP de P, Masson MLV, Carvalho FM. Vocal warm-up and breathing training for teachers: randomized clinical trial. *Rev Saude Publica*. 2015; 49: 67. <http://dx.doi.org/10.1590/S0034-8910.2015049005716>
- Hermes EGC, Bastos PRH de O. Prevalência de sintomas vocais em professores na rede municipal de ensino em Campo Grande - MS. *Rev CEFAC*. 2015; 17(5): 1541–55. <http://dx.doi.org/10.1590/1982-021620151751215>



22. Cielo CA, Lima JP de M, Gonçalves BF da T, Christmann MK. Relações entre /s/ e /z/ e entre /e/ e /e/ não vozeado ou áfono. *Rev CEFAC*. 2013; 15(5): 1308–15. <http://dx.doi.org/10.1590/S1516-18462013005000026>
23. Beber BC, Cielo CA. Características vocais acústicas de homens com voz e laringe normal. *Rev CEFAC*. 2010; 13(2): 340–51. <http://dx.doi.org/10.1590/S1516-18462010005000040>
24. Teixeira JP, Oliveira C, Lopes C. Vocal Acoustic Analysis – Jitter, Shimmer and HNR Parameters. *Procedia Technol*. 2013; 9: 1112–22. <https://doi.org/10.1016/j.protecy.2013.12.124>
25. Ferrand CT. Harmonics-to-Noise Ratio. *J Voice*. 2002; 16(4): 480–7. [https://doi.org/10.1016/S0892-1997\(02\)00123-6](https://doi.org/10.1016/S0892-1997(02)00123-6)
26. Huang DZ, Minifie FD, Kasuya H, Lin SX. Measures of vocal function during changes in vocal effort level. *J Voice*. 1995; 9(4): 429–38. [https://doi.org/10.1016/S0892-1997\(05\)80206-1](https://doi.org/10.1016/S0892-1997(05)80206-1)
27. Brown WS, Morris RJ, Michel JF. Vocal jitter in young adult and aged female voices. *J Voice*. 1989; 3(2): 113–9. [https://doi.org/10.1016/S0892-1997\(89\)80137-7](https://doi.org/10.1016/S0892-1997(89)80137-7)
28. Yumoto E, Gould WJ. Harmonics-to-noise ratio as an index of the degree of hoarseness. *J Acoust Soc Am*. 1982; 71(6): 1544–50. <https://doi.org/10.1121/1.387808>
29. Falcão LMG, Masson MLV, Oliveira G, Behlau M. Spectrographic analysis of the effect of vocal warm-up on the voice of choir girls. *Audiol - Commun Res*. 2014; 19(4): 380–6. [https://doi.org/10.1016/S0892-1997\(89\)80137-7](https://doi.org/10.1016/S0892-1997(89)80137-7)
30. Lima JP de M, Cielo CA, Scapini F. Fonação em tubo de vidro imerso em água: análise vocal perceptivoauditiva e videolaringoestroboscópica de mulheres sem afecções laringeas, queixas ou alterações vocais. *Rev CEFAC*. 2015; 17(6): 1760-72. <http://dx.doi.org/10.1590/1982-021620151768814>

