

Revision articles

Vocal warm-up and cool-down: systematic review

Aquecimento e desaquecimento vocais: revisão sistemática

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ABSTRACT

For this literature review, we researched national and international scientific publications on vocal warm-up and cool-down of the speaking voice, through databases such as Lilacs, MedLine and Scielo, in order to identify and describe the methodological parameters and the effects of the vocal warm-up and cool-down proposals that are described in national and international literature. We performed the location and selection of studies through a survey of texts published on the theme from 1999 to 2013. We included original research articles; published in Portuguese or English; with emphasis on vocal warm-up and cool-down; associated or not. The recommended time of execution for warm-up ranged from 15 to 30 minutes or three sets of 15 repetitions, and the cool-down from 5 to 15min. The most used exercises for warm-up were voiced fricative sounds and vibrant of tongue or lips, in ascending scales, and for the vocal cool-down the nasal sounds, fricative sounds and vibrant of tongue or lips, in descending scales, were the most used exercises. The exercises showed positive vocal changes, observed by vocal acoustic and auditory-perceptual vocal and, self-evaluation and aerodynamic related to phonation. There was unanimity on the importance of completing the vocal warm-up and cool-down for voice professionals and on the positive results after carrying out the procedures. There was no agreement on the time of execution and on the exercises that were used.

Keywords: Warm-up Exercise; Voice Quality; Voice Training; Voice; Speech, Language and Hearing Sciences

RESUMO

Esta revisão da literatura levantou publicações científicas nacionais e internacionais sobre aquecimento e desaquecimento vocais da voz falada, por meio das bases de dados Lilacs, *MedLine* e *Scielo*, com o objetivo de identificar e descrever os parâmetros metodológicos e os efeitos das propostas de aquecimento e desaquecimento vocal descritas na literatura nacional e internacional. Foi realizada a localização e seleção dos estudos por meio de levantamento de textos publicados sobre o assunto no período de 1999 a 2013. Foram incluídos artigos originais de pesquisa; publicados na língua portuguesa ou inglesa; que pesquisaram aquecimento e desaquecimento vocal; associados ou não. O tempo de execução recomendado para o aquecimento variou de 15 a 30min ou três séries de 15 repetições, e para o desaquecimento foi de 5 a 15min. Os exercícios mais utilizados para o aquecimento foram sons fricativos sonoros e vibrantes de língua ou de lábios, em escalas ascendentes, e para o desaquecimento vocal foram sons nasais, fricativos sonoros e vibrantes de língua e ou de lábios, em escalas descendentes. Os exercícios mostraram mudanças vocais positivas, observadas por meio de medidas vocais acústicas e perceptivo-auditivas, de autoavaliação e aerodinâmicas relacionadas à fonação. Houve unanimidade quanto à importância da realização do aquecimento e desaquecimento vocais para profissionais da voz e aos resultados positivos após a realização dos procedimentos. Não foi encontrada concordância quanto ao tempo de execução e os exercícios utilizados.

Descritores: Exercício de Aquecimento; Qualidade da Voz; Treinamento da Voz; Voz; Fonoaudiologia

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INTRODUCTION

The actions that seek to promote vocal health of voice professionals can be of two types, direct or indirect¹. The indirect approach helps the subject to understand the vocal use and to develop strategies that might minimize the risk factors, by developing actions towards the guidance on vocal health that seek to reduce the incorrect use of the voice. The direct approach provides a change of vocal functioning, by offering some instruction techniques for voice, in order to encourage an efficient vocal production, and they usually involve the practice of vocal warm-up and cool-down programs¹.

The vocal warm-up aims to increase the blood flow, the oxygenation and the flexibility of tendons, ligaments and muscles, which allows greater glottal closure, increased flexibility of the vocal folds to proper stretching and shortening during frequency variations, vocal quality with higher component harmonic, increased sound pressure level (SPL) and improved vocal projection and articulation of sounds¹⁻⁴. The cool-down, on the other hand, aims at the return to the regular muscular adjustments of the speaking voice, decreasing the blood flow and promoting the return of lactic acid, thereby preventing muscle fatigue⁵.

The approaches for vocal warm-up and cool-down act as prophylactic measures to improve vocal performance and prevent the appearance of laryngeal lesions resulting from incorrect and abusive uses of voice, making them essential for the subjects who use their voice intensively in their labor activity^{3,6,7}.

The larynx is more susceptible to injuries. Then, when it is used improperly or without the adequate preparation, makes the warm-up and cool-down of the muscles involved in phonation essential to health and adequate vocal performance vocal³, mainly for voice professionals.

Since there are few studies on vocal warm-up and cool-down, it is believed that the review of the information presented in the literature on the theme may be relevant in order to provide clinical practice based on evidence, and also to indicate which topics need to be further explored.

Therefore, this work aims to identify and describe the methodological parameters and the effects of warm-up and cool-down proposals that are described in national and international literature.

METHODS

Search strategy

The research questions that supported the review were: "What are the methodological parameters that have been guiding vocal warm-up and cool-down proposals?" and "What are the results obtained from the use of vocal warm-up and cool-down?"

Two researchers from different institutions of higher education, independently, carried out the search in databases such as Lilacs (Latin American and Caribbean Center on Health Sciences Information), MEDLINE (Medical Literature Analysis and Retrieval System Online) and Scielo (Scientific Electronic Library Online), by selecting the articles published from 1999 to 2013. Descriptors in Health Sciences (DeCS, 2013) used for the location of the articles were: exercise; voice; voice quality; voice training. We carried out the search with the associated descriptors (and).

Selection Criteria

We separated the selection of published studies in four stages: the selection of materials with the associated descriptors (published in the period from January 1999 to December 2013) in the searched databases - they were available in complete form electronically; selection of materials whose titles and abstracts were related to the proposed theme; application of the inclusion and exclusion criteria; complete reading of the articles to sort them at the level of scientific evidence.

We included original research articles, being them published in Portuguese or English; with focus on vocal warm-up and cool-down; associated or not.

The adopted exclusion criteria were based on the classification of the level of scientific evidence according to the study type that was recommended by the Oxford Centre for Evidence-Based Medicine, which offers a level of evidence rating from 1A to 5, being the studies classified, respectively, as the most and the least reliable levels of scientific evidence. Thus, we excluded studies with lower evidence drawings, such as case reports (including cohort and case-control of lower quality - level of evidence 4) and expert opinions with lacks of critical evaluation or based on basic materials (evidence level 5). Furthermore, we also decided to exclude studies of non-systematic literature reviews, which are not part of the type evaluated by this classification, considering the lack of a systematic approach in the search and selection of the studies

analyzed in this type of research. We also excluded articles that specifically addressed the singing voice and studies addressing people with laryngeal diseases.

We found out 1782 articles (exercise and voice: 55; exercise and voice quality: 104; exercise and voice training: 139, voice and voice training: 1484), of which 1668 were excluded for not addressing the vocal warm-up and/or cool-down themes; 21 were excluded because they were out of the period from 1999 to 2013; 12 were excluded because their titles and abstracts were not related to the proposed theme; 42 were excluded due to the application of the the inclusion and exclusion criteria related to the type of study (annals, books, monographs, theses or dissertations) and in terms of the levels of evidence; 28 were excluded because they addressed only singing voice, leaving 11 studies for analysis.

Data analysis

To analyze the 11 selected articles, we used a predefined protocol developed by the authors for this research, which covered the following topics: number of subjects; professional of voice or not; age; gender; procedures; vocal technique; number of repetitions or run time; results obtained.

LITERATURE REVIEW

The vocal apparatus needs favorable muscle conditioning for its correct functioning. For this purpose, the vocal warm-up is used. It is considered a fast procedure, which is performed in order to prevent laryngeal diseases and prepare the voice before its use⁷⁻⁹. It is expected, with the performance of vocal

warm-up exercises, to get more loudness, to improve quality and vocal projection, among other benefits such as prevention of lesions^{7,8,10}.

Physiologically, by means of a controlled exhalation, a reduction of airflow occurs and the heat caused in performing the vocal warm-up reduces the elastic and viscous tissue resistance, which makes the muscles of the vocal folds more flexible and capable of being shortened and lengthened. This improves voice projection and the articulation of sound, and hence it also facilitates the professional use of the voice in a healthy way^{7,8}.

The vocal cool-down, in turn, is carried out in order to reduce the vocal overuse, returning to the regular voice adjustment⁷. Since laryngeal muscles are similar to the skeletal muscles of the whole body, they respond and adjust themselves to the intensity of the vocal demand, so vocal and laryngeal muscle dynamics is benefited from the completion of the vocal warm-up and cool-down for maintaining the vocal health^{10,11}.

Figure 1 shows the description of the studies⁷⁻¹⁷ in relation to the number of subjects, voice professionals or not, age, gender, methodological procedures, vocal techniques, number of repetitions or time of execution of the vocal warm-up and cool-down programs.

However, despite the physiology of vocal warm-up and cool-down that is proposed by the studies are convergent, we verified some differences between surveys regarding the methodological parameters and the effects of different vocal warm-up and cool-down programs. Thus, we observed that there is the necessity to review systematically and describe those factors related to vocal warm-up and cool-down.

Study	N	Professional of voice (type)?	Age (in years)	Gender	Procedures	Vocal technique	Number of repetitions or time of execution	Results
Masson et al. ⁷	14	Future professionals of voice (undergraduate students of the Education Major)	Not informed	Not informed	Self-evaluation of the aspects related to the body and to the voice before and after the vocal warm-up and after vocal cool-down. The procedures were performed in a short-term workshop.	Warm-up: stretching, shoulders and head rotation, tongue crack, beak/smile and kiss, long expiration emitting /s/, long expiration emitting /z/, vibrant sounds of lips and tongue and nasal sounds. Cool-down: breathing, yawning, rotation of shoulders and head, vibrant sounds of lips and tongue in descendant scales, laryngeal manipulation and chanted voice.	30 minutes of warm-up; 15 minutes of cool-down.	There was less discomfort with the completion of vocal warm-up according to the perception of 85.71% of the participants (symptoms of effort for talking, voice changes, hoarseness, sore throat and loss of voice) and to 100% in completion of the vocal cool-down (symptoms of effort for talking, voice range, sore throat, hoarseness and loss of voice).
McHenry, Johnson, Foshea ⁸	20	Yes (actors)	From 17 to 25	10 men and 10 women	Acoustic evaluation (Computerized Speech Laboratory) and aerodynamic measures related to phonation before and after two vocal warm-up protocols.	1st condition: relaxation in the supine position, then soft phonation with nasal sounds until the subject is in the standing position, gradual increase in pitch and loudness. 2nd condition: aerobic exercise (running on the treadmill) to reach 70-80% of the recommended maximum heart rate; in case of not reaching the heart rate should be made jacks. After, they performed interval with an intake of 250ml of water and vocal warm-up.	1st condition: 20 minutes of vocal warm-up; 2nd condition: 5 minutes of warm-up in the recommended heart rate, 3 minutes of rest, 20 minutes of vocal warm-up.	For men, there was a reduction of jitter in the 2nd condition; for women, there was a reduction of the sound pressure in the 2nd condition. There were no changes after the 1st condition.
Moreira et al. ⁹	27	Yes (Telemarketers)	From 18 to 40	24 women and 3 men	Pre and post-intervention evaluation: questionnaire about vocal habits, evaluation of the speech profile of the telemarketer and auditory-perceptual vocal analysis (GRBASI). Five workshops in which topics were discussed: role of the speech therapist in the call center area, vocal health, vocal production (anatomophysiology notions and running exercises emphasizing proper breathing posture); guidance on body posture; articulatory exercises, tongue twisters and over-articulation; warm-up and cool-down notions.	In the last session (5th) vocal warm-up exercises were used with vibrant sounds of lips and tongue, nasal and fricative sound in order to cool down the voice	The workshops lasted 30 minutes.	After the workshops, there was an improvement in voice quality, articulation, fluency, perceptual decrease of asthenia in both genders. An increase of MPT of the /a/ vowel was verified in women.
Van Lierde et al. ¹⁰	45	Future professionals of voice (undergraduate students of the Speech, Hearing and Language Sciences Major)	From 18 to 21	Women	Auditory-perceptual, acoustic (Multi Dimensional Voice Program) and aerodynamic vocal evaluation before and after vocal warm-up post-program with control and experimental groups.	Vocal warm-up program consisting of exercises: over-articulation of vowels, vibrant sounds of tongue, basal sound, vocal fry, lip constriction, glottis firmness, ascendant and descendant scales.	30 minutes.	There was an increase of the fundamental frequency and reduced sound pressure level in the subjects in the experimental group.

Study	N	Professional of voice (type)?	Age (in years)	Gender	Procedures	Vocal technique	Number of repetitions or time of execution	Results
Mendonça, Sampaio, Oliveira ¹¹	17	Yes (teachers of elementary school)	From 20 to 60	Women	Auditory-perceptual voice evaluation (RASAT scale) and the variability of the fundamental frequency; acoustic analysis (Vox Metria Program), pre and post-implementation of the program; questionnaire of vocal self-evaluation after the program. We used the Functional Vocal Exercises Program of Stemple and Gerdeman.	Functional Vocal Exercises Program of Stemple and Gerdeman: /i/ sustained vowel ascendant glissando and descendant of the word / nol / and scale of the musical tones C, D, E, F, G, with emission of / ol in maximum phonation time.	Individually, 1 weekly meeting for a total of 8 meeting.	There was an increase of maximum phonation time, the sound pressure and the amount of harmonics, and expanding vocal range and improvement of the quality, strength and vocal projection.
Silverio et al. ¹²	42	Yes (teachers of elementary school)	From 25 to 52	Women	Auditory-perceptual voice evaluation (GRBASI scale) before and after 12 meetings of 1 hour the themes: psychodynamic and proprioceptive voice analysis, anatomy and physiology of the larynx and vocal production, vocal health, warm-up and cool-down, environmental conditions and work organization.	Warm-up: cervical relaxation, chewed / m /, voiced vibrant fricative sounds of lips and tongue in ascendant scales. Cool-down: same exercises, but in descendant scales.	At the beginning and at the end of the sessions.	After the voice experience, there was a decrease in the auditory-perceptual degree of tension.
Luchesi, Mourão, Kitamura ¹³	13 started, but only 5 finished	Yes (teachers of elementary school)	Not informed	Not informed	Auditory-perceptual voice evaluation (visual analogue scale where the left end was characterized as "inadequate" and the right as "adequate") and acoustic evaluation (Praat software) before and after 12 meetings, once a week, sessions of 1: 30h on : anatomy and physiology phonation, vocal health, breathing, coordination pneumophonoarticulatory, phonation tension, articulation, speed and modulation of speech, resonance, vocal projection, verbal and non-verbal expressivity, warm-up and cool-down.	During the 11th meeting, there was reflection on the importance of the warm-up and cool-down, guidance for their performance, choosing two to three exercises learned during the meetings: cervical stretching, facial relaxation, digital manipulation of the larynx, yawn-sigh, glottis firmness, tongue crack, chewing method, over-articulation, chanted voice, vibrant sound (without specifying whether tongue and or lips), fricative and nasal, tongue rotation in the vestibule associated with nasal sound. Guidance on cool-down and execution of yawning-sigh techniques and descendant glissandos.	Warm up: 15 minutes at the beginning of the 11th session. Cool-down: in the same session, the final 5 minutes.	After 12 meetings, there was a significant expansion of the extension of frequency and increased 1 formant of the / i/ and /u/ vowels.
Ferreira et al. ¹⁴	11	Yes (Telemarketers)	From 16 to 38	9 women and 2 men	Evaluation through observation of the authors. 2 groups of telemarketers, 7 meetings. The content covered in the actions considered voice issues, hearing and health promotion, carried out with dynamics, exercises and experiences.	Awareness and execution of warm-up and cool-down exercises, without specifying which ones.	Not informed	Qualitative gains in relation to the comprehension that the speech therapist offers.

Study	N	Professional of voice (type)?	Age (in years)	Gender	Procedures	Vocal technique	Number of repetitions or time of execution	Results
Penteado et al. ¹⁵	36	No (children)	6	19 girls and 17 boys	Evaluation based on observation information, notes and photographic records. Group with children who sought the shared construction of knowledge on vocal health in the perspective of health promotion at school.	At the 1st meeting vocal warm-up was performed with ludic exercises: voiced fricative sounds / z / associated with a bee, vibrant sounds of lips and tongue with variations in pitch and loudness associated with a car. During the production of sounds, children were asked to put their hands in the neck to feel the vibration of the larynx and neck at the time of voice production.	Not informed	The qualitative analysis of the data shows that issues related to vocal health, strategies and resources used during the experience of group voice were suitable to the promotion of vocal health of children.
Roman-Niehués, Cielo ¹⁶	23	No (women)	From 18 to 39	Women	Acoustic voical analysis (Multi Dimensional Voice Program) pre and post-isolated execution of hyperacute sound.	Evaluation of the immediate effect of hyperacute sound and they suggest its use as a vocal warm-up in subjects who do not present laryngeal problems.	3 sets of 15 repetitions maximum phonation time, at intervals of 30 seconds of passive rest between each set.	Increased acoustic measures of fundamental frequency and disruption of the fundamental frequency, reduction of disturbance measures of the amplitude, noise, voice breaking, voice irregularity and trembling.
Penteado et al. ¹⁷	20	Yes (professionals who worked at different sectors of a hospital)	Not informed	Not informed	Auditory-perceptive and self-evaluation. - Group of experience in voice held for 7 weeks (1: 30h each weekly meeting) with the themes: vocal self-perception; professional use of voice and contexts and working conditions; vocal warm-up; impacts of voice / speech / communication / language and expressiveness in professional relations; changing possibilities.	In the 3rd, 4th and 5th meetings, the importance of vocal warm-up and the performance of physical exercises (rotation of shoulders and head) are worked and vocal exercises (voiced fricative / z /, crack and tongue rotation associated with nasal sounds ranging from loudness, vibrant sounds of lips and tongue usual pitch and ascendant and descendant scales).	Not informed	The group was efficient, favoring vocal perception, and promoting improvement in habits related to vocal health. Among the reports, there was an improvement of vocal health habits, such as increased hydration, care with posture, increased loudness, reduced speech rate, among others.

Figure 1. Results of the systematic review of the literature on vocal warm up and cool-down

Methodological parameters of vocal warm-up and cool-down proposals

Among the articles that were included in this review, we found some studies that address vocal warm-up and cool-down^{7,9,12-14}, and other studies that only address the vocal warm-up^{8,10,11,15-17}. However, not all research propose the use of exercises just for these objectives, highlighting the warm-up or cool-down among the applicability of the proposed programs, which makes some studies do not have proposals for vocal cool-down^{11,16}.

The studies addressed different populations, with samples composed of preschool children¹⁵; non-professionals of voice (women)¹⁶; future professionals of voice and undergraduate students of the Speech, Hearing

and Language Sciences Major¹⁰ and undergraduate students of the Education Major⁷, and professionals of voice such as teachers¹¹⁻¹³, telemarketers^{9,14}, actors⁸ and hospital employees¹⁷. Thus, the main aspects of sampling and the methodology for exercises implementation and vocal warm-up and cool-down programs will be described below.

Authors describe the vocal warm-up that was carried out in a group with 36 preschool children who were six years old - 19 girls and 17 boys. This group had three meetings and the vocal warm-up was introduced on the first meeting, without mentioning the duration of the meeting and time of execution of the exercise. The vocal warm-up consisted of exercises as support of the voiced fricative sound /z/ and the vibration of lips and

tongue with variation of pitch and loudness. In this case, since they are children, the warm-up happened in a ludic way by using different toys and the exercises were associated with characters like, for example, the voiced fricative sound /z/ was associated with a bee and the vibration of the lips or language was associated with the sound of a car engine. In addition, as a facilitating resource for the production of sounds, the authors asked these children to put their hands in the neck to feel the vibration of the larynx and neck at the time of voice production. The authors do not mention the work with the vocal cool-down in the study, however, they state that the interest of the children by vocal exercises motivated educators to propose vocal warm-up and cool-down to the school as part of the school routine. Then, exercises could be performed at the beginning and at the end of classes¹⁵.

A group of 23 young adult women without voice complaints and with normal larynx, non-professionals of voice, had a session of hyperacute sound in three sets of 15 repetitions, at maximum phonation time, with intervals of 30 seconds of passive rest between each set. The literature indicates the hyperacute sound as a technique of physiologic vocal warm-up, since it allows a greater elongation flexibility and shortening of the vocal folds during frequency changes, leaving the mucosa more released and providing greater wave ability, which together provides better conditions for general vocal production. Although the primary aim of the study was to verify the effects of hyperacute sound technique, the authors recommend its use in vocal warm up¹⁶.

In training with the group of women of the Speech, Hearing and Language Sciences Major, for vocal warm-up for about 30 minutes, the following exercises were used: over-articulation of vowels, vibrant sounds of tongue, basal sound, lip constriction, glottal firmness, ascendant and descendant scales. The study aimed to verify the effect of vocal warm-up program on voice quality, not being proposed a cool-down program¹⁰.

Fourteen undergraduate students of the Education Major attended a short course of three hours, in which some theoretical explanation of the aspects of the voice were mentioned. Afterwards, the practical part of the warm-up and cool-down exercises were performed. The vocal warm-up lasted 30 minutes and it consisted of the following exercises: stretch, rotation of the shoulders and head, orofacial organs exercises (tongue rotation, beak-smile, kiss), vibrant sounds of lips and tongue, fricative sounds and nasal sounds

in pitch and regular loudness. The vocal cool-down lasted 15 minutes, involving exercises with the purpose of eliminating the tensions of the body such as the cervical region and the vocal tract, as well as reducing vocal loudness and pitch. The exercises performed in vocal cool-down were breathing, yawning, rotation of shoulders and head, vibrant sounds of lips and tongue, laryngeal manipulation and chanted voice⁷.

At the work in which the Functional Vocal Exercises program (or Vocal Function) was applied in 17 teachers, individual meetings were held on a weekly basis, for eight consecutive weeks with the following sequence of exercises: the vowel /i/ in MPT, ascendant and descendent glissando and maintenance of the sound [o:] in each musical note. The authors do not present number and time of execution of each exercise; they only refer to the sequence of techniques that was used. Among the applicability of the program, they mention the vocal warm-up¹¹.

In a study, 13 teachers participated in a group in which one of the themes was the performance of vocal warm-up exercises before classes and vocal cool-down exercises after classes, in order to restore normal loudness of speech and undo the sensations vocal abuse and fatigue. In vocal warm-up, they used exercises such as cervical relaxation, chewed /m/, voiced fricative sounds and vibration of lips and tongue in ascending scales. For vocal cool-down, the same exercises were used, but in descending scales. This group had 12 meetings with one hour each, however, the author did not mention the specific time and the session in which the vocal warm-up and cool-down were worked¹².

In a vocal enhancement group in which 12 weekly meetings with teachers were held, a vocal warm-up of 15 minutes before class was suggested by electing up two to three exercises learned during the meetings (cervical stretching, facial relaxation, digital manipulation of the larynx, yawning-sigh, glottal firmness, tongue popping, masticatory method, over-articulation, chanted voice, vibrant sounds of lips and tongue) and 5min after the cool-down with yawning-sigh techniques and descending glissando¹³. In a study with 27 telemarketers, of both genders, who participated in five workshops in vocal enhancement, each with 30 minutes, one of them on vocal warm-up and cool-down. For vocal warm-up, they used exercises with vibrant sounds of lips and tongue and, for vocal cool-down, they used exercises with nasal and fricative sounds to cool down the voice⁹.

Group of 20 actors, ten men and ten women, performed two protocols of vocal warm-up with the aim of comparing the effects of both, with interval of one week between applications of both programs. In the first program, 20 minutes of specific vocal exercises were carried out, starting with relaxation in the supine position, soft phonation with nasal sounds until the actors stay in orthostatic position, with gradual increase in pitch and loudness. In the second program, a combination of 5 minutes of aerobic exercise (running on the treadmill) was held with monitoring of heart rate, followed by rest of 3 minutes with intake of 250 ml of water and, after, 20min of vocal warm-up with the same exercises of the first condition. This study was specifically about vocal warm-up, not proposing exercises for vocal cool-down⁸.

Twenty employees of a hospital participated in a group in which one of the topics discussed was the vocal warm-up. From seven meetings that were held from October to December, with each meeting lasting an hour and fifteen minutes. From seven meetings, the vocal warm-up was performed on the second, third and fourth meetings. Vocal warm-up exercises were carried out, being them physical exercises (rotation of shoulders, head movements) and vocal exercises (sustained emission of voiced fricative sound /z/ and chewed /m/ on regular pitch, popping and tongue rotation associated with nasal sounds with loudness variation, vibration of lips and tongue in regular pitch and ascendant and descendant scales)¹⁷. This study did not discuss vocal cool-down.

Although some studies found in the literature did not give details about warm-up exercises and vocal cool-down and their effects¹⁴, it is possible to verify that different exercises can be performed, each one with different functions and goals, for example, relaxation exercises may favor the mental state, while vocalization exercises favor the increase of vocal range, similarly to physical exercise⁸.

In vocal warm-up, it was noted that the recommended exercises were cervical relaxation¹², nasal sounds^{7,8,12,17}, voiced fricative sounds^{7,12,15,17}, vibrant sounds of tongue or lips^{7,9,10,12,15,17}, stretching⁷, rotation of shoulders and head^{7,17}, orofacial organs exercises (tongue rotation, beak-smile, kiss)⁷, over-articulation of vowels¹⁰, hyperacute sound¹⁶, basal sound¹⁰, lip constriction¹⁰, glottal firmness¹⁰, ascending scales^{10,12,17} and association of nasal sounds and body movements hydration and after running, as well as there was a

recommendation to apply the warm-up in a ludic way with children¹⁵.

For vocal cool-down, the exercises performed were cervical relaxation¹², nasal sounds^{9,12}, voiced fricative sounds^{9,12}, yawning or yawning-sigh^{7,13}, rotation of shoulders and head⁷, vibrant sounds of tongue and or lips^{7,12}, laryngeal manipulation⁷, chanted voice⁷, descendant scales^{12,13}.

The duration of the vocal warm-up in the literature varies from 30 minutes⁷, 20 minutes⁸, 15 minutes¹³ or three sets of 15 repetitions in maximum phonation time at intervals of 30 seconds of passive rest between each set¹⁶. For the cool-down, the recommendation varies from 15 minutes⁷ to 5 minutes¹³.

Effects of vocal warm-up and cool-down proposals

To evaluate the effects of the vocal warm-up and cool-down, different procedures were used in the studies that we analyzed. Most studies used self-evaluation^{7,9,11,12,17}, while others used the acoustic evaluations^{8,10,11,13,16}, auditory-perceptual evaluations^{9-13,17} and aerodynamic measures⁸⁻¹⁰. Some authors also used the observation, evaluating the results of programs and/or exercises qualitatively^{14,15,17}. We highlight that most of studies used more than one form of evaluation^{8-13,17}. The main effects obtained with the completion of vocal warm-up and cool-down will be presented afterwards, being the studies organized according to the evaluation method that were used.

A work that was carried out with future professionals of voice verified through self-evaluation on visual analogue scale of 10cm, considering the aspects related to body and to voice, decreased general discomfort with the completion of vocal warm-up and cool-down, with greater effect on aspects related to voice, such as reduction on the effort for talking, voice changes, hoarseness, sore throat and loss of voice⁷.

Research has found improvement in vocal health habits, reduction in asthenia, through analysis with GRBASI scale, and an increase in the maximum phonation time after voice workshops with instructions in relation to vocal warm-up and cool-down, in which participated telemarketers of both genders. There was no difference between the pre and post-workshop moments in other parameters of the GRBASI scale⁹.

In a study with teachers who underwent the Functional Vocal Exercises program, which can be used for vocal warm-up, the effects of the program were analyzed through vocal auditory-perceptual evaluation (RASAT scale), through variability of the fundamental

frequency of the acoustic analysis (Vox Metria software), the collection of aerodynamic measures, pre and post-program application, and through vocal self-evaluation questionnaire. All participants obtained increased SPL and maximum phonation time, and they showed improved voice quality and greater quantity and better definition of the amplified harmonics, reduced noise filling between them and increased intensity observed in the degree of darkening of the track after the exercises. Most teachers reported improved vocal self-evaluation and, in relation to the variability of the fundamental frequency, there was an increase in the number of semitones, resulting in higher vocal extensions¹¹.

In another study, after being part of a group, teachers showed a significant reduction in the degree of vocal strain (vocal auditory-perceptual evaluation according to the GRBASI scale), being this improvement given by the participants themselves to the modification of vocal health habits, including, performing vocal warm-up exercises¹².

Authors evaluated the results of a group with professionals of voice at a hospital, where one of the topics was the vocal warm-up, and they found improvement in vocal health habits, such as increased hydration, care with posture, as well as increased loudness and reduced speech rate¹⁷.

After two different warm-up programs, actors obtained some improvement in vocal parameters after the second program that combined vocal warm-up exercises with aerobic exercise. Women presented reduction in SPL and, in the group of men, there was a reduction of jitter. The authors found that the combination of general exercise for the body and specific exercises for the voice might cause greater effects on aerodynamic measurements, such as SPL, and vocal acoustics (Computerized Speech Laboratory) due to the primary effect of the warm-up, which is the increase of the temperature tissue and, consequently, a reduction of its viscosity. This favors the improvement of the resonance and vocal production⁸.

The Functional Vocal Exercises program, performed with undergraduate student of the Speech, Hearing and Language Sciences Major, generated an increase of habitual fundamental frequency, verified by the acoustic voice evaluation (Multi Dimensional Voice Program), and reduction of NPS¹⁰. Another study carried out with a group of teachers for vocal enhancement was identified an improvement in acoustic analysis (Praat software) with amplification of the fundamental frequency

extension and an increase of the first formant in vowel such as /i/ and /u/ after the intervention¹³.

It was found in the acoustic analysis (Multi Dimensional Voice Program) of a group of adult women without complaints or laryngeal disorders after performing the hyperacute sound like vocal warm-up, the increase in fundamental frequency measures and perturbation measures of the fundamental frequency, as well as reduction of disturbance measures of the amplitude, noise, voice breaking, voice irregularity and trembling. The authors verified that the warm-up of the muscles involved with the completion of hyperacute sound might have improved the glottal source, promoting improved resonance and creating a more harmonious and better glottal signal propagated by the vocal resonance tract¹⁶.

The vocal warm-up with children of both genders is reported in the literature in a study that a group of preschool children performed exercises in a ludic way. The authors, through observation, concluded that the fact that children show interest in vocal warm-up exercises led their teachers to discuss the possibility of organizing the school day in order to carry out the warm-up and cool-down, respectively, at the beginning and end of the class period every day¹⁵. Finally, another study did not show the effects of warm-up and cool-down in the voice of telemarketers¹⁴.

With the implementation of vocal warm-up and cool-down, regarding the objective verifications, there was an increase of the fundamental frequency measures¹⁶ and disturbance of fundamental frequency^{10,16}, as well as a decrease in the disturbance measures of amplitude^{8,16}, noise¹⁶, voice break¹⁶, voice irregularity¹⁶ and trembling¹⁶, an increase of SPL, of the maximum phonation time^{9,11}, of frequency extension and of the first formant of the vowel such as /i/ and /u/ /u/¹³, and also, a reduction of SPL^{8,10}.

Studies that evaluated the voice in a auditory-perceptual way and the and self-perception after the performance of the vocal warm-up and cool-down observed a decrease in the level of tension¹² and vocal asthenia⁹, increased loudness¹⁷, modification of vocal health habits vocal^{9,12,17} and a reduction of the discomfort and negative vocal symptoms^{7,11}.

CONCLUSION

Studies show unanimity in relation to the importance of completing the vocal warm-up and cool-down for professionals of voice. The recommended time of execution for the warm-up ranged from 15 to 30

minutes or three sets of 15 repetitions in maximum phonation time with intervals of 30 seconds of passive rest between each set and the cool-down from 5 to 15 minutes. For the warm-up, the most used exercises were voiced vibrant fricative sounds of tongue and or lips, in ascendant scales and the most used ones for cool-down were nasal sounds, voiced vibrant fricative sounds of tongue and or lips, in descendant scales. The warm-up and cool-down exercises caused positive vocal changes, observed by acoustic vocal and auditory-perceptual measures, self-evaluation and aerodynamic measures related to phonation.

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