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# Alinhamento postural e qualidade vocal em cantores

## Singers' postural alignment and vocal quality

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## ABSTRACT

**Purpose:** To identify and describe changes in posture and voice quality in a group of popular singers. **Methods:** Series of cases with nine volunteers (six women and three men) with a mean age of 28.3±6.4 years. Postural assessment was performed using the SAPO software. The auditory-perceptual assessment of the voice was performed by judges using the VPAS-PB, and the acoustic analysis was carried out with the PRAAT software. **Results:** The maximum phonation times varied between 7.1 and 22.0 sec. The fundamental frequency between 104.7 and 247.7 Hz, adequate to the gender and age of the participants. The intensity, jitter and shimmer varied within the reference values, respectively, 59.8 and 68.6 dB, 0.110 and 0.306% and 0.903 to 2.673 dB. While the harmonic-noise ratio was above the reference values for both sexes, between 18.1 and 31.5 dB. The auditory-perceptual assessment of the voice defined non-neutral phonation adjustments, with nine participants presenting breathy; five, harsh; and two, creaky voices, with the presence of inadequate respiratory support. All participants showed postural changes and / or adaptations. **Conclusion:** Non-neutral adjustments to phonation were identified and described, defining alterations in vocal quality in a group of singers, in which participants also presented adaptations and / or postural alterations, which may suggest that these adjustments cooccur in the group evaluated.

**Keywords:** Voice quality; Singing; Voice; Posture; Posture balance

## RESUMO

**Objetivo:** Identificar e descrever as alterações de postura e de qualidade de voz em um grupo de cantores populares. **Métodos**: Série de casos com nove voluntários (seis mulheres e três homens) com idade média de 28,3±6,4 anos. A avaliação postural foi realizada pelo *software* SAPO. A avaliação perceptivoauditiva da voz foi realizada por juízes, utilizando o VPAS-PB, e a análise acústica com o *software* PRAAT. **Resultados:** Os tempos máximos fonatórios variaram entre 7,1 e 22,0 s. A frequência fundamental entre 104,7 e 247,7 Hz, mostrando-se adequada ao sexo e à idade dos participantes. A intensidade, o *jitter* e o *shimmer* variaram dentro dos valores de referência, respectivamente, 59,8 e 68,6 dB, 0,110 e 0,306% e 0,903 a 2,673 dB. Enquanto a proporção harmônico-ruído ficou acima dos valores referência para ambos os sexos, entre 18,1 e 31,5 dB. A avaliação perceptivoauditiva da voz definiu ajustes não neutros à fonação, com nove participantes apresentando soprosidade; cinco, aspereza, e dois, crepitação, com presença de suporte respiratório inadequado. Todos os participantes apresentaram alterações e/ou adaptações posturais. **Conclusão:** Foram identificados e descritos ajustes não neutros à fonação, definindo alterações de qualidade vocal em um grupo de cantores, no qual também se observou que os participantes apresentaram adaptações e/ou alterações posturais, o que pode sugerir que estes ajustes coocorrem no grupo avaliado.

**Palavras-chave:** Qualidade da voz; Canto; Voz; Postura; Equilíbrio postural

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## INTRODUCTION

Singing is an activity that requires training, use and adaptation of the voice mechanism and a proper postural alignment. Breathing control is greater when an adequate posture is assumed, which, in addition to allowing a better use of the resonance cavities, inhibits increased tension in the neck muscles and indirectly favors the production of a good voice [1].

Postural imbalance can occur both due to exaggerated tension and hypotonia and muscle weakness in the muscles responsible for body alignment. When the standard posture does not reach a state of balance in space, it can cause injuries or wrong adjustments to the structures related to these muscles, as they will not have support for the performance of their activity, which can cause pain and discomfort [2]. Thus, the misalignment or imbalance of the spine, especially in the cervical area, directly influences the position of the hyoid bone and indirectly influences the position of the larynx [3] and, although postural assessment is not part of the Speech-Language Pathologists' training, the study of muscle physiology is important for understanding and analyzing the complex interactions between muscles that affect the maintenance of good postural alignment [4].

The upright posture with relaxed shoulders and slightly lowered chin is the most suitable for vocal production as it provides free laryngeal movement and sound projection without blocking the vocal tract. A tense voice results from an excessive intrinsic and / or extrinsic muscle action and, in general, is accompanied by a characteristic posture, with a forward head and tension in the muscles of the cervico-scapular girdle [5]. This inadequate posture, which leaves "marks" on each individual, can cause dysfunction in the functioning of the vocal folds, interfering with breathing and the opposite relationship is also valid [6].

Reflecting on the anatomical trains, defined by Myers, and questioning about the comparison of postural and structural relationships, can result in treatment strategies that allow reversing bodily patterns of compensation, and raises the concept of "tensegrity", proposed by Fuller in 1975 [7], which suggests that traction and compression combined provide stability and strength, ensuring the overall integrity of a body, that is, it creates a resilient and stable "neutral" around which movement occurs.

Thus, the individual who have an expressive vocal demand must be considered in its entirety, so that they can really benefit from the application of vocal and body techniques as facilitating resources for their vocal production [8].

Musicians externalize a sharp concentration around an object that cannot change shape, and the tendency for the body to mold around the solid instrument is very strong in all styles of music [7]. It can be suggested that the microphone can support the body position, by extrapolating this relationship to singers, which will favor changes in posture throughout the performance. It is noteworthy that posture is dynamic and since the parts of the body undergo frequent adaptations in response to the stimuli it receives over time, the body reflects the experiences lived at each moment [7].

In singers, the association between voice and posture changes can be more expressive or manifest, given the use of the body during their performances and the request for "adaptations", which may require vocal and laryngeal adjustments to meet the vocal demand. We believe that this study can direct the attention of the Speech-Language Pathologists to the biomechanical postural alignment in search of an improvement in the vocal quality of their clients. Thus, this study assumed that postural alterations or adaptations could co-occur with vocal alterations and aimed to identify and describe alterations in posture and voice quality in a group of popular singers.

## METHODS

A case series study carried out with nine volunteer professional singers, three male (32.0±5.3 years old and 8.3±4.7 years of professional singing) and six female (26.5±6.5 years old and 11.3±10.6 years of professional singing) with a mean age of 28.3±6.4 years and mean time of professional singing of 10.3±8.8 years.

Initially, the study had 15 subjects who sought the research laboratory voluntarily. However, data from six individuals were excluded for not meeting the eligibility criteria, namely: (1) being in speech therapy for speech and / or voice alterations while participating in the study; (2) present vocal alterations of extreme degree, detected in the auditory-perceptual assessment and / or acoustic analysis and / or (3) for not having completely or legibly filled out the requested demographic data.

All participants had laryngoscopic exams performed in the six months prior to data collection, with a normal report, issued by an otolaryngologist.

Personal, professional data and information of development and use of singing voice were collected. The voices were recorded in an acoustic booth, with a unidirectional microphone with linear response, without condenser (Audio 50, Plantronics Inc., California, USA), with a sampling rate of 44,100Hz, following the sequence: sustained vowel /a/ in maximum phonation time (MPT) and a phonetically balanced phrase used in the Vocal Profile Analysis Scheme for Brazilian Portuguese (VPAS-PB) protocol: "*O objeto de estudo da fonética é essa complexa, variável e ponderosa face sonora da linguagem: a fala*" ,

The auditory-perceptual assessment (APA) of the voice was performed by three judges with extensive experience in voice assessment in clinical and research contexts, after 2-h training and calibration sessions, so that the judges were familiarized with the instrument, its completion, and had the same understanding about the parameters under evaluation.

The APA was performed using the VPAS-PB, a protocol based on the phonetic description of voice quality, in terms of "settings", which include the dimensions: phonation (basically vocal fold vibration mode), vocal tract (supralaryngeal or articulatory) and tension (laryngeal and vocal tract). All dimensions are evaluated from a neutral configuration (reference), in which the vibration of the vocal folds is balanced (adduction forces and longitudinal tension), the voice is produced without audible whispering or other noises, the supralaryngeal vocal tract cavities do not show any degrees of constriction or expansion; the total distance between the vocal cords and the lips is kept intermediate without any shortening or stretching effects, and the laryngeal and supralaryngeal tensions are moderate[9].

The judges did not receive any information regarding the age, presence of vocal complaints, changes, or disturbances in the voice of the subjects and were instructed to use headphones to hear the voices at a comfortable volume and to register the parameters they considered neutral (without deviations) in those voices. Then, listen to them as many times as deemed necessary to assess the non-neutral parameters (with deviations), quantifying them in moderate (scores 1, 2 or 3) or extreme (scores 4, 5 or 6) degrees. In addition to identifying short-term occurrences (breaks, instabilities, diplophonia and tremor).

For the acoustic analysis of the voice, the PRAAT software (version 6.1.16, https://www.fon.hum.uva.nl/praat/) was used, in which 3 to 5 second excerpts from the sustained emission of the vowel /a/ were selected, and the values of fundamental frequency (F0), jitter, shimmer, and harmonic/noise ratio (HNR) were extracted from the voice report module.

The photographs were taken following the recommendations of the SAPO software (http://pesquisa.ufabc.edu.br/bmclab/sapo/), with a plumb line attached to the ceiling, with two styrofoam balls spaced one meter apart, glued onto the wire for later image calibration. The subject was positioned in such a way that he / she and the plumb line were in the same plane perpendicular to the axis of the 13.0 megapixel digital camera (Nikon, Coolpix L820), positioned on a tripod, leveled at a height of 1.20 m, parallel to the floor, located 2.35 m away from the participant.

The photographs were taken in the anterior, posterior, and left lateral views, with the participants in a bathing suit, with bone references, for angular calculations, marked with polystyrene balls, following the SAPO protocol, at the anatomical points described in Figure 1. The marking of the anatomical points was performed by a trained Physical Education professional, with extensive experience in postural analysis, with mastery of the protocol and handling of the assessment software, which analyzed and established the relationships between postural alterations and adaptations.

Data were entered into a spreadsheet for descriptive analysis by obtaining mean, standard deviation, and frequency distribution analysis. Data were extracted in Excel.

This project was registered at the Research Ethics Committee under CAAE no. 03250818.4.0000.8093 and approved by report no. 3.058.749. All participants signed the Informed Consent Term, in compliance with Resolution no. 466/2012 of the National Health Council and its complementary documents.

## RESULTS

All participants reported having formal training for singing, developed with a singing teacher (100%), associated with a vocal coach (50.0%) or a musician (33.3%) or with vocal coaching (16.7%). Among the participants, 22.2% reported working exclusively with singing and 77.8% performed singing activities associated with other activities with high vocal demand, such as teacher, singing teacher, street music or theater.

All women, 66.7% of the sample, had already sought out professionals due to vocal alterations in the singing voice (50.0%) or in the singing and spoken voices simultaneously (50.0%). The most cited support professionals were the singing teacher and the Speech-Language Pathologist (66.7% each), followed by the otorhinolaryngologist (50.0%), and the most frequent complaint was hoarseness (66.7%).

All participants reported abuse or misuse of the voice, such as excessive use (50.0%), singing out of range (33.3%), vocal effort (16.7%) and lack of vocal warm-up (16.7%). However, 88.9% reported performing vocal warm-up and cool-down sequences with semi-occluded vocal tract exercises (nasal sounds, voiced fricatives, high-pitched blowing, *bocca chiusa*, tongue and lips thrills), vocal fry, ascending and descending vocalizes and yawns.

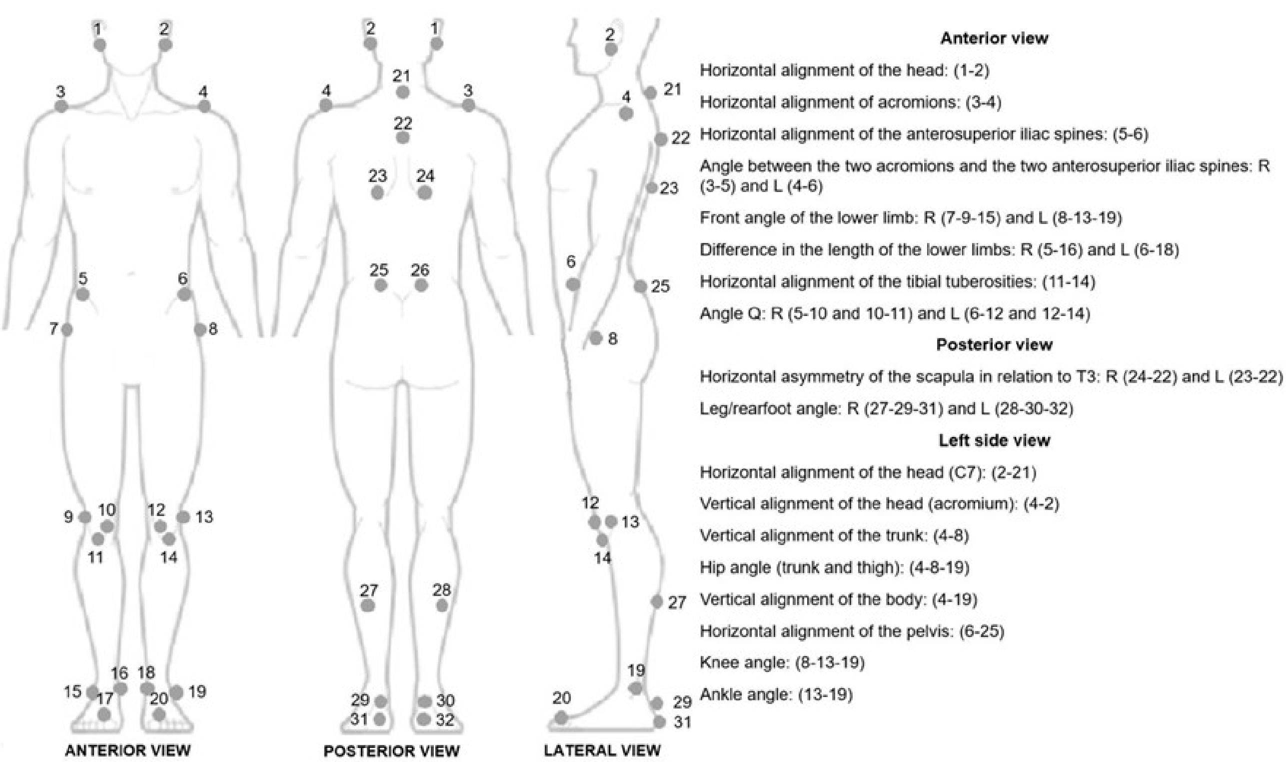


**Figure 1.** Anatomical points used for postural assessment by the SAPO software in the anterior, posterior and left lateral views.

Table 1 presents the individual values of the acoustic parameters of the voice of the participants.

Table 2 shows the APA scores of the voice of the participants in this study.

Postural assessment data suggest that there was posture deviation in all participants, since none of them fell within the reference values proposed by the analysis performed (Table 3).

**Table 1.** Acoustic analysis data of the participants of the study

| SUB | MPT (sec) | F0 (Hz) | I0 (dB) | Jitter (%) | Shimmer (dB) | HNR |
|---|---|---|---|---|---|---|
| 1 | 13.3 | 247.7 | 64.2 | 0.238 | 1.517 | 21.7 |
| 2 | 14.0 | 223.7 | 66.6 | 0.110 | 0.903 | 31.5 |
| 3 | 7.1 | 198.4 | 65.8 | 0.306 | 2.401 | 19.2 |
| 4 | 8.5 | 239.5 | 67.6 | 0.241 | 1.944 | 20.6 |
| 5 | 10.5 | 239.2 | 68.6 | 0.149 | 0.998 | 25.4 |
| 6 | 7.1 | 219.8 | 66.9 | 0.123 | 0.996 | 28.3 |
| 7 | 22.0 | 115.6 | 59.8 | 0.230 | 2.673 | 18.6 |
| 8 | 17.0 | 95.0 | 68.0 | 0.196 | 2.168 | 18.1 |
| 9 | 18.4 | 104.7 | 67.0 | 0.141 | 1.561 | 21.9 |

**Subtitle:** SUB = subject; MPT = maximum phonation time; F0 = fundamental frequency; I0 = vocal intensity; HNR = harmonic-to-noise ratio. Female, participants 1 to 6. Male, participants 7 to 9

**Table 2.** Description by the judges of the non-neutral settings of the vocal quality of the study participants, using the VPAS-PB protocol

| Settings | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| **A. VOCAL TRACT FEATURES** | | | | | | | | | |
| 1. Labial | | | | | | | | | |
| Lip rounding/protrusion | 3 | - | - | 3 | - | - | - | - | - |
| Lip spreading | - | - | 3 | - | 3 | 3 | 1 | - | - |
| Minimized range | 2 | - | - | - | - | - | - | - | - |
| Extensive range | - | - | - | 3 | - | - | - | 3 | - |
| 2. Mandibular | | | | | | | | | |
| Close jaw | - | - | 3 | - | - | 2 | - | - | - |
| Minimized range | 2 | - | 3 | - | - | - | - | - | - |
| Extensive range | - | - | - | - | - | - | - | 2 | - |
| 3. Lingual tip/blade | | | | | | | | | |
| Advanced tip/blade | - | 1 | - | - | - | 3 | - | - | - |
| Retracted tip/blade | - | - | 3 | - | - | - | 1 | - | 2 |
| 4. Lingual body | | | | | | | | | |
| Backed tongue body | 2 | - | - | - | - | - | - | - | - |
| Raised tongue body | 2 | - | 3 | 3 | 2 | - | - | - | 3 |
| Minimized range | - | - | - | - | 2 | - | - | - | - |
| 5. Pharyngeal | | | | | | | | | |
| Pharyngeal constriction | - | - | 3 | 1 | 3 | 3 | - | 2 | 1 |
| Pharyngeal expansion | - | - | - | - | - | - | - | 1 | - |
| 6. Velopharyngeal | | | | | | | | | |
| Nasal | - | 2 | 2 | 1 | 3 | 3 | - | 3 | 2 |
| 7. Larynx height | | | | | | | | | |
| Raised larynx | - | - | - | 3 | 2 | 2 | - | - | - |
| Lowered larynx | - | - | 3 | - | - | - | - | - | - |
| **B. OVERALL MUSCULAR TENSION** | | | | | | | | | |
| 8. Vocal tract tension | | | | | | | | | |
| Tense vocal tract | - | - | 3 | 2 | 3 | 3 | - | - | - |
| 9. Laryngeal tension | | | | | | | | | |
| Tense larynx | 1 | - | 3 | 3 | 3 | 3 | - | 3 | 3 |
| Lax larynx | - | 3 | - | - | - | - | - | - | - |
| **C. PHONATION FEATURES** | | | | | | | | | |
| 10. Voicing type | | | | | | | | | |
| Voice | - | N | N | N | N | N | - | - | N |
| Creak | - | - | - | - | - | - | N | - | - |
| Creaky voice | - | - | - | - | - | - | - | 3 | 3 |

**Subtitle:** N = non-neutral; P = present; i = intermittent. Male, participants 1 to 6. Male, participants 7 to 9

**Table 2.** Continued...

| Settings | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 11. Laryngeal frication | | | | | | | | | |
| Whisper | N | - | - | - | - | - | - | N | - |
| Breathy | 1 | 1 | 3 | 2 | 2 | 3 | 1 | 2 | 2 |
| 12. Laryngeal irregularity | | | | | | | | | |
| Harsh | - | - | 3 | 1 | - | 3 | 1 | - | 3 |
| Short-term occurrences | - | - | - | - | - | - | - | - | - |
| Breaks | - | - | I | - | - | - | - | - | - |
| Instability | - | - | I | i | i | i | i | - | P |
| Tremor | - | i | - | - | - | - | - | - | - |
| **D. PROSODIC FEATURES** | | | | | | | | | |
| 13. Mean pitch | | | | | | | | | |
| High | - | - | - | 3 | 3 | 3 | - | - | - |
| Minimized range | 2 | - | - | - | - | - | - | 2 | - |
| Low variability | - | 1 | - | - | - | - | - | - | - |
| 14. Mean loudness | | | | | | | | | |
| Low | - | 1 | - | - | - | - | - | - | - |
| Low variability | - | 3 | - | - | - | - | - | - | - |
| **E. TEMPORAL ORGANIZATION** | | | | | | | | | |
| 15. Tempo | | | | | | | | | |
| Interrupted continuity | - | 2 | - | - | - | - | 1 | - | - |
| Fast rate | - | - | 3 | - | 3 | - | - | - | - |
| Slow rate | - | 3 | - | - | - | - | 1 | - | - |
| **F. OTHER FEATURES** | | | | | | | | | |
| Respiratory support | 2 | 3 | 3 | - | 3 | 3 | 3 | - | 3 |

**Subtitle:** N = non-neutral; P = present; i = intermittent. Male, participants 1 to 6. Male, participants 7 to 9

**Table 3.** Description of the individual postural assessment performed by the SAPO software. All values are expressed in degrees

| Parameter | Ref | Subject | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **1. Anterior view** | | | | | | | | | | |
| **Head** | | | | | | | | | | |
| Horizontal alignment of the head | 0 | 2.6 | 1.4 | 4.6 | 6.7 | 8.1 | 1.5 | -2.9 | -2.6 | 3.3 |
| **Trunk** | | | | | | | | | | |
| Horizontal alignment of acromions | 0 | 4.8 | -0.7 | 1.5 | -0.7 | 3.9 | 0.8 | -1.8 | -0.9 | 1.8 |
| Horizontal alignment of the anterosuperior iliac spines | 0 | 0 | -0.9 | -1.5 | -3.4 | 0 | -5.1 | -1.4 | -0.9 | 3.0 |
| Angle between the two acromions and the two anterosuperior iliac spines | 0 | -4.8 | -0.3 | -3.0 | -2.7 | -3.9 | -5.9 | 0.5 | 0 | 1.2 |
| **Lower limbs** | | | | | | | | | | |
| Front angle of the lower limb | NA | -6.3 | 0.9 | -7.0 | -4.7 | -4.5 | -8.4 | -10.9 | 3.2 | -7.4 |
| Front angle of the left lower limb | NA | -3.5 | -0.5 | 4.0 | -4.5 | -3.5 | -4.8 | -14.8 | 2.0 | -9.0 |
| Difference in the length of the lower limbs (R-L) | 0 | -23.7 | 3.7 | 37.4 | 13.4 | 0.2 | 7.0 | 4.6 | 9.9 | 0.3 |
| Horizontal alignment of the tibial tuberosities | 0 | 2.3 | 3.2 | 1.0 | -1.1 | -2.8 | -2.5 | -7.1 | 1.0 | 0 |
| Right Q angle | 15 | 37.7 | 29.8 | 20.6 | 25.9 | 35.7 | 46.6 | 2.9 | 23.2 | 16.1 |
| Left Q angle | 15 | 21.7 | 17.2 | -10.3 | 17.6 | 47.5 | 33.5 | 10.5 | 12.9 | 1.2 |
| **2. Posterior view** | | | | | | | | | | |
| **Trunk** | | | | | | | | | | |
| Horizontal asymmetry of the scapula in relation to T3 | 0 | 30.8 | 42.6 | 29.9 | 18.2 | 56.3 | 5.1 | 7.3 | 35.3 | 27.6 |
| **Lower limbs** | | | | | | | | | | |
| Right leg/rearfoot angle | NA | 1.6 | 3.6 | 9.0 | 8.0 | 7.4 | 2.7 | 18.9 | 6.7 | 13.8 |
| Left leg/rearfoot angle | NA | 5.8 | 1.1 | -10.7 | 5.1 | 8.5 | 28.5 | 3.4 | 9.8 | -2.9 |

**Subtitle:** Ref = reference value; NA = not available. Female. participants 1 to 6. Male. participants 7 to 9

**Table 3.** Continued...

| Parameter | Ref | Subject | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **3. Left lateral view** | | | | | | | | | | |
| **Head** | | | | | | | | | | |
| Horizontal alignment of the head (C7) | NA | 40.3 | 38.0 | 49.4 | 46.4 | 45.0 | 50.7 | 37.9 | 56.6 | 38.9 |
| Vertical alignment of the head (acromion) | 0 | 29.2 | 9.6 | 13.8 | 15 | 19.7 | 23.1 | 24.1 | 7.4 | 20.8 |
| **Trunk** | | | | | | | | | | |
| Vertical alignment of the trunk | NA | -7.4 | 0.9 | -2.1 | -7.1 | -6 | -5.9 | -3.6 | -4.8 | 1.2 |
| Hip angle (trunk and thigh) | NA | -23.6 | 2.5 | 2.3 | -10.8 | -14.9 | -7.4 | -9.1 | -8.0 | -5.4 |
| Vertical alignment of the body | NA | 2.9 | 2.9 | 2.3 | 0.5 | 2.3 | 0.7 | 3.5 | 1.6 | 4.5 |
| Horizontal alignment of the pelvis | NA | -13.0 | -35.6 | -16.1 | -22.0 | -14.0 | -19.1 | -16.4 | -13.8 | -10.6 |
| **Lower limbs** | | | | | | | | | | |
| Knee angle | NA | -12.3 | 12 | 21.7 | 4.3 | -1.5 | 8.6 | 5.5 | 8.0 | 0.8 |
| Ankle angle | NA | 86.1 | 79.6 | 72.7 | 82.0 | 82.6 | 79.9 | 79.0 | 78.8 | 82.6 |
| **4. Gravity center** | | | | | | | | | | |
| Frontal plane asymmetry (%) | - | 25.8 | 0.7 | 10.2 | 8.4 | 0.9 | 4.9 | -17.3 | -4.5 | 9.1 |
| Sagittal plane asymmetry (%) | - | 62.8 | 41.5 | 49.2 | 37.3 | 56.5 | 39.6 | 59.6 | 43.0 | 50.5 |
| GC projection position relative to the middle position of the malleolus (frontal plane) (cm) | - | 25.8 | -0.6 | 12.8 | -8.7 | 0.8 | 4.6 | -23.7 | -5.9 | 12.6 |
| GC projection position relative to the middle position of the malleoli (lateral plane) (cm) | - | 75.3 | 52.7 | 57.5 | 44.7 | 60.5 | 44.8 | 85.2 | 57.2 | 72.7 |

**Subtitle:** Ref = reference value; NA = not available. Female. participants 1 to 6. Male. participants 7 to 9

## DISCUSSION

In this study, the effective participation of a small group of singers, six women and three men, whose vocal potential is recognized and valued socially and whose careers are consolidated locally was achieved.

It was found, through the APA of the voice, that all the participants presented some non-neutral setting of the vocal tract. All participants had breathy vocal quality, five of them, harsh and, two, creaky voice, with inadequate respiratory support. These findings may suggest that the vocal alterations observed in the group result from inadequate vocal adjustments and not necessarily from laryngeal alterations, which may justify the fact that experienced singers do not report or perceive alterations in vocal quality.

Inadequate respiratory support can lead to an antagonism between subglottic pressure and glottic resistance. Changes in vocal fold vibration can be caused by the presence of structural lesions, by the existence of laryngeal muscle hypertonia or by a deficiency in glottic coaptation [(10)]. Breathy and tension are vocal qualities in which there is great activity of the suprahyoid muscles, which can elevate the larynx and cause this sound to be produced at a higher frequency, with a reduced projection and effort in the laryngopharyngeal region [(11)] and may be associated with changes in head and neck posture, as observed in the studied group, whose APA data suggest that there is a hyperfunction of the vocal tract, with the presence of moderate laryngeal tension [(3)]. Besides, deviations in loudness, pitch, laryngeal signs and symptoms can be observed, such as vocal fatigue and aphonia, which can be a way for the body to demonstrate that there is an alteration in a certain segment, generating compensation and overloads in its functionality [(12)].

As the pitch changes from low to high, the cervical spine changes its curvature from lordosis to kyphosis, shortening the airway and elevating the larynx, epiglottis, and soft palate in relation to the cervical spine; the distance between the sternum and the larynx becomes greater and the distance between the hyoid and the larynx decreases. Thus, posture can have a direct effect on vocal effort, even if there is no vocal load. Even subtle changes in head positioning and balance can have a significant impact on laryngeal movement and its efficiency. Open mouth posture, for example, is generally related to effective changes in vocal behavior, including increased F0, clearer voice and better phonation stability [(13)]. In this study, most participants had hyperkyphosis with forward head position, associated with scoliosis in five of them, and pectoral retraction in three, which the literature refers to as common among singers and speakers, associated with shoulder protrusion and cervical spine extension [(5)].

The intrinsic muscles of the larynx are responsible for the movement of the arytenoid cartilages, and, therefore, for the adduction, abduction, and tension of the vocal folds. The extrinsic musculature, on the other hand, keeps the larynx in a natural and stable position, allowing the intrinsic musculature to contract freely and without disturbances [(3,13)]. In the adequate alignment of the thoracic and cervical spine, the sternocleidomastoid and scalene muscles have their activity diminished, stabilizing the cervical, and, consequently, allowing the basis for cervical and laryngeal mobility [(14)].

The way the individual breathes also influences both posture and voice. Incoordination of breathing or oral breathing pattern at rest can lead to changes in body posture, which, in turn, affect the positioning of the larynx. In costal breathing, for example, there is greater activity of the sternocleidomastoid muscle. And the more present the hypertonicity of the musculature and the inadequate body posture, or even the combination of both, the greater the complaints about vocal disadvantages. Asymmetrical cervical or scapular tension can lead to an increase in cervical lordosis and impact on the phonatory process [15].

The act of singing requires coordination between the respiratory and phonatory systems. Regularly exhaling favors the singer's ability to sustain the pitch. During a sustaining of the musical note, many of the characteristics of the voice and its limitations in performing/using the techniques are noticeable. The lack of precise support of the musical note at the end of a stanza portrays a feeling of fatigue and reduced vocal control, which can compromise the communicative intention of the music and the emergence of emotions that this would cause in the listener. Thus, the MPT is a way to identify how the larynx behaves in face of the aerodynamic force produced during the air passage from the lungs, with the emission time being directly proportional to the individual's ability to control the outflow of expired air [16].

The visual assessment that provides a basic "body reading" performed by different professionals can be enriched by the internalization of the concept of "tensegrity", as therapists seek biomechanical alignment and other forms of movement efficiency, as well as "kinesthetic literacy" and psychosomatic relief. Starting from this concept, as well as its distributive properties, accommodating local tension or trauma by dispersion through small adjustments throughout the entire system, as dysfunctional patterns are resolved, it comes closer to a balance, bringing efficiency and desired relief [7].

The balance between the support structures should involve a minimum amount of effort and overload, with maximum body efficiency, seeking its coordination for the individual's ideal posture, whether in movement or at rest. For balance, therefore, it is important to maintain the biomechanical alignment, that is, the balance between the scapular and pelvic girdles, in order to obtain a better overall body position due to the relationship between body tonus and the force of gravity; head position in harmony with the temporomandibular joint and pelvic girdle; adequate distribution of weight on both sides of the body; projection of the entire body weight on the ground, reflecting on the center of the feet, vision, proprioception and vestibular system [17–19].

To achieve balance, both dynamic and static structures responsible for postural balance must be considered. Muscles provide dynamic forces opposing extension and flexion movements caused by joint gravitational torque and require an intact nervous system to provide sensorimotor feedback. Bone structures and ligaments provide passive joint tension and weight-bearing support in the upright posture. In balance, the line of gravity passes near to or through the axes of rotation of the joints and the compressive forces are optimally distributed over the weight-bearing surfaces [17–19].

The adequacy of the postural alignment favors, then, the improvement in the alignment of the head in people who present clinical conditions such as exacerbated tension in the trapezius (upper fibers), temporal and masseter muscles, temporomandibular dysfunction, and postural deviations. This demonstrates that postural deviations generate tension on muscle chains and, therefore, on masticatory and neck muscles, which can interfere with laryngeal functions [12].

Inadequate head position changes the craniofacial and craniomandibular biomechanical relationships and is influenced by the individual's growth and body posture [7,20].

Combining the postural study with the vocal analysis was a great challenge for the group, given the knowledge of postural patterns, but the lack of knowledge of how to analyze them without the influence of a merely visual "body reading". The interaction with the Physical Education professional and the identification of the possibility of using biophotogrammetry, whose reliability was recognized, added the possibility of an objective assessment of postural deviations and asymmetries, since its record highlights the interrelationships between body parts and the slightest postural changes, whose measurement is difficult to assess [21].

It should be considered that the perception that many people have of their postural deviations is almost always limited, as changes in the posture of the head, neck, shoulders, abdomen, and hips are sometimes integrated into the movement system adopted by the individual who become habitual and taken as part of their physical constitution [22]. So, it is possible to evaluate and suggest the relationship between posture and extrinsic muscles of the larynx, establishing that in the upright posture the production of vocal sound is improved [5,13].

The evaluation and / or graphic visualization of the voice allows obtaining specific sound parameters, important in aiding and understanding the phonation mechanism, in addition to allowing the inference of the mechanisms present in different voice disorders [23], and as already discussed, good posture plays a fundamental role in adequate voice quality [3], to the same extent that an incorrect posture can cause pain and change in the function of different systems, it could be related to the tensegrity of the body, when it describes a principle of structural relationship in which the shape of the structure is guaranteed by tensional behaviors, that is, if any of the tensegrity elements break, this dynamic balance is disturbed and the structure will change shape and reach or seek another point of balance [7].

An example of this is the protrusion of the head, which can generate dysfunction of the anterior neck muscles, such as the sternocleidomastoid, the supra- and infra-hyoid and the scalene, which, therefore, causes changes in the functionality of the extrinsic laryngeal muscles. and it brings about inadaptations and variations in vocal production [21]. It can be considered that these postural patterns may be associated with excessive lordosis or kyphosis, generating a compensation or muscular adaptation in the larynx and neck, which may be reflected as one of the causes of problems with pitch control in singers [15].

The shortening of the muscles of the pectoral region and the adaptive shortening of the muscles of the abdomen, when the individual assumes a thoracic kyphotic posture, prevents the middle trapezius and rhomboid muscles from correctly repositioning the shoulders, compromising their alignment [4].

Exacerbated tension in the cervical muscles interferes with body balance, as it affects the position of the vestibular system and the muscles responsible for regulating eye movement, generating less range of neck movements and forward head movement, leaving the infrahyoid musculature more tense and pulling the mandible posteriorly [12]. During cervical extension, the anterior musculature of the neck stretches while the trapezius and the jaw elevator muscles (suboccipital musculature) shorten. Thus, when this posture is assumed, the anterior muscles weaken, while the suboccipital group shortens, which can cause a change in the shape of the larynx, especially its narrowing, intensifying the adduction of the vocal folds and modifying the voice resonance [24].

Thus, it is essential to create postural awareness, through self-knowledge of the body and posture, according to individual biomechanical possibilities. Exercises such as general relaxation, breathing regulation, joint movement, awareness of aligned balance, contact and sensation perceptions are recommended [2].

Although this is an initial exploratory research on the possibilities of co-occurrence of postural changes or adaptations with the assessed vocal quality, it was observed that in all cases analyzed there was the presence of postural and vocal parameters changes, which showed that the voice is a product of the whole body and even singing professionals, attentive to the quality of their voices, do not perceive or do not value the impacts and disadvantages arising, most likely, from the adoption of adapted or compensatory postures or positions.

The awareness of these voice professionals, especially those who move, dance, and need strong intensities during their performances, will bring numerous benefits and a significant impact, providing a clear and free voice that achieves the goal, which is to thrill and be perceived by the audience.

## CONCLUSION

Changes in posture and voice quality in a group of popular singers were identified and described. All participants presented adaptations and / or postural alterations, non-neutral adjustments to phonation and variation in acoustic and auditory-perceptual parameters, suggesting that vocal and postural alterations co-occur in these individuals.

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