Associations between Posture, Voice, and Dysphonia: A Systematic Review

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Summary: Objective. The study aimed to systematize the associations between posture, voice, and dysphonia in order to support future research directions and possible clinical interventions.

Study Design. The study is a systematic review.

Methods. According to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses flowchart, a search on PubMed/Medline, SciELO, RCAAP, LILACS, Cochrane Library, PEDro, and Isi Web of Knowledge was performed from their inception through January of 2017 using the key words “posture” and (“voice” or “dysphonia”). The inclusion criteria were full-text journal articles in French, English, Portuguese, or Spanish, exploring the relationship between posture and voice or dysphonia, in adult human beings. The exclusion criteria coupled treatments for voice disorders, literature reviews and meta-analyses, case studies, opinion articles, and studies linking breathing with posture without assessing voice. Studies were analyzed using a modified version of the Newcastle–Ottawa Scale (NOS).

Results. Twelve papers met the inclusion criteria with high methodological quality through the NOS. The review shows that a correct posture is necessary for an efficient voice production; however, the relation between dysphonia and posture seems to be contradictory.

Conclusion. An effective posture allows a subject in a static posture or while moving to more easily shift the tension between muscles, allowing for a free movement of the larynx without blockages and with benefits to voice production.

Key Words: Voice–Voice disorders–Dysphonia–Posture–Systematic review.

INTRODUCTION

The voice is one of the most important components of communication between human beings. Through it, humans are able to convey their intentions, revealing itself crucial in the interpersonal communication process.[1] Any change in voice characteristics may affect the person’s quality of life.[2,3]

Dysphonia is characterized by any difficulty or change in voice production that prevents its natural emission, conditioning oral communication,[4] normally promoting changes in vocal parameters that result in modifications in sound quality, timbre, pitch, or intensity.[5] A gradual increase in the diagnosis of dysphonia was observed from 1.3% to 1.7% of the population from 2008 to 2012, with an associated increase in the diagnosis of acute laryngitis, the largest diagnostic category. A strong correlation has been demonstrated between the diagnosis of acute laryngitis and age, being more common in the younger populations and associated with malignancies in older ages.[6] This fact may change postural reflexes and awareness of postural use because this may increase muscular tension and promote the anteriorization of the head, which may change overall posture. In the study of Golub et al,[7] the prevalence of dysphonia in older people was 20%, with a large proportion having significantly impaired quality of life related to their dysphonia. Prevalence rates of the diagnosis of dysphonia are increasing and are associated with large health-care costs.[6]

Craniocervical positional changes have been reported to influence voice production.[8] Therefore, posture has been understood as an important component of voice quality, especially from studies of functional dysphonia and more precisely with the introduction of the classification of the vocal abuse/misuse syndrome also referred to as the Bogart-Bacall syndrome and muscle tension dysphonia.[9]

A good posture is considered an optimum alignment of the body, with minimal energy requirements from the neuromuscular system without causing excessive strain on the various tissues.[10,11] The effect of a change in one joint can have consequences anywhere along the kinetic chain. These changes can manifest in gait, joint load, neural function, endurance, strength, balance, muscle coordination, respiratory function, and ultimately the voice.[10,12]

Among the specific activities in which posture is associated with, voice production must be considered. In particular, Hoit et al[13] found that during speech production in a standing posture, the oblique abdominal muscles of the lateral region of the abdomen are actively contracted. The activity of abdomen and chest muscles seems to impair the postural control because the active contraction of these muscles may induce the loss of postural balance or provide a less effective postural strategy during voice production as a result of a modification of the body proprioceptive scheme in patients with voice disorders or even in healthy subjects.[14,15]

The postural imbalances in the neck and head structure promotes changes in the soft tissue of the pharynx and in the muscles that elevate the larynx, which impairs control and resonance of the voice.[12]

This systematic review aims to systematize the association between posture, voice, and dysphonia in order to understand future research directions and possible clinical interventions.

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METHODS

The systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).[16]

A computerized search was undertaken by two independent reviewers on the databases PubMed/Medline, SciELO, RCAAP, LILACS, Cochrane Library, PEDro, and Isi Web of Knowledge in order to identify studies that evaluated the relation between posture, voice, and dysphonia. The search was made according to the PRISMA flowchart and the following key words combination was used: "posture" and ("voice" or "dysphonia"). The databases were searched from their inception through January of 2017.

Studies were included if (1) they were published as full-text journal articles in French, English, Portuguese, or Spanish; (2) they explored the relationship between posture and voice or dysphonia; (3) they were in humans; and (4) their samples comprised only human adults (18 years and older).

Studies were excluded if (1) they focused on coupled treatments for voice disorders; (2) they linked breath with posture without assessing voice; (3) they were literature reviews and meta-analyses; (4) they were case studies; or (5) they were opinion articles.

Data extraction

Two independent reviewers conducted the data extraction. The characteristics of the collected studies included the authors; year of publication; sample size, age, and gender; study design; outcome measures; methods; and results/conclusions.

Methodological quality

The methodological quality of each study included in this review was assessed by two independent reviewers using a modified version of the Newcastle–Ottawa Scale (NOS) for quality assessment of cross-sectional studies (Table 1).[17] In a "star rating system," each included study was judged in the following areas: sample representativeness, sample size, nonrespondents, ascertainment of the exposure, comparability of results, outcome assessment, and statistical methods. Studies' quality was rated on a scale from 0 (high risk of bias) to 10 (low risk of bias). A maximum score of 10 points was given for the study that fulfilled all quality criteria.[17] In this review, studies with five or more points were considered high quality. This categorization was previously used in other systematic reviews.[18,19] The reviewers solved any rating discrepancies through verbal discussion. A consensus was reached regarding all studies during the first meeting.

RESULTS

Studies' selection

The literature search identified 1,334 records. After removing the duplicates, 1,319 records were screened for content through the title and the abstract by two independent reviewers. From these, 1,302 were excluded. The full text of 17 articles was then assessed by the same reviewers for eligibility, and five articles were excluded. In total, 12 articles were included in the systematic review. The reasons for the exclusions are listed on the PRISMA flowchart (Figure 1).

Studies' description

The total number of subjects included in the 12 articles was 501, with a minimum sample size of 10 and a maximum size of 100. The studies included 163 male and 338 female participants. The age of the participants ranged from 18 to 93 years old. Most of the participants included in the 12 articles were heathy, being present in 10 articles.[20–29] However, dysphonic subjects,[20,22,27] teachers,[30] and singers[29,31] were also included. The summary of the articles' content is presented in Table 2.

All studies were cross-sectional studies. The studies were heterogeneous in relation to the outcome measures used, with a wide variety of instruments being applied. The outcome measures most frequently used for posture were photogrammetry[20–22] and magnetic resonance imaging.[28,29,31] The outcome measure most frequently applied for voice assessment was a perceptual speech analysis,[21,22,26,27,30] followed by acoustic analysis.[21,22] In addition to these, other measurements were used for assessment, such as electroglottography,[25] cervical mobility tests,[27] the craniocervical dysfunction index,[20] soft tissue palpation,[27] nasoendoscopy,[22] visual analog scale,[23,30] audiovisual recordings,[30] x-ray,[27] and postural assessment.[27]

Some studies had two groups: a group of healthy subjects was compared with a dysphonic group.[20,22,27] The majority of studies had only one group.[21,23–26,28–31]

The professional backgrounds of the examiners mentioned were speech therapy,[21,27,30] physiotherapy,[27,30] orthopedics,[27] and otolaryngology.[27]

Studies' quality

The mean modified NOS score for the studies included in the review was 9.16 points (range: 8–10 points). Quality criteria for methodological assessment are shown in Table 3. According to the quality criteria set, all the studies included in this review were considered high quality.

The major bias of these cross-sectional studies was the risk of bias in the sample selection. No study mentioned blinding of the examiners.

DISCUSSION

This systematic review provides an overview of the published evidence concerning the association between posture, voice, and dysphonia. In an extensive search, only 12 cross-sectional studies met the inclusion criteria.

Dysphonia is characterized by the change of vocal parameters that result in modifications in sound quality, timbre, pitch, or intensity.[5,31] Craniocervical changes have been reported in association with impairments in voice production.[8] Mitchinson and Yoffey[32] observed that the change from humming a low note to a high note was accompanied by increased anteroposterior thickness of the prevertebral soft tissues. Some studies included in this review[28,29,31] also related craniocervical changes with voice production. Miller et al[29] found that as the humming pitch changes from low to high, the cervical spine moves from lordosis toward kyphosis, the airway becomes shorter, vocal structures (larynx,

TABLE 1.
Modified Version of the NOS for Quality Assessment of Cross-Sectional Studies

Selection				Comparability	Outcome	
Representativeness of the sample	Sample size	Ascertainment of exposure	Nonrespondents	The subjects in different outcome groups are comparable, based on the study design or analysis. Confounding factors are controlled.	Assessment of outcome	Was the follow-up long enough for outcomes to occur?
a) Truly representative of the average in the target population* (all subjects or random sampling). b) Somewhat representative of the average in the target population* (nonrandom sampling). c) Selected group of users. d) No description of the sampling strategy.	a) Justified and satisfactory.* b) Not justified.	a) Validated measurement tool. ** b) Nonvalidated measurement tool, but the tool is available or described. * c) No description of the measurement tool.	a) Comparability between respondents' and nonrespondents' characteristics is established, and the response rate is satisfactory.* b) The response rate is unsatisfactory, or the comparability between respondents and nonrespondents is unsatisfactory. c) No description of the response rate or the characteristics of the responders and the nonresponders.	a) The study controls for the most important factor.* b) The study control for any additional factor.*	a) Independent blind assessment.* b) Record linkage.** c) Self report. d) No description.	a) The statistical test used to analyze the data is clearly described and appropriate, and the measurement of the association is presented, including confidence intervals and the probability level (p value).* b) The statistical test is not appropriate, not described, or incomplete.

The article can be scored with 1 star (*) or 2 stars (**), depending on whether it meets the requirements.

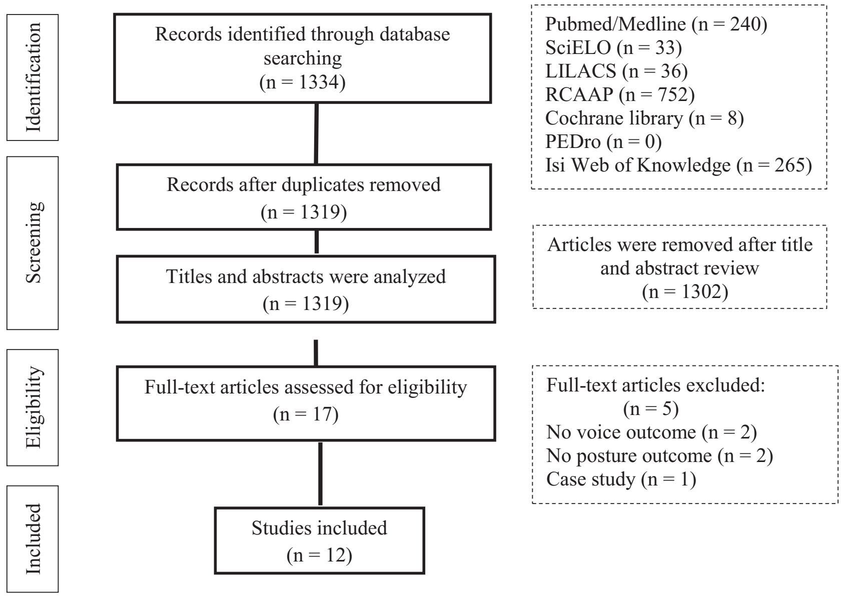

FIGURE 1. PRISMA flow diagram showing selection of article review.

hyoid, epiglottis, and velum) rise together in relation to the cervical spine, the distance between the sternum and larynx increases, and the distance between the larynx and hyoid decreases. Johnson and Skinner[31] identified postural changes in the craniocervical region associated with the demands of voice production in professional opera students where the angles measuring the positional change of the atlas and C4 relative to the true horizontal were shown to be significantly related to an increased pharyngeal airway space at the C3 level. Miller et al[28] showed that the switch from humming a low note to a high note is accompanied by significant changes not only affecting the vocal tract and related structures but also extending to other regions of the head and neck. This investigation reported pitch-related changes involving the craniocervical angles in a nonphonetic context, a view supported by reports of pitch-related involvement of the neck muscles during phonation.[33,34] An explanation for this finding might be the recognizing of the common nerve root origin of the nerves supplying postural neck and hyoid muscles.[35]

The presence of synergy between cervical and strap muscles has important clinical implications because muscle tension dysphonia, for example, is characterized by excessive tension in extrinsic or (para)laryngeal musculature,[9] and the increased tension of the extrinsic muscles leads to the elevation of the larynx in the neck, with the constant participation of the extrinsic muscles on phonation.[9,27] A study[36] showed a statistically significant difference between genders related to the vertical larynx position in the neck, because the women presented a higher larynx position than men. This vertical larynx position has significant acoustic and physiological implications,[36] as a higher larynx position is a characteristic often found in hyperfunctional dysphonia.[37,38]

Some other studies reinforce the relation between body posture and larynx extrinsic muscles,[20–23,25,26] mostly assessed by photogrammetry.[20–22] A case study, not included in this review, that used photogrammetry found a relationship between posture and voice quality, where a computerized photogrammetry stated that the best way to produce the sound was in a straight posture.[39] In another study, Carneiro[21] verified that in a forward head, backward head, and cervical extension positions, the voice becomes more acute, with more tension and worse quality when compared with a straight/neutral position. Additionally, Carneiro[21] found that in a backward head position and cervical extension, an increased loudness can be observed.

Gilman and Johns[23] found that posture can have a strong effect on vocal effort, even in the absence of vocal loading. The authors concluded that posture, even subtle shifts in the position of the head or balance, can have a significant impact on the efficiency of laryngeal movement.

However, Franco et al[22] found significant differences in some sagittal spine posture measures between normal and dysphonic speakers because for thoracic length curvature, and for the kyphosis index, a significant effect of dysphonia was observed, with the mean thoracic length curvature and the kyphosis index significantly higher for the dysphonic speakers than for the normal speakers. Authors concluded that postural measures can add useful information to voice assessment protocols and should be taken into account when considering particular treatment strategies. Another investigation that studied the relation of posture and dysphonia was that of Bigaton et al,[20] where there were no differences between the evaluated groups regarding head position. However, dysphonic women presented a more severe craniocervical dysfunction than the control group. In the study of Menoncin et al,[27] the authors found that the cervical x-ray in the nondysphonic group was normal, while the dysphonic participants showed that a reduction in interdiscal spaces prevailed. In this study, most of the dysphonic participants showed a significant dysphonia in the auditory-perceptual assessment and a muscle shortening in the cervical region; however, the diagnosis by videolaryngostroboscopy showed no lesion on the vocal folds. The authors also inferred that significant cervical abnormalities were found in both groups and that it could not be inferred that the changes were directly associated with dysphonia.

TABLE 2.
Studies' Description

Author(s), Year	Sample Size	Study Design	Outcome Measures	Methods	Results/Conclusions
Troni et al, 2006[30]	21 teachers (range: 22–62 years old) 0 M and 21 F	CSS	MPT; audiovisual recordings to speech and posture; perceptual-visual evaluation (spontaneous speech).	After vocal assessment, audiovisual recordings were performed to measure the speech articulation patterns and posture of teachers in two different situations: professional context (classroom) and outside the professional context (maintained dialogue with one of the researchers, who asked the teachers to talk about their "life in teaching").	Female teachers showed differences in speech articulation patterns and posture when they were compared in a dynamic professional situation and in a nonprofessional context.
Johnson and Skinner, 2009[31]	18 professional opera students (mean age F: 20.86 ± 3.07 years; M 18.66 ± 1.36 years), 6 M and 12 F	CSS	Roentgen-cephalograms.	Two registrations for each participant were carried out via Roentgen-cephalograms using a Wehmer cephalostat with the participant in standing in the SUP and the head fixed by ear rods: 1) participant in the SUP at the end of quiet expiration; 2) participant in the SUP while singing the /a/ vowel and holding the /a/ pitch.	Of the craniocervical postural variables in the singing registration, the angles measuring positional change of the atlas and C4 relative to the true horizontal were shown to be significantly related to an increased pharyngeal airway space at the C3 level ($P < 0.01$).
Lagier et al, 2010[24]	20 healthy subjects (range: 20–43 years old), 0 M and 20 F	CSS	Voice data collection: SPL; F0; closed quotient; coefficient of variation of F0; duration of the words. Kinematic data collection and postural analysis: kinematic curves focused on the positions of the head, the trunk, and the thighs in the sagittal plane (movement amplitude; movement duration).	Participants had to communicate with a listener under three conditions requiring different levels of vocal effort: WVEC, MVEC, and HVEC.	The close correlation of posture with vocal production shows that movement is not a mere consequence of vocal effort. Posture and voice are coordinated in communication behavior, and each body segment plays its specific role in the vocal effort behavior.

(*Continued*)

TABLE 2.
(continued)

Author(s), Year	Sample Size	Study Design	Outcome Measures	Methods	Results/Conclusions
Bigaton et al, 2010[20]	28 healthy and dysphonic women (31.25 ± 8.14 years old), 0 M and 28 F	CSS	CDI and photogrammetry, determining the anterior angle formed between the seventh cervical vertebra and the tragus, which corresponds to the head position in the sagittal plane.	Two groups: experimental (N = 16, patients with dysphonia) and control (N = 12, clinically normal)	There was no difference between the evaluated groups regarding head position ($P = 0.2565$). Dysphonic women presented more severe craniocervical dysfunction than the group control, which suggests that the dysphonia is more related to the functional alterations of the cervical region than to the postural ones of the same region.
Menocin et al, 2010[27]	50 healthy and dysphonic subjects (range: 25–55 years old), 0 M and 50 F	CSS	Cervical mobility tests; soft tissue palpation; x-ray; postural assessment; auditory-perceptual measurement (spontaneous speech; GRBAS).	Two groups: experimental (N = 32, patients with dysphonia) and control (N = 18, clinically normal).	Significant cervical abnormalities were found in both groups; it cannot be inferred that the changes are directly related to dysphonia.
Miller et al, 2012[28]	10 healthy subjects (range: 20–47 years old), 5 M and 5 F	CSS	Magnetic resonance imaging: midsagittal magnetic resonance image; craniocervical and angular variables; craniocaudal variables; anteroposterior variables.	Each individual was scanned three times: at rest during quiet breathing and while performing first an LNH and then an HNH. Participants were asked to establish the lowest and highest notes they could comfortably sustain while humming over 20 s. Twenty-two craniocervical, angular, and linear dimensions defined on these images were compared.	Significant differences between low- and high-note conditions in 6 of the 22 measures and widespread pitch-related correlations between variables ($r \geq 0.63$, $P < 0.05$) were found. Compared with low-note humming, high-note humming was accompanied by increased craniocervical angles opt/nsl and cvt/nsl ($P = 0.008$ and 0.002, respectively), a widening of the C3-menton distance ($P = 0.003$), a rise of the larynx and hyoid in relation to the cranial base ($P = 0.012$ and <0.001, respectively), and an increased sternum-hyoid distance ($P < 0.001$).

(*Continued*)

TABLE 2.
(continued)

Author(s), Year	Sample Size	Study Design	Outcome Measures	Methods	Results/Conclusions
Carneiro, 2013[21]	100 healthy subjects (mean age: F = 24, 72 years old; M = 23, 46 years old), 50 M and 50 F	CSS	Acoustic analysis; perceptual speech; photogrammetry angles: condyle-acromion (ACA), menton-sternum (AME), and Frankfurt (AF).	Participants were photographed sited in lateral view in a straight spine alignment simultaneously to the recording process of the sustained vowel /a/ by the program sound forge 7.0 in four different cervical postures: P1) straight alignment; P2) forward head position; P3) backward head position; P4) cervical extension.	In the P2, P3, and P4 positions the voice became more acute, with more tension and worse quality, when compared with the P1 position, and also in P3 and P4 increased loudness was observed.
Franco et al, 2014[22]	74 healthy and dysphonic subjects (range: 20–50 years old), 35 M and 39 F	CSS	Sagittal plane photographs TL, KI, and LL. The KI was calculated as a ratio of the thoracic width and the TL; acoustic analysis; perceptual speech; nasoendoscopy. normal and dysphonic speakers.	Two groups: experimental (N = 33, participants with dysphonia) and control (N = 41, clinically normal). A sagittal photograph was taken, with the participants in an upright standing position. Ten photographs were "rerated" three times, and the mean value obtained was then used. Laryngeal inspection was made by the ear, nose, and throat surgeon after a nasoendoscopic examination. The reference values of perceptive measures (grade component of the GRBAS scale) and acoustic measures (F0, jitter, intensity, shimmer, and harmonic-to-noise ratio) were used to decide the diagnosis.	Findings indicated significant differences in some sagittal spine posture measures between normal and dysphonic speakers. Postural measures can add useful information to voice assessment protocols and should be taken into account when considering particular treatment strategies.

(*Continued*)

TABLE 2.
(continued)

Author(s), Year	Sample Size	Study Design	Outcome Measures	Methods	Results/Conclusions
Miller et al, 2014[29]	10 healthy subjects (range: 20–47 years old), 5 M and 5 F	CSS	Midsagittal magnetic resonance	Six midsagittal magnetic resonance images (at rest, while breathing out, and while listening to, and humming low and high notes) were obtained. Eighty landmark points were chosen to define the shape of interest, and an ASM was built using these (60) images.	As the humming pitch changes from low to high, the cervical spine moves from lordosis toward kyphosis, the airway becomes shorter, vocal structures (larynx, hyoid, epiglottis, and velum) rise together in relation to the cervical spine, the distance between the sternum and the larynx increases, and the distance between the larynx and the hyoid decreases.
Mautner, 2015a[25]	85 healthy subjects (range: 38–93 years old), 29 M and 56 F	CSS	Acoustic measures; electroglottographic measures	Participants were instructed to sustain the vowel /a/ at a constant comfortable intensity level for approximately 3 s in three different pitch levels: normal, low, and high. To calculate a quadrilateral vowel space area (VSA), participants were asked to repeat the sentence "We saw two cars" containing the corner vowels /i/, /ɔ/, /u/, and /a/.	An open-jaw posture was generally associated with positive changes in vocal behaviors, including higher F0, improved phonatory stability, and voice clarity.
Mautner 2015b[26]	40 normal-hearing listeners (range: 18–47 years old), 20 M and 20 F	CSS	Auditory-perceptual measurement	Participants performed two separate tasks: identifying vowels and comparing vowel clarity. Stimuli included vowels segmented from a sentence ("We saw two cars") produced using a normal and an open-jaw posture by 40 individuals aged between 30 and 80 y. Three types of stimuli were presented: variable length and intensity, fixed length and variable intensity, and fixed length and normalized intensity.	The open-jaw posture resulted in higher rates of correct vowel identification, and vowels from contrast pairs were consistently judged as being "clearer" than vowels produced in the normal-jaw posture.

(*Continued*)

TABLE 2.
(continued)

Author(s), Year	Sample Size	Study Design	Outcome Measures	Methods	Results/Conclusions
Gilman and Johns (2016)[23]	45 healthy subjects (27, 5 years old), 13 M and 33 F	CSS	VAS (0–40 least effort, 40–60 habitual effort, and 60–100 increased effort).	Participants sustained the vowel /a/ at a comfortable pitch and loudness for 5–10 s in each of six positions: sitting and standing in the manner habitual for each subject, two exaggerated positions of the head (head back and head forward), and two exaggerated positions in standing (standing with knees locked and with knees soft). Each position was repeated three times in randomized order, resulting in 18 trials for each subject. After each repetition of the sustained /a/, subjects were asked to rate their experience of vocal effort using a VAS.	The exaggerated forward and back head positions in both sitting and standing positions showed the greatest significance on the Tukey *post hoc* tests ($P < 0.000$). Posture may play a more important role in vocal fatigue than previously thought.

Abbreviations: CDI, Craniocervical Dysfunction Index; CSS, cross-sectional study; F, female; F0, fundamental frequency; GRBAS, grade, roughness, breathiness, asthenia, and strain scale; HNH, high-note hum; HVEC, high vocal effort condition; KI, kyphosis index; LL, lumbar length curvature; LNH, low-note hum; M, male; MPT, maximum phonation time; MVEC, moderate vocal effort condition; SUP, standardized upright posture; TL, thoracic length curvature; VAS, Visual Analog Scale; VCOP rms, velocity of variation of the center of pressure; WVEC, weak vocal effort condition.

TABLE 3.
Methodological Quality by a Modified Version of the NOS for the Included Studies

	Selection				Comparability	Outcome		
References	1	2	3	4	1	1	2	Total
Troni et al, 2006[30]	B	B	A	B	A/B	B	A	8
Johnson and Skinner, 2009[31]	B	B	A	B	A/B	B	A	8
Lagier et al, 2010[24]	B	B	A	A	A/B	B	A	9
Bigaton et al, 2010[20]	B	B	A	A	A/B	B	A	9
Menocin et al, 2010[27]	B	A	A	A	A/B	B	A	10
Miller et al, 2012[28]	C	B	A	A	A/B	B	A	8
Carneiro, 2013[21]	B	A	A	A	A/B	B	A	10
Franco et al, 2014[22]	B	A	A	A	A/B	B	A	10
Miller et al, 2014[29]	C	B	A	A	A/B	B	A	8
Mautner, 2015a[25]	B	A	A	A	A/B	B	A	10
Mautner 2015b[26]	B	A	A	A	A/B	B	A	10
Gilman and Johns, 2016[23]	B	A	A	A	A/B	B	A	10

Another author included in this review that reported associations between posture and voice production was Mautner,[25] who found that an open-jaw posture was generally associated with positive changes in vocal behaviors, including higher F0, improved phonatory stability, and voice clarity.

In another research, Troni et al[30] found that female teachers showed differences in speech articulation patterns and posture when they were compared in a dynamic professional situation and in a nonprofessional context. The authors found that teachers in the professional context adopted a more rigid and tense posture, increasing their vocal effort and slowing down their voice. The data led to the consideration that increasing the vertical range of mandibular movement, associated with postural changes and tension, especially in the cervical area, can lead to the appearance or worsening of a voice disorder.

All subjects can be taught what an ideal posture is. However, anatomical considerations and different body types can result in different compensations that can lead an individual away from a perfect posture, which should be a result of a correct body alignment, where an imaginary line goes through the external acoustic meatus, articular line of the shoulder, great trocanter, knee, and ankle. A good posture should reflect the alignment of the different body segments in space with minimum energy requirements and tension on the musculoskeletal system and is considered by some authors to be something dynamic.[10,11]

A good posture is necessary because it can help harmonize muscle tension, which itself can cause postural changes. Also, muscle tension can both cause dysphonia and be a result of dysphonia as subjects increasingly add muscle effort to try to make their voices work. The small intrinsic laryngeal muscles are responsible for the movement of the arytenoid cartilages and thus for vocal fold adduction, abduction, and tension. The larger extrinsic musculature (suprahyoid and infrahyoid muscles) maintain the larynx in a stable and natural position in which the intrinsic laryngeal musculature can contract freely and undisturbed. In patients with muscle tension dysphonia, an altered tension of the extrinsic musculature results in a changed position of the larynx in the neck (a mostly higher position) and a disturbed inclination of the cartilaginous structures of the larynx (hyoid, thyroid, cricoid, and arytenoid) that immediately affects the intrinsic musculature. Tension of the vocal folds is altered, and the voice becomes disturbed.[40]

Although the methodological quality of the studies included in the review was high, 9,16 points (range: 8–10 points), this review has some limitations. Only one study evaluated muscle tension by palpation, and no study measured this outcome through objective methods like electromyography or algometry. Without research that includes the assessment of muscle tension there can be no direct association of voice with a healthy postural use. Some studies had small samples, only four investigations had two groups, and most of the included studies did not mention the professional background and the years of experience of the examiners in the physical evaluations; nor did they mention the questionnaire evaluators. No study mentioned the blinding of examiners. The studies did not note if assessments were always performed at the same hour of the day or in the same season.

Another limitation is that all included studies were cross-sectional observational clinical studies. These studies leave open the possibility of selection bias as no randomization was performed, and therefore, any associations drawn in cross-sectional studies do not imply causation. Although we did not exclude longitudinal studies from our literature search, none were found, suggesting that studies with more prolonged follow-up studies should be performed.

Despite these limitations, this review is, as far as the authors are aware, the first to comprehensively and critically assess evidence of the associations between posture, voice, and dysphonia, which may provide a useful insight for further studies and clinical practice. This review can be considered as a first step in order to document these relations.

We suggest further research with more similar assessment methods in order to better compare the studies and systematize knowledge about the relationship between posture and voice and dysphonia. We also suggest longitudinal studies, investigations with larger samples and that relate gold standard measurements of voice, like acoustic evaluation and auditory-perceptual measurement, with objective measurements of posture, like photogrammetry or imaging exams such as magnetic resonance imaging, as well as an evaluation of muscle tension through electromyography or muscle palpation by validated scales. The posture assessment should be analyzed both in a fixed position and during a specific action or task. We suggest studies with two groups—healthy individuals and individuals with voice disorders—using experienced blinded examiners. Samples with professionals who are frequently affected with voice disorders, like teachers and singers, are suggested as well as samples with more males.

CONCLUSION

The interaction between muscle tension, postural use, and vocal use has a very complex relation.

The knowledge of the relationship between body posture, laryngeal muscles, voice production, and dysphonia is of paramount importance because a transdisciplinary action can optimize the evaluation and treatment in order to provide benefits to patients with voice problems. An effective posture allows a subject in a static posture or while moving to more easily shift the tension between muscles, allowing for a free movement of the larynx without blockages and with benefits to voice production. However, additional studies should be made to further demonstrate this both statically and while moving.

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