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Analysis of vocal dose in cisgender people: preliminary results

Análise da dose vocal em pessoas cisgênero: resultados preliminares

Caroline de Lima[1], *Alana Dantas Barros*[2], *Ana Cristina Côrtes Gama*[3]

ABSTRACT

Purpose: The purpose of this study is to verify the difference in fundamental frequency, intensity and vocal dose measurements between male and female cisgender people, in same voice demand situations. **Methods:** This is a cross-sectional observational case study. Group 1 participated with five male people, aged between 21 and 24 years old and Group 2 with five female people, aged between 22 and 25 years old, both without vocal complaints, students of the Speech-language pathology course. The individuals were paired by vocal demand, and all were enrolled in the same activists of the undergraduate course. All participants defined themselves as cisgender, that is, they identified themselves with the gender designated at birth. The data was carried out at the same time, for a period of 10 hours, while the participants carried out their daily activities for that period. For data collection, two dosimeters of VoxLog®, were used. Student's t test was used to compare measures between groups. The 95% confidence level was considered. **Results:** It was observed that women have higher values of fundamental frequency (p=0,001), percentage of phonation (p=0,037), cyclic dose (p=0,002) and distance dose (p=0,008). The voice intensity of both groups was similar in the period evaluated. **Conclusion:** cisgender women have higher values of fundamental frequency, percentage of phonation, cyclic dose and distance dose than cisgender men. Assessing the vocal dose between genders is important for a better understanding of the etiological factors of behavioral dysphonia and to define a more personalized vocal rehabilitation.

Keywords: Voice; Gender identity; Dysphonia; Dosimetry; Speech, Language and Hearing Sciences

RESUMO

Objetivo: verificar a diferença das medidas de frequência fundamental, intensidade e de dose vocal entre mulheres e homens cisgêneros, em situações de mesma demanda de voz. **Métodos:** trata-se de uma pesquisa observacional transversal. Participaram do Grupo 1 cinco homens cisgêneros, com idade entre 21 e 24 anos, e do Grupo 2, cinco mulheres cisgêneras, com idade entre 22 e 25 anos, todos sem queixas vocais e estudantes do curso de Fonoaudiologia. Os indivíduos foram pareados por demanda vocal, sendo que todos estavam matriculados nas mesmas disciplinas do curso de graduação. Todos os participantes se autodefiniram como cisgêneros, ou seja, identificaram-se com o sexo designado ao nascer. A coleta foi realizada de forma simultânea aos pares (um participante do G1 e um do G2), por um período contínuo de dez horas. Para a coleta de dados, utilizaram-se dois dosímetros da marca VoxLog®. Para comparação das medidas entre os grupos utilizou-se o teste t de Student, com nível de confiança de 95%. **Resultados:** observou-se que as mulheres cisgêneras apresentaram maiores valores de frequência fundamental (p=0,001), porcentagem de fonação (p=0,037), dose cíclica (p=0,002) e dose de distância (p=0,008). A intensidade da voz de ambos os grupos foi semelhante no período avaliado. **Conclusão:** mulheres cisgêneras apresentam maiores valores de frequência fundamental, porcentagem de fonação, dose cíclica e dose de distância, do que homens cisgêneros. Avaliar a dose vocal entre os gêneros é importante para a melhor compreensão dos fatores etiológicos das disfonias comportamentais e para definir uma reabilitação vocal mais personalizada.

Palavras-chave: Voz; Identidade de gênero; Disfonia; Dosimetria; Fonoaudiologia

Study carried out at Curso de Fonoaudiologia, Universidade Federal de Minas Gerais – UFMG – Belo Horizonte (MG), Brasil.
[1]Curso de graduação em Fonoaudiologia, Faculdade de Medicina, Universidade Federal de Minas Gerais – UFMG – Belo Horizonte (MG), Brasil.
[2]Programa de Pós-graduação em Saúde Coletiva (doutorado), Faculdade de Ciências da Saúde, Universidade de Brasília – UnB – Brasília (DF), Brasil.
[3]Departamento de Fonoaudiologia, Faculdade de Medicina, Universidade Federal de Minas Gerais – UFMG – Belo Horizonte (MG), Brasil.
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Correspondence address: Ana Cristina Côrtes Gama. E-mail: anaccgama@gmail.com
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INTRODUCTION

The concept of gender is formed based on social construction, reflection on different dimensions, whether intersubjective or cultural; and absorbs diverse values, identities, behaviors and feelings[1]. It differs from the concept of sex, which classifies individuals as men or women according to anatomical characteristics[1].

Sex determines certain laryngeal[2,3] and aerodynamic[4] characteristics, that influence differences in the phonatory patterns of people of masculine and feminine sex.

Regarding anatomy, the vocal folds (VF) of individuals of masculine sex are larger and broader than in people of feminine sex, and the vertical position of the larynx is lower in the masculine sex[2]. Vocal production also reflects the influence of facial structures, such as the shape, size, density, and tension, which differ between the sexes[2].

Hyaluronic acid found in the lamina propria of the VF is described as a substance that interferes in the vibratory patterns of the vocal fold mucosa[3]. Its properties seem to reduce the chance of developing a benign lesion through impact during phonation, due to its important role in absorbing phonotrauma[3], with individuals of the masculine sex, who seem to present higher quantities of this substance in their VF than those of the feminine sex[3].

For speakers of Brazilian Portuguese, the average fundamental frequency for adult males is 113 Hz and for adult female, 204 Hz (average of 18 to 45 years old)[4]. The expected maximum phonation time (MPT) for adult females is above 14 seconds and for adult males, above 20 seconds[4]. The vital capacity (VC) also differs between the sexes. The literature shows that the minimum value for men is 2.200 ml and for women, 2.100 ml[4].

There are many differences in the voice that depend on biological characteristics determined by the sex of the speaker, but gender can also affect communicative patterns.

Research shows that there are profiles related to personality and behavior that are feminine and masculine. Men appear to present greater engagement in collective physical activity of a competitive nature; women on the other hand, are more engaged in individual activities that require less physical exertion from the body[5]. Women present higher stress, anxiety, and depression scores than men[6]. In another study, men presented a higher score for the personality trait of openness to change, while women presented a higher score for the personality trait of friendliness[7].

Regarding women, one study highlighted that they speak more in the work environment, in comparison with men[8]. Another study showed that women possess greater interest and proactivity in seeking out advice regarding vocal health, and that men show less understanding of vocal hygiene[9].

Differences in voice are related to questions that involve gender, such as aspects of communicative patterns, vocal behavior and, probably, vocal dose parameters.

The vocal dose is defined as the exposure of the vocal fold (VF) tissue to vibration over time[10]. The vocal dosimeter is a portable device used to determine important parameters of vocal performance during normal daily activities. This equipment aims to measure the intensity of the voice in terms of the sound pressure level (dBSPL), the fundamental frequency (Hz) and the duration of the vocal activity of the participants, defined by the time spent using the voice. Based on these three vocal parameters, the vocal dose values are determined[10]. These values can be used as data for complementary evaluation to assist in analyzing the complex relationship between the use of the voice, vocal fatigue, and the time for vocal recuperation[10].

The literature suggests that speakers of feminine sex present higher cycle dose, in comparison with male speakers since this dose is sensitive to the average fundamental frequency[11]. Additionally, the vocal behavior between people of different genders differs in terms of the social and/or professional vocal requirements and it is believed that the vocal dose is equally sensitive to these different demands related to gender.

The literature defines people who identify with the gender they are given at birth as cisgender, or "cis"; while those who do not identify with the gender they are given at birth as "trans"[12]. Despite being common in the literature, these terms are not consensus due to the variety of human experience regarding self-identification based on the body[12].

In the case of "trans" people and gender variability, the voice can be a significant factor in the perception of gender, and nonconformity between them can generate feelings of inadequacy and a consequent reduction in communication and expression via the voice[13,14].

It is important to understand questions of gender involved in the vocal dose to define more personalized treatment methods for dysphonia, mainly those of a behavioral nature. The literature shows a greater prevalence of dysphonia in the feminine sex[15]. The vocal behavior influenced by gender, seems to be an important etiological factor in vocal alterations[16]. Analyzing the behavior of the vocal dose between the genders is important to better understand the etiological factors of behavioral dysphonia and to define more individualized vocal rehabilitation processes.

Given this, this research aims to present preliminary findings regarding the differences in the measurements of fundamental frequency, intensity and vocal dose between people who self-define as cisgender in situations of similar vocal demands.

METHOD

The present study is a transversal analytic observational type of study approved by the Ethics Committee of the Universidade Federal de Minas Gerais – UFMG, under the process 3.059.941. All participants read and signed the Informed Consent Form (ICF).

Two groups were selected for the study: the first group (G1) was composed of five individuals of the masculine sex without vocal complaints, aged between 21 and 24 (average age = 22.2 years); and the second group (G2) was composed of five individuals of the feminine sex without vocal complaints, aged between 22 and 25 years (average 23.2 years). There was no significant age difference between the groups (p=0.322). All participants were students from the speech-language pathology (SLP) course at UFMG.

The inclusion criteria were being between 18 and 45 years old, due to this being the period of greatest vocal stability; presenting no vocal complaints; presenting neutral vocal quality on the SLP evaluation and self-identifying as cisgender.

To determine the absence of vocal symptoms, participants were questioned regarding the presence of vocal fatigue and/or phonatory discomfort. Participants presenting no fatigue symptoms or vocal discomfort were included.

To analyze the vocal quality, the auditory-perceptive evaluation of the voice was undertaken by two SLP with more than five years-experience in vocal evaluation. The analysis was performed in a consensual manner. The general degree of dysphonia (G) was evaluated, in a sustained /a/ vowel task and in spontaneous speech, in comfortable pitch and loudness, and classified using a 4-point scale, with zero (0) indicating no alteration and three (3), an intense degree of alteration. Participants with a neutral vocal quality were included (G0).

For the self-definition of cisgender, participants were asked if they identified with the gender they were given at birth. People who responded affirmatively were defined as cisgender.

As exclusion criteria for the two groups, individuals who reported suffering with allergies or with the flu were excluded. For the group of cisgender women (G2), pregnant women or women who were pre-menstrual or menstrual were excluded.

Individuals from both groups (G1 and G2) were paired by vocal demand, with all participants being enrolled at the same time and in the same subjects in the SLP graduate course at the UFMG.

The collection was simultaneously performed in pairs (one from G1 and one from G2), for a continuous period of ten hours, while the participants went about their activities. Therefore, throughout the collection, each pair of individuals was undertaking the same university activities.

Data collection took place at the Faculty of Medicine of the UFMG, in pairs. Over a continuous period of ten hours each individual registered on a control board information relevant to the activities performed during their day. Participants were asked to indicate if their academic activities were practical (observation of clinical appointments), theoretical or clinical residency (attending patients and subsequent supervision with the teacher responsible for the subject). Both groups performed exactly the same classroom activities out in pairs throughout the whole period of recording.

For data collection, two VoxLog® brand, 3.1 model Sonvox dosimeters were used, composed of a microphone, an accelerometer, and a portable unit for phonatory data storage. A dosimeter was used by one participant from G1 and the other, by the participant from G2. The recordings were simultaneous (Figure 1).

Figure 1. VoxLog® brand 3.1 model Sonvox vocal dosimeter

The accelerometer was secured using micropore tape near to the thyroid cartilage on the neck of the participant, and the portable unit was fixed onto their belt. The data collected was composed of the following parameters[17]:

1. **Fundamental frequency (f_0):** is the number of sound waves per time unit; it is measured in Hz (Hertz);
2. **Vocal intensity:** represents the quantity of sound energy produced, measured in dBSPL (Decibel sound pressure level);
3. **Phonation percentage:** compared with the time taken during the monitoring period;
4. **Cycle dose (Cd):** quantifies the number of oscillations of the VF during the recorded period. It is calculated using the phonation time and the average fundamental frequency. Measured in thousands of cycles.
5. **Distance dose (Dd):** is the total distance covered by the VF tissue in the cyclical trajectory during the vibration and depends not only on the total phonation time and the fundamental frequency, but on the amplitude of the vibration of the VF. Measured in meters.

The data collected were analyzed on the computer, using software specific to the equipment. Given that the distance dose is not calculated using the available software, it was defined using the calculations proposed in the literature[17].

The statistical analysis of the data was performed using the MINITAB, version 17 statistical program. Firstly, a descriptive analysis of the data was performed, with measurements of the central tendency and dispersion. Subsequently, the Anderson-Darling test was used to verify the normality of the sample. For the comparison of the measurements between the groups, the parametric Student t test was used. The level of confidence was 95%.

RESULTS

The cisgender women presented higher values for fundamental frequency, phonation percentage, and cycle and distance doses. The only acoustic parameter that did not differ between the groups was voice intensity (Table 1).

DISCUSSION

The fundamental frequency was higher in the female cisgender group. The factors that could explain these results are related to sex, as shown in the literature[18], due to female individuals presenting smaller VF and a shorter vocal tract[3]. Despite the literature showing results referent to the acoustic f_0, it is known that the fundamental frequency values estimated by the microphone and the accelerometer present a perfect correlation[19], which allows for the analysis of the f_0 acoustic data found in the literature with the f_0 values obtained in this study. We did not find any studies that had analyzed f_0 values regarding the gender of the speakers.

In Brazil, authors indicated the range of normality for f_0 as being between 80 and 150 Hz for masculine sex and 150 to 250 Hz for the feminine sex[3]. The f_0 values in this study were higher than those reported in the literature, which could be

Table 1. Comparison of the vocal parameters between masculine and feminine genders

Parameter	Masculine gender				Feminine gender				Value of p
	Average	DP	Min	Max	Average	DP	Min	Max	
Fundamental frequency (Hz)	169.8	35.41	121.53	204.67	286.55	16.28	267.52	303.56	0.001*
Vocal intensity (dBSPL)	86.56	1.98	84.85	89.63	87.61	0.909	86.26	88.75	0.331
Phonation percentage (%)	9.632	2.55	6.32	12.42	13.662	2.423	10.15	16.03	0.037*
Cycle dose (thousands of cycles)	445	0.391	319	553	1164.2	244.5	804	1406	0.002*
Distance dose (m)	3940.7	1000.2	25559.9	5325.8	6472.4	1181.4	4593.8	7686.5	0.008*

*T test significant at 5%.
Subtitle: Hz = Hertz; dBNPS = decibel sound pressure level; m = meter; DP = standard deviation; Min = Minimum value; Max = Maximum value

due to the interference from the vocal intensity and the vocal warming up throughout during data collection period using the voice dosimeter.

It has been observed that the f_0 values increase when intensity increases[20], and that there is increase in f_0 with vocal warming up due to the continuous use of the voice throughout the day[21]. Given that the data collection period was of ten hours, the increase in f_0 could have been the result of the use of the voice during the long collection period[210]. Also, participants were, at sometimes of the day, in open, noisy environments, which may have increased the intensity values, and consequently, the f_0 values[20].

Intensity is a physical measurement of the quantity of sound energy measured in dBSPL[10]. In the present study, the average intensity did not differ between the groups and the average intensity values observed were greater than the typical intensity values described in the literature[22].

We did not find studies comparing this acoustic parameter between the genders and sexes of speakers, and the result for average intensity from the vocal dosimeter was greater than that observed in the literature[22]. This might be explained by the fact that participants were exposed to open and noisy communication environments. The literature shows that intensity is dependent on the discourse situation[23] and on the presence of vocal alterations[24]. It is noteworthy that since the participants of the two groups were exposed in pairs to the same communication situations during collection, the environment and the noise level were variables that interfered in a similar way in the values of both groups.

The results of the intensity parameter in this research can be related to the same environmental speech conditions of the participants of both groups[23,25] and due to their not presenting any type of vocal alteration[24].

There is a lack of research evaluating the interference of gender in the vocal dose of speakers, which limited the comparison of our findings with data from the literature.

The phonation percentage is a measure of the dose that evaluates how much the VF vibrated, quantifying the time that the person used their voice throughout their communication activities[17], being measured as a percentage. Of the vocal dose measurements evaluated, the phonation percentage is the only one that is not dependent on f_0.

The results showed that cisgender women spoke around 14% of the time that they were monitored, while the cisgender men, who were submitted to the same communication environment and performed the same activities throughout the day, showed a phonation percentage of around 11%, suggesting that cisgender women use their voice more throughout the day.

This result agrees with the literature, which shows higher percentage values for phonation for individuals of the feminine sex, in both occupational (30.7%), and non-occupational (14.7%) activities in comparison with male individuals (27.4% and 13.7%)[26]. Another study, carried out with an electronically activated recorder (EAR), showed that the feminine sex tends to use around 7% more words in a day than the masculine sex[27]. Studies that compared the percentage values for phonation between the genders were not encountered.

For the transgender group, we found no studies related to the vocal dose. One study showed that "trans" people have presented a low quality of life regarding their voice[28] and that "trans" men have reported a sensation of vocal fatigue and difficulty in vocal projection in work situations such as teaching[29]. These results can be explained by factors related to the vocal quality of "trans" people. Research related to the vocal dose of "trans" individuals is important to improve our understanding of vocal demands in the emergence of such symptoms.

The cycle and distance doses presented higher values in the group of cisgender women. These two measurements depend on the f_0 values, and, as this is higher in the female sex, the results observed could have been influenced by this acoustic parameter.

The literature did not present studies comparing the vocal dose values between the gender and sex of speakers. In other populations, the vocal dose values varied according to the activities performed, such as the use of sound amplification by teachers[24], singing activities[27] and tasks involving vocal overload without laryngeal alteration[30]. Despite both doses using f_0 to calculate their data, it is reasonable to suppose that, given that the phonation percentage presented higher values in the group of cisgender women, this result can also be associated with the greater use of the voice in the feminine gender during the activities performed throughout the day.

The limitations of this study include the small number of participants, which limits the external validity of the results. Future research with a larger cohort of individuals is important to expand on the preliminary results that were obtained in this study.

CONCLUSION

Cisgender women presented higher values than cisgender men for fundamental frequency, phonation percentage, and cycle and distance doses. The vocal intensity of both genders was similar for the period of vocal use evaluated.

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