ACOUSTIC ANALYSIS OF CHILDREN'S VOICES: PHONATORY DEVIATION DIAGRAM CONTRIBUTIONS

Análise acústica de vozes infantis: contribuições do diagrama de desvio fonatório

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ABSTRACT

Purpose: to analyze the discriminatory power of the phonatory deviation diagram in assessing the predominant voice and intensity of vocal disorders in children. **Methods:** sustained vowel /ɛ/ recordings were obtained from 93 children. The intensity of vocal deviation and quality were analyzed using a visual analog scale. Diagram was used for acoustic analysis, combined with the evaluation of vocal signs distribution according to area, quadrant, form, and density. We carried out the proportions equality test and the chi-square test (x^2) to compare the variables, and the Spearman correlation test to correlate the acoustic and auditory perception measures. **Results:** a correlation between quadrant classification and vocal deviation intensity was observed for all parameters analyzed. Differences statistically significant were detected among children with roughness, breathiness, strain, and instability, with regard to area, quadrant, and form. When considering the distribution of voices in the quadrants, no difference statistically significant was observed between the children with and without vocal deviation and voice quality for any parameter analyzed. **Conclusion:** phonatory deviation diagram was able to differentiate predominant vocal quality through quadrant distribution, although it did not discriminate between the healthy and altered voices of children.

KEYWORDS: Voice Quality; Acoustic; Dysphonia; Voice Disorders; Child

INTRODUCTION

One of the key difficulties in evaluating the voice of children is the very definition of what could be considered abnormal in that age group, since instability, strain, and breathiness are expected manifestations in the vocal production of children due to their neuromuscular immaturity, the rudimentary structure of the larynx, and the anatomy of the vocal tract [1-4].

An effective evaluation of the voice of children must take into consideration the fact that voice is a multidimensional trait, which requires an assessment encompassing perceptual, acoustic, aerodynamic, and laryngological measures, as well as a self-reported evaluation, in order to map and establish correlations between most of the voice characteristics for an overview of the vocal status and to detect the true cause and impact of an individual's dysphonia [5-7].

Acoustic analysis is a routine procedure in voice evaluation to characterize the vocal quality, assist in differential diagnosis, document and monitor the voice parameters, and assess the outcomes of the treatment provided to the patient with a voice disorder[8]. Acoustic analysis employs computer-based techniques to measure the properties of the acoustic signal—whether from a vowel or connected speech—providing more objective information regarding the voice signal compared to the auditory-perceptual analysis, as it produces quantitative data in the voice assessment process[9-13].

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Multiple studies[1,9,14,15] have sought to determine the relationship between the acoustic characteristics of the voice signal and the perceived voice quality. It is increasingly important to establish the extent of the correlation between those two assessments, to which extent acoustic measures are capable of distinguishing normal from deviant voices, and even the discriminating power between different grades of voice disorder.

Voice disorders tend to perturb the sound signal in different ways, combining a variety of types of perturbation and noise. In view of this, some studies[8-12] have indicated that a voice assessment should use a combination of several acoustic measures of perturbation and noise, so that each individual utterance is quantified by a set of attributes.

The phonatory deviation diagram (PDD)[16], originally termed "hoarseness diagram"[12], is a two-dimensional graph that enables the analysis of the voice signal from combined measures of periodicity (jitter, shimmer, and coefficient of correlation) and noise (glottal-to-noise excitation ratio – GNE). Studies on the utilization of the PDD in voice evaluation[10,12,17] have shown that the diagram is effective in analyzing the regularity of the sound signal and the additive noise component, thus providing information on the characteristics of the voice production of healthy and dysphonic individuals.

To date, no studies have used the PDD in the evaluation of children's voices, especially with the purpose of establishing relationships between the auditory-perceptual evaluation and the PDD-based analysis. An investigation into that relationship could determine whether the PDD could be a useful tool for the evaluation of children's voices—particularly with a view to implementing screening programs for schoolchildren, with larger populations, requiring expedient and effective methods to identify individuals requiring further evaluation, such as laryngeal examination.

In this setting, the aim of the present study was to analyze the discriminating power of the PDD in the assessment of the predominant type of voice and the severity of voice deviance in children.

METHODS

The present descriptive, quantitative cross-sectional study was analyzed and approved by the Human Research Ethics Committee of our university hospital under protocol no. 775/10. This study was developed between March–October 2012.

Participants were 93 children aged 3–10 years (48 female, 45 male). The age range distribution was as follows: 26 children aged 3–5 years; 22 aged 6–7 years, and 45 aged 8–10 years. All children attended a school affiliated with a federal educational institutional.

Children were excluded if they had any neurological disorder, cognitive impairment, upper or lower airway pathology at the time of data collection, or were unable to perform the elicited speech task.

Prior to the collection of data, the location of the study was visited with the purpose of selecting a quiet environment with ambient noise of less than 50dB SPL. On that occasion, the school principal was informed of the research procedures and goals and authorized the study. The informed consent papers were subsequently forwarded to be completed by the parents of the children included in the study.

After the signed informed consent forms were returned, the voice recordings were conducted at times previously scheduled with the school supervisor. The teachers referred the children individually to the recording environment during the first morning and afternoon classes.

The recording sessions lasted 5 min on average. The production of the vowel /ɛ/ was elicited to be sustained to maximum phonation time. The samples were recorded onto an HP notebook through a Logitech microphone headset and using the PRAAT software version 5.1.44 with a sampling rate of 44,100 Hz.

The voices were edited using the Sound Forge software version 10.0. The initial two seconds and the final one second of the vowel phonation were edited out due to the greater irregularity present in those segments, while a minimum length of three seconds was maintained for each phonation sample. Subsequently, the audio was normalized using the *"normalize"* function of Sound Forge in the peak level mode in order to standardize audio output between -6 dB and 6 dB.

The auditory-perceptual analysis of voice was performed using a visual analog scale (VAS) with a 0 to 100 mm line. The closer to "0" (zero) the markings, the lower the grade of voice deviance; the closer to "100", the greater the voice deviance. This rating was done by consensus among three speech-language pathologists specialized in voice, with more than 10 years' experience in auditory-perceptual evaluation of voice. The following attributes were assessed: overall severity (grade) of voice deviance (GG); grade of roughness (GR); grade of breathiness (GS); grade of strain (GT), and grade of instability (GI).

The perceptual evaluation session was conducted in a quiet environment. First, the judges were instructed that voices should be considered healthy when socially acceptable for children, produced naturally, without effort, noise, or instability, and always taking into account the characteristic patterns expected for children. The judges were also instructed to consider roughness as the presence of vibrational irregularity; breathiness involved audible escape of air during voice production; strain was the perception of vocal effort, and instability was the occurrence of fluctuating voice quality, frequency and/or intensity during phonation. In addition, the judges were trained with "anchor" stimuli of children's voices for reference of healthy and dysphonic phonations at varying degrees, as well as examples of predominantly rough, breathy, strained, and unstable voices.

Each phonation of a sustained vowel was presented three times through a loudspeaker at a comfortable sound intensity as self-reported by the raters. The judges then defined the presence or absence of voice deviance, the predominant voice type in the deviant voices (rough, breathy, strained, or unstable) and, finally, rated the severity of deviance (GG, GR, GS, GT, and GI).

By the end of the perceptual evaluation session, 10% of the samples were repeated randomly for an analysis of the reliability of the consensus assessment by the judges using Cohen's Kappa coefficient. The value of Kappa was 0.80, indicating good agreement between raters.

Finally, a correspondence was established between the numerical scale (AS) and the visual analog scale[7,18], with grade 1 (0–35.5 mm) representing healthy voices; grade 2 (35.6–50.5 mm) corresponding to mild deviance; grade 3 (50.6–90.5 mm), moderate deviance, and grade 4 (90.6–100 mm) indicating severe deviance. The same procedure was repeated for GR, GS, GT, and GI, considering that the healthy production or normal variability of voice quality encompasses, among other aspects, the vocal manifestations expected for the individual's age group.

The acoustic analysis was done on the *VoxMetria* software version 4.5h in the vocal quality module. The PDD was employed in this evaluation to analyze the distribution of the voice signals according to area, quadrant, shape, and density.

The PDD is used for a combined analysis of parameters of perturbation and noise in a voice signal, based on measures of jitter, shimmer, coefficient of correlation, and GNE [12].

With regard to the area of the diagram, the software itself indicates whether the voice signal is within the limits or outside of the area of normality, as illustrated in Figure 1.

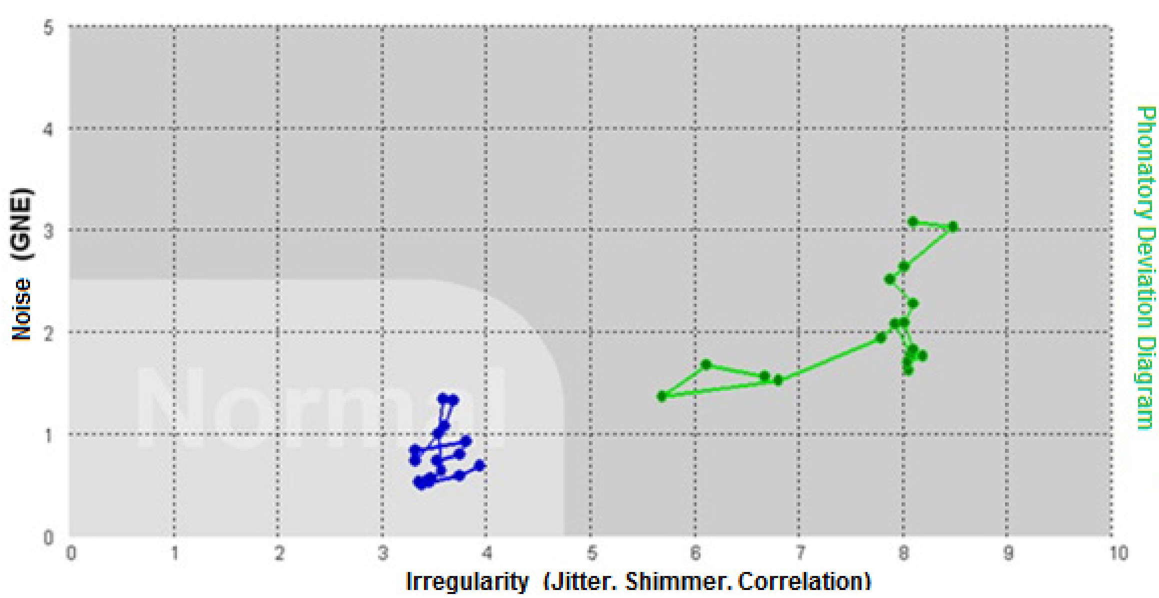

Figure 1 – Area of normality in the phonatory deviation diagram, shown in a lighter shade of gray. The blue points represent a voice signal of concentrated density while the green points represent a voice signal with spread density.

The points corresponding to the distribution of the voice signals (Figure 1) were categorized for density as concentrated, when distributed within the space of one square, or spread, when the points extended across the space of more than one square in the PDD [16]. Density was classified using a standard 10 cm ruler over the printout of each PDD generated by the software, which corresponded to the image of each voice signal analyzed, without previous knowledge of the severity of the voice deviance and predominant voice type.

With regard to shape, the points relative to the distribution of the voice signals were categorized as a) vertical, when the distance between the points over the X-axis was shorter than that along the Y-axis (X<Y); b) horizontal, when the distance between the points along the X-axis was greater than that over the Y-axis (X>Y), and c) circular, when the distance between the points over the X-axis and Y-axis was approximately equal (X≅Y) [16]. The same 10 cm ruler used for density estimation was used over each PDD printout.

Finally, the PDD was divided into four equal quadrants[16]: lower left (1), lower right (2), upper right (3), and upper left (4) (Figure 2).

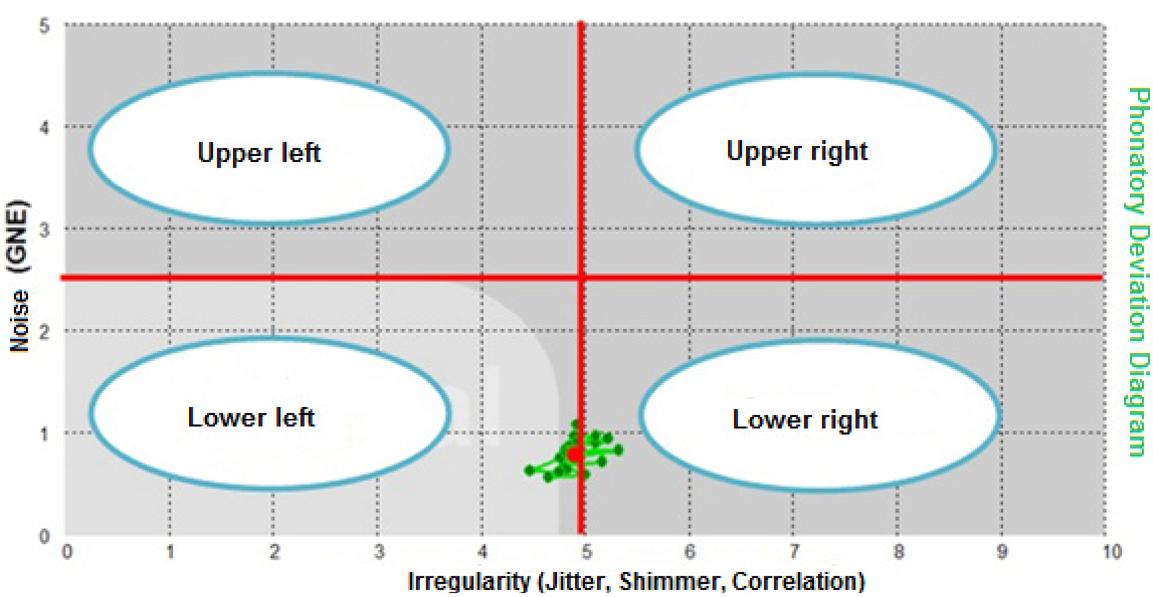

Figure 2 – Division of the phonatory deviation diagram into quadrants

The statistical analysis was descriptive for all the variables investigated; the test of equality of proportions and the chi-squared (X^2) test were used to compare the analysis of the variables related to the auditory-perceptual measures (severity of voice deviance and predominant type of voice) and to the acoustic measures (area, density, shape, and quadrant of the PDD).

Further, an inferential statistical analysis was performed using Spearman's correlation to test for correlations between the position in the PDD quadrant and the severity of voice deviance for the parameters GG, GR, GS, GT, and GI.

The level of significance was set at $p \leq 5\%$ across analyses. The *STATISTICA* software version 6.0 was used in the analyses.

RESULTS

The evaluation of the overall severity of voice deviance (GG) showed that 74.1% (n = 69) of the children were mildly deviant and 14% (n = 13) were moderately deviant. Only 11.9% (n = 11) of the subjects were found to have a healthy voice. No child showed severe alterations in vocal quality.

Most children showed mild deviance in the attributes of roughness (47.47%, n = 47), instability (45.45%, n = 45), breathiness (37.37%, n = 37), and strain (37.37%, n = 37), with means of 42.29 (SD = 14.58), 45.87 (SD = 11.14), 37.05 (SD = 19.55), and 38.88 (SD = 15.56), respectively.

Regarding the predominant voice type, instability (26.9%, n = 22) and strain (25.6%, n = 21) were the prevailing attributes in the children with voice deviation, followed by breathiness (24.3%, n = 20) and roughness (23.2%, n = 19).

No statistically significant differences were found between the groups of children with and without voice disorders with respect to area, density, quadrant, and shape in the PDD (Table 1).

There was no difference in severity of voice deviance between the number of children with healthy voices and those with mild and moderate deviance considering their distribution in the PDD quadrants (Table 2).

There was a positive correlation between the classification based on the PPD quadrants and the severity of voice deviance, both for the GG (p = 0.02) and the parameters GR ($p < 0.001$), GS ($p < 0.001$), and GI (p = 0.008), while a negative correlation was found to the GT (p = 0.05) (Table 3). Given that the quadrants were classified according to the sequence (1) lower left; (2) lower right; (3) upper right, and (4) upper left, the greater the GG, GR, GS, and GI values, the more the voices were oriented toward the upper left quadrant. On the other hand, the greater the GT value, the more the voice signals were located toward the lower left quadrant.

The proportion of children with rough, breathy, strained, and unstable voices were statistically different in relation to the area, quadrant, and shape in the PDD (Table 4). We noted that 73.7% (n = 14) of the rough voices, 85% (n = 17) of the breathy voices, and 68.2% (n = 15) of the unstable voices fell outside of the area of normality in the PDD. However, most of the strained voices (71.4%, 15) were located within the area of normality in the diagram.

Regarding the PDD quadrants, the rough voices were located in the lower right (52.7%, n = 10) and lower left (47.3%, n = 9) quadrants; the breathy voices were distributed in the lower right (35%, n = 7), lower left (30%, n = 6), and upper right (30%, n = 6) quadrants; the strained voices were positioned predominantly in the lower left quadrant (76.2%, n = 16), and the unstable voices in the lower right (50%, n = 11) and lower left (45.5%, n = 10) quadrants (Table 4).

The rough (47.3%, n = 9), strained (81%, n = 17) and unstable (77.3%, n = 17) voices were predominantly horizontal in shape, while the breathy voices were evenly distributed (40%, n = 8) between horizontal and circular shapes (Table 4).

Significant differences were found between the rough and strained voices (p = 0.007), breathy and strained voices ($p < 0.001$), and strained and unstable voices (p = 0.009) in their distribution in the PDD quadrants (Table 5).

Table 1 – Configurations of area, density, quadrant, and shape in the phonatory deviation diagram for the groups with healthy and disordered voices

Configuration	Healthy voice group		Disordered voice group		p-value
	n	%	n	%	
Area					
Inside	6	54.5	30	36.6	
Outside	5	45.5	52	63.4	0.251
Density					
Concentrated	5	45.5	20	24.4	
Spread	6	54.5	62	75.6	0.139
Quadrant					
Lower left	7	63.6	41	50.0	
Lower right	4	36.4	33	40.2	
Upper right	0	0.0	7	8.5	
Upper left	0	0.0	1	1.2	0.692
Shape					
Circular	1	9.1	22	26.8	
Horizontal	9	81.8	50	61.0	
Vertical	1	9.1	10	12.2	0.372

* Significant values at $p \leq 0.05$, test of equality of proportions
Note: n = sample size; % = percentage relative to the sample

Table 2 – Distribution of the severity of voice deviance in the phonatory deviation diagram quadrants

Configuration	Healthy (1)		Mild (2)		Moderate (3)		Overall		p-value
	n	%	n	%	n	%	n	%	
Quadrant									
Lower left	8	72.7	36	52.2	4	30.8	48	51.6	0.119
Lower right	3	27.3	28	40.6	6	46.2	37	39.8	
Upper right	0	0.0	5	7.2	2	15.4	7	7.5	
Upper left	0	0.0	0	0.0	1	7.7	1	1.1	
Total	11	11.9	69	74.1	13	14.0	93	100	

* Significant values at *p* ≤ 0.05, test of equality of proportions
Note: n = sample size; % = percentage relative to the sample

Table 3 – Correlation between the severity of voice deviance and the phonatory deviation diagram quadrants

Variables	Quadrant in the PDD	
	Correlation	*p*-value
Overall severity	0.26	0.02*
Grade of roughness	0.44	< 0.001*
Grade of breathiness	0.62	< 0.001*
Grade of strain	-0.67	0.05*
Grade of instability	0.31	0.008*

* Significant values at *p* ≤ 0.05, Spearman correlation
Note: PDD= phonatory deviation diagram

Table 4 – Configurations of area, density, quadrant, and shape in the phonatory deviation diagram for the predominant voice types

Configuration	Rough		Breathy		Strained		Unstable		p-value
	n	%	n	%	n	%	n	%	
Area									
Inside	5	26.3	3	15.0	15	71.4	7	31.8	0.001*
Outside	14	73.7	17	85.0	6	28.6	15	68.2	
Density									
Concentrated	4	21.0	4	20.0	6	28.6	6	27.3	0.909
Spread	15	79.0	16	80.0	15	71.4	16	72.7	
Quadrant									
Lower left	9	47.3	6	30.0	16	76.2	10	45.5	0.004*
Lower right	10	52.7	7	35.0	5	23.8	11	50.0	
Upper right	0	0.0	6	30.0	0	0.0	1	4.5	
Upper left	0	0.0	1	5.0	0	0.0	0	0.0	
Shape									
Circular	6	31.6	8	40.0	2	9.5	5	22.7	0.031*
Horizontal	9	47.3	8	40.0	17	81.0	17	77.3	
Vertical	4	21.1	4	20.0	2	9.5	0	0.0	

* Significant values at p ≤ 0.05), test of equality of proportions
Note: n = sample size; % = percentage relative to the sample

Table 5 – Comparison between the predominant voice types in relation to the quadrant of the phonatory deviation diagram

Types of voice	p-value
Rough and breathy	0.335
Rough and strained	0.007*
Rough and unstable	0.781
Breathy and strained	< 0.001*
Breathy and unstable	0.201
Strained and unstable	0.009*

* Significant values at $p \leq 0.05$, X^2 test

DISCUSSION

The high prevalence of childhood dysphonia mandates that special attention be paid to the evaluation and diagnosis of children's voices, with objective measures to enable an understanding of the severity of the voice deviance and how it manifests itself at different stages between the ages of 3 and 9 years[1,19-21].

In the present study, the discriminating power of the PDD was investigated in the assessment of the predominant type of voice and the severity of voice deviance in children. When the groups of children with healthy and disordered voices were compared, there were no statistically significant differences between the proportion of children in those two conditions in relation to area, density, quadrant, and shape in the PDD (Table 1). Moreover, no differences were found between the proportion of children with healthy voices and those with mild and moderate disorders considering the PDD quadrant distribution (Table 2).

However, when Spearman's correlation was calculated, a correlation was found between the classification of quadrants in the PDD and the severity of voice deviance, both for the overall grade of severity (GG) and for the attributes of roughness, breathiness, strain, and instability (Table 3). The strength of correlation of 0.26 found between the GG and the PDD quadrants, albeit statistically significant (p = 0.02)—implying a relationship between those variables—represents a weak correlation; therefore, further studies with larger samples may be warranted.

The correlation between the parameters of roughness, breathiness, strain, and instability was moderate, with values of 0.44 ($p < 0.001$), 0.62 ($p < 0.001$), -0.67 ($p = 0.05$), and 0.31 ($p = 0.008$), respectively (Table 3). Since roughness, breathiness, and strain are universally accepted voice attributes and, more specifically, roughness and breathiness are the most important voice characteristics to detect a voice disorder or laryngeal dysfunction[22], it can be inferred that the PDD is a good tool for monitoring the voice of children over the course of therapy.

A study[16] of the PDD in the evaluation of adult voices showed significant differences between healthy and deviant voices, especially with respect to the area and quadrant of the PDD. In that study, the voices judged to be healthy or mildly deviant were located in the lower left quadrant; the voices with moderate deviation were distributed in the lower right and upper left quadrants, while the severely deviant voices were positioned in the upper left quadrant.

In the present study, however, the PDD configurations were not effective in discriminating between the groups of children with healthy and dysphonic voices. In addition, the location of the voices in the quadrants was not sufficiently sensitive to differentiate the severity of voice deviance. The reason for this may be the fact that instability, strain, and breathiness are expected characteristics in children's voices, even those considered healthy.

The discriminating power of a measure is particularly important in the process of voice diagnosis, when the purpose is to detect or exclude an alteration and/or disease. The fact that no difference was noted in the configuration of the PDD between healthy and dysphonic voices whereas a correlation was found between the quadrants in the PDD and the degree of roughness, breathiness, strain, and instability, could indicate the usefulness of the PDD in the case of children's voices to objectively monitor a child's voice throughout the therapeutic process therapy—since, as roughness, breathiness, and instability decrease in the perceptual dimension, the points corresponding to the voice signals return to the lower left quadrant, which corresponds to the area of normality for irregularity and additive noise.

Another aspect that should be examined is that the PDD analyzes voice signals from a combination of measures, which could improve or worsen its accuracy in discriminating healthy and dysphonic voices[23]. A study comparing the different degrees of voice deviance in children and the acoustic measures of jitter, shimmer and GNE separately showed GNE to be the only parameter that could effectively differentiate the severity of voice deviance. Thus, GNE proved a robust measure to distinguish between healthy and disordered children's voices, which enables it to be used in voice screening programs[1].

Jitter and the shimmer are known to be of more utility in monitoring a voice disorder along a continuum, that is, in documenting and evaluating a voice therapy program; they are, therefore, instrumental in describing and quantifying the perceptual and vibrational characteristics of the vocal folds. Thus, they are more often used in clinical practice and in descriptive research[13,24,25].

It should be highlighted that a child's vocal fold has not yet concluded the differentiation process of the intermediate and deep layers of the lamina propria[24]. Moreover, children are still developing neuromuscular control; therefore, it is expected that measures of perturbation/irregularity will be more altered in children, especially in early childhood.

Regarding the predominant voice type, differences were found in the proportion of children with rough, breathy, strained, and unstable voices in relation to the area, quadrant, and shape in the PDD (Table 4). Most rough, breathy, and unstable voices were located outside of the normality area. By contrast, the majority of strained voices were distributed within the area of normality of the PDD.

A study[16] of the application of the PDD in the assessment of adult voices showed that 84.2% (n = 48) of the breathy voices, 68.3% (n=41) of the rough voices, and 52.2% of the strained voices were outside of the area of normality in the diagram.

The fact that the rough, breathy, and unstable voices were located outside of the normality area confirms that the PDD is sensitive to the presence of irregularity and noise in voice production and can be instrumental in the evaluation and follow-up of children's voices.

The roughness in a child's voice is quite frequently associated with laryngeal changes that, in turn, may be the result of allergic factors, personality traits, inadequate voice compensations, among other causes[26].

Another study[6], conducted with 10-year-old children, showed the occurrence of roughness and breathiness around that age; personality, gender, and the number of daily hours spent in group activities were the most prominent factors associated with the deviant voice attributes.

Changes in vocal quality are generally related to an enlargement in the vocal folds or alterations in glottal closure—the two leading determinants of voice disorders. Typically, incomplete glottal closure due to alterations in the glottal proportions, as is the case with a child's larynx, can generate hyperfunction of the phonatory mechanism in an attempt to increase voice loudness, especially in group activities and in the presence of competing noise in the environment[19].

Strained voice production by children is consistent with a hyperfunctional voice pattern, which may be related to recurring lower airway infections, social determinants, or anatomic and behavioral characteristics[1,22]. In addition, the presence of strain with greater median glottal constriction can mask the presence of roughness (aperiodicity) and breathiness (additive noise) in the production of voice, which explains the position of the predominantly strained voices within the area of normality.

It is worth noting that the presence of phonatory strain can be a risk factor for voice disorders due to vocal apparatus hyperfunction and the unbalance in the physiological functioning of phonation. If such compensations persist, this could result in lesions to the vocal folds, such as nodules or mucosal thickening of the free edges of the vocal folds, which are the most frequently diagnosed laryngeal lesions in the pediatric population[3,27].

The rough voices were predominantly located in the lower right quadrant; the breathy voices were distributed proportionally in the lower right, lower left, and upper right quadrants; the strained voices were situated predominantly in the lower left quadrant, and the unstable voices, in the lower right and lower left quadrants (Table 4).

In the evaluation of adult voices, the voice signals were distributed among the PDD quadrants as follows: rough voices in the lower right quadrant, breathy voices in the upper right quadrant, and strained voices in the lower left quadrant[16].

Thus, although the rough, breathy, and unstable voices of children were found significantly outside of the area of normality, only the rough and the strained voices were prominently located in a definite quadrant—the lower right and lower left, respectively. It is noteworthy that, proportionally, only the breathy voices were found in the upper right quadrant.

When the parameter shape was analyzed, the rough, strained, and unstable voices were predominantly horizontal while the breathy voices were equally distributed between horizontal and circular shapes (Table 4). At this point, it should be reminded that the vertical axis of the PDD corresponds to the noise component and the horizontal axis represents the irregularity component. Therefore, it is expected that voices with a more marked component of aperiodicity (roughness and instability) will tend to exhibit a horizontal shape, while breathy voices show a greater additive noise component. In the study of adult voices, there was no significant relationship between the shape in the PDD and the predominant type of voice[16].

In the X^2 test comparing paired voice types, differences were noted between rough and strained, breathy and strained, and strained and unstable voices regarding the distribution in the quadrants of the PDD (Table 5). Thus, strained voices represented the only significantly different type of voice, which could be explained by the underlying physiological mechanism in this voice type, with greater subglottic pressure occurs, greater median compression between the vocal folds, and a less marked component of noise and aperiodicity compared to breathy and rough voices.

In a study[28] developed with the purpose of evaluating the efficacy of voice therapy in children with functional dysphonia, the auditory-perceptual evaluation showed more substantial changes in overall severity, roughness, and breathiness, with less marked changes in the parameters of strain and instability. This finding may further support the notion that the parameters of strain and instability are more common in the phonation pattern of children and not always indicate voice pathology or laryngeal tissue alterations.

Instability can be a reflection of the rudimentary status of the larynx of children, which undergoes a series of changes until the adult stage, thus compromising the regularity of the voice signal[28]. The phonatory strain found in the vocal production of children, on the other hand, may reflect their effort to project the voice, since their resonance cavities are still developing. In addition, increased intensity in children's voices is predominantly related to an increase in subglottic pressure and, consequently, hyperfunction of the laryngeal apparatus[29].

Therefore, in the evaluation of the voice of children, the PDD seems to be a good instrument to monitor vocal function throughout the child's developmental stages or over the course of voice therapy, especially considering the sensitivity of the PDD in detecting roughness and breathiness in the vocal production of children.

Given the multidimensional nature of voice, a variety of measures are required to adequately describe a voice disorder. However, the instrumental evaluation is still complementary, and a more comprehensive approach should be favored when assessing the severity of the voice deviance and the predominant vocal quality[13].

CONCLUSIONS

The phonatory deviation diagram was able to distinguish the predominant vocal quality through the distribution of the voice signals in the quadrants, although it did not serve to discriminate between healthy and dysphonic children's voices.

RESUMO

Objetivo: analisar o poder discriminatório do diagrama de desvio fonatório na avaliação do tipo de voz predominante e da intensidade do desvio vocal em crianças. **Métodos:** coletou-se a vogal /ɛ/ sustentada de 93 crianças. A intensidade do desvio e a qualidade vocal foram analisadas por meio da escala analógico-visual. Utilizou-se o diagrama para a análise acústica, com avaliação da distribuição dos sinais vocais de acordo com a área, quadrante, forma e densidade. Realizou-se o teste de igualdade de proporções e o teste *Qui-quadrado* (x^2) para comparar as variáveis, e o teste de Correlação de Spearman para correlacionar as medidas acústicas e perceptivo-auditivas. **Resultados:** houve correlação entre a classificação de quadrantes e a intensidade do desvio vocal para todos os parâmetros analisados. Houve diferença estatisticamente significante entre a proporção de crianças com rugosidade, soprosidade, tensão e instabilidade em relação à área, ao quadrante e à forma. Não houve diferença estatisticamente significante entre a proporção de crianças com e sem desvio da qualidade vocal em relação a todos os parâmetros analisados, ao considerar a distribuição das vozes nos quadrantes. **Conclusão:** o diagrama de desvio fonatório foi capaz de diferenciar a qualidade vocal predominante por meio da distribuição nos quadrantes, embora não tenha discriminado as vozes infantis saudáveis e alteradas.

DESCRITORES: Qualidade da Voz; Acústica; Disfonia; Distúrbios da Voz; Criança

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