A LONGITUDINAL SURVEY OF PERCIEVED VOICE QUALITY OF A PEDIATRIC POPULATION WITH BILATERAL VOCAL FOLD LESIONS

By

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ABSTRACT

A LONGITUDINAL SURVEY OF PERCIEVED VOICE QUALITY
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Bilateral vocal fold lesions can result in negative emotional reactions, physical or functional problems, or adverse self-perception. Many factors, such as age, gender, occupation, or personality, affect the perceived voice quality of an individual with bilateral vocal fold lesions. Anatomical or functional changes occurring during puberty may correlate with a shift in prevalence amongst individuals with bilateral vocal fold lesions and perceived poor vocal quality. Age and gender play an especially important role in prevalence and perceived severity of vocal quality (Kilic, Okur, Yildirim, Guzelsoy, 2003). In this study, physical, functional, and emotional complaints were compared pre- and post-puberty in participants with bilateral vocal fold lesions. Descriptive statistics were used to find the mean percent change of pre-puberty and post-puberty Pediatric Voice Handicap Index (pVHI) subtest scores related to perceptual voice quality in children with bilateral vocal fold lesions. An improvement in perceived vocal quality (67.41% decrease in functional scores, 63.09% decrease in emotional scores, 58.06% decrease in physical scores) was noted in post-puberty surveys. The comparison between pre- and post-puberty data showed that males experienced a marked improvement in perceptual vocal quality, while females experienced improvement to a lesser extent.

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KEY TO ABBREVIATIONS

VHI Voice Handicap Index

pVHI Pediatric Voice Handicap Index

CPVD Center for Pediatric Voice Disorders

INTRODUCTION

Bilateral vocal fold lesions

Difficulty producing voice or dysphonia, can occur from "inflammatory, infectious, congenital, traumatic, neurological, iatrogenic, and functional causes" (Martins, Ribeiro, de Mello, Branco & Tavares, 2012). Vocal fold lesions are the most common cause of dysphonia and other related voice problems in the pediatric and adult populations (Martins, Branco, Tavares & Gramuglia, 2013). Vocal fold lesions are defined by the American Academy of Otolaryngology (2016) as abnormal, benign growths that develop on the covering of one or both of the vocal folds. The human vocal folds produce a vibrating frequency supplied by their multi-layered histology. The vocal folds are comprised of five varying layers (Hirano, 1977).

During speech, the vocal folds abduct and adduct repetitively, producing vibrations. These vibratory behaviors of the vocal folds affect the perceptual quality of the speech signal produced by vocalization. The vibratory pattern of the vocal folds determines the quality of voice production. This vibratory pattern can be altered by the presence of vocal fold lesions.

Vocal nodules, vocal fold cysts, and vocal polyps are three varying types of benign vocal fold lesions. The term bilateral vocal fold lesion describes both vocal nodules and vocal fold cysts, which occur on the left and right sides of the vocal folds. Vocal nodules are typically located bilaterally at the juncture of anterior one third and posterior two thirds of the true vocal fold (Owens, Metz, & Farinella, 2011). An image depicting bilateral vocal fold lesions, and their location on the true vocal folds, can be found in Figure 1. Vocal fold nodules are the most common type of bilateral vocal fold lesion and are often caused by vocal misuse and abuse (Martins, et al., 2012). This vocal abuse causes trauma which extends to the capillaries of the

vocal fold mucosa, which causes edema and variations in the dynamic of the fluid of the lamina propria, which triggers the formation of vocal fold nodules (Martins, et al., 2012). These anatomical changes in the vocal fold mucosa and lamina propria often manifest as perceptual symptoms: hoarseness, aphonia, increased speaking effort, vocal fatigue, and strain. These perceptual symptoms of vocal abuse have shown to be present in 6-23% of children ages 4 to 12 (Martins, Branco, Tavares, Gramuglia, 2013).

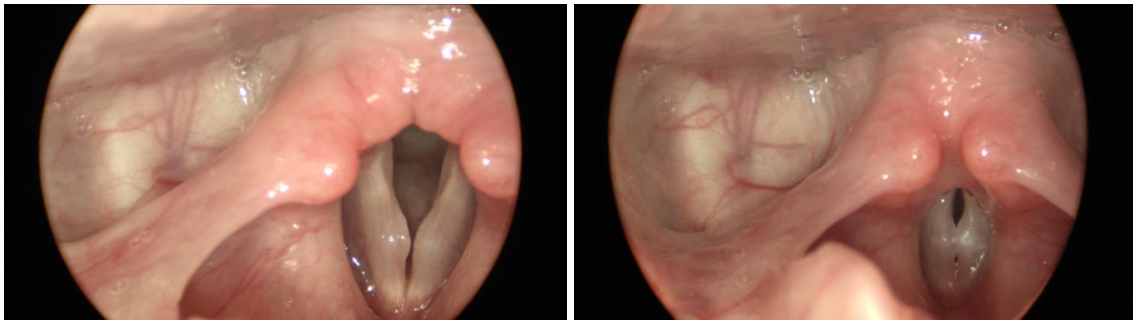

Figure 1: Images of human vocal folds, with bilateral vocal fold lesions, in the abducted position (left) and the adducted position (right). Credit: Stephanie Zacharias (date unknown).

Development of vocal nodules often occurs following "constant and traumatic collision of the vocal folds in situations of vocal abuse" (Martins, et al., 2013). Vocal trauma and bilateral vocal fold lesions in the pediatric population are often occur secondary to shouting incorrectly, screaming, talking loudly, clearing the throat frequently (Hooper, 2004). This abuse contributes to structural damage of the vocal folds and affects the vibratory behavior of the vocal folds (Owens, Metz & Farinella, 2011). Over extended durations, continued vocal misuse and abuse causes vocal nodules to mature. As vocal nodules mature they become hard and fibrous, which greatly interferes with vocal fold vibration and perceptually acceptable vocal quality.

The characteristics of one's voice reflect gender, age, various personality dimensions, and general health (Colton & Casper, 1990). Voice problems can manifest as hoarseness, breathiness, or tremor, which are three perceptual characteristics that reflect vocal quality. Hoarseness, also referred to as roughness, describes a voice that is noisy and lacks acoustical clarity (Owens, et al., 2011). The term breathiness refers to the audible slow release of air through the glottis, during phonation. Incomplete vocal fold closure during phonation causes the excessive airflow that contributes to perceived breathiness. Rhythmic, audible variations in voice pitch and loudness are described as vocal tremor. Vocal tremor is often a result of damage to the central nervous system (Owens, et al., 2011). Poor or reduced voice quality frequently warrants management through medical intervention, direct voice therapy, or vocal hygiene programs.

Management of symptoms

Common management programs for pediatric voice disorders include: primary prevention programs, vocal hygiene programs (secondary prevention programs), direct voice therapy, medical intervention, surgical intervention, or a combination of the above management practices. Treatment programs for pediatric populations often include common themes, such as, family involvement, lifestyle education, psychodynamic and interpersonal factors, vocal behavior, and age-appropriate therapy activities. (Hooper, 2004).

There is scientific and clinical evidence that individuals with varying voice disorders will benefit from the services of speech-language pathologists. The above evidence is documented in "experimental research, retrospective analysis, case studies, and program evaluation data" (Ramig & Verdolini, 1998, pp. 101). Although research on treatment efficacy exists, direct and indirect voice therapy with a certified speech-language pathologist is reported to occur in only

1% of instances when a child has been diagnosed with a voice disorder (McNamara & Perry, 1994). Management of voice disorders through direct voice therapy also varies between the adult and pediatric population. Children with dysphonia often have co-occurring receptive or expressive language disorders (Hooper, 2004). These co-occurring conditions can create additional difficulties when introducing and administering therapeutic programs for voice. In addition, children may have greater difficulty recognizing normal voice production and behaviors which require alteration (Hooper, 2004). Disordered expressive and receptive language learning can have implications for other behaviors (Hooper, 2004). When providing a therapeutic program for voice, speech-language pathologists often advocate the use of several phases of therapy, which can include: a general awareness of behaviors related to voice use, specific awareness of which behaviors to change, direct voice therapy, and carryover activities or generalization of these skills (Andrews & Summers, 2002). A variety of activities and direct therapy programs exist to target the treatment of voice disorders in the pediatric population. Programs often offer a variety of examples to aid in providing general and specific awareness, as well as, activities for voicing, timing, pitch, and loudness. Voice therapy programs often advocate to maintain appropriate interpersonal skills such as, turn taking, preventing conversational interruptions, and regulating voice and emotion (Hooper, 2004).

In the treatment of pediatric vocal fold nodules, surgical intervention is rarely recommended (Colton & Casper, 1996). Surgical intervention in children as a sole treatment of bilateral vocal fold lesions caused by vocal abuse was recommended by less than 1% of otolaryngologists (Ramig & Verdolini, 1998). More commonly, surgical intervention may be warranted if the presenting voice disorder is related to certain medical or physical conditions.

When co-occurring conditions are present or treatment of nodules is not effective after continued trials of voice therapy, surgical treatment of vocal nodules is performed with phonomicrosurgery and microdissection techniques. The ideal age for voice surgery related to bilateral vocal fold lesions in children is 9 to 11 years old, at which compliance with therapy and limiting voice misuse and abuse is improved (Smith, 2013). There are a variety of treatment methods, such as primary prevention programs, vocal hygiene programs, and direct voice therapy, currently being utilized to improve dysphonia and voice disorders. These treatments include the use of surgical and non-surgical correction methods. Adequate treatment is essential to prevent the presence of continuing dysphonia and voice problems during adolescence and into adulthood (Hooper, 2004). It is essential that bilateral vocal fold lesions are documented, assessed in a quantifiable way, and treated appropriately, in order to improve voice outcomes.

Quantifiable measures have been developed to identify important perceptual aspects of voice disorders. The Voice Handicap Index (VHI) was created to measure the way an individual perceives the impact of his or her voice disorder (Rosen, Murry, Zinn, Zullo & Sonbolian, 1999). A great deal of research has been completed regarding the VHI and perceived voice outcomes in the adult population (Rosen, et al., 1999). Various studies have been completed to ensure internal consistency reliability and test-retest stability (Jacobsen, et al., 1997). This measure also defines the change of the person's perspective following treatment for a voice disorder. Use of a patient perspective-based evaluation can measure changes over time and following treatment. The Pediatric Voice Handicap Index (pVHI) was developed as an adaptive form of the VHI to be utilized with the pediatric population. The pVHI utilizes parent proxy responses of 23 items, which focus on the functional, physical, and emotional impacts of the child's voice disorder. The

pVHI is highly comparable to the VHI and provides a high internal consistency and test-retest reliability (Zur, Cotton, Kelchner, Baker, Weinrich & Lee, 2006).

Impacts

Children who suffer from the symptoms of bilateral vocal fold lesions often suffer some degree of adverse impact on general health, communicative effectiveness, social development, education, or self-esteem (Connor, et al., 2006). In past studies related to the impacts of disordered voice, children reported "sore throat associated with voice" and "hot burning sensation in throat" (Connor, et al. 2006, pp. 202). Dysphonic children may avoid speaking situations, which can have a negative impact on many aspects of daily life. Children with chronic hoarseness may be more hesitant to establish social relationships with their peers. They may be more resistant to contribute in an academic setting, fearing the negative reactions of teachers and peers. (Carroll, Mudd & Zur, 2013, pp. 628).

Children with voice disorders also report an increase in negative emotions, such as, anger, sadness, fear, and frustration (Ruscello, Lass & Podbesek, 1988). School-aged children (8-12 years old) and adolescents (13-18 years old) describe feeling of humiliation caused by undue attention related to voice. Negative feelings in emotional domains (sadness, nervousness, anger, embarrassment, and frustration) were noted by 80% of participants in a study regarding the attitudes of children with dysphonia (Connor, et al., 2008). The presence of voice disorders in speech often influences others to perceive these children negatively (Ruscello, Lass & Podbesek, 1988). The above outlined situations and emotional distress caused by dysphonia can negatively impact an individual's quality of life. It is important to be able to identify the presence of these

emotions and an individual's perception of their voice disorder throughout diagnosis and treatment.

Children with diagnosed vocal fold lesions are reported to have an increased incidence of respiratory symptoms, auditory symptoms, and gastroesophageal reflux. Respiratory symptoms, such as nasal blockage and increased secretions, often contribute to the contamination of laryngeal structures (Martins, et al., 2012). It is recognized that management of these patients requires consideration of the interaction between the airway, voice, and swallowing, as perturbations in any one of these functions can impact the others (Hartnick, 2012).

The reported incidence of benign bilateral vocal fold lesions varies amongst certain populations. The percentage of diagnosed occurrence of a voice disorder can vary based on the type of etiology, as well as the gender, age, nationality, vocation, or personality of the individual with dysphonia (Martins, et al. 2012). Certain personality profiles may be predominant in voice disorder occurrence. Children or adults with personalities that include traits of impulsivity, aggression, hyperactivity, anxiety, or aptitude for leadership may have higher incidence for diagnosis of voice disorders. Certain personality profiles may reflect directly on the phonatory mechanisms related to voice production, which may result in vocal abuse (Martins, et al., 2012).

Prevalence amongst genders

The distribution of prevalence of bilateral vocal fold lesions between the male and female gender varies by age. In children, the prevalence of vocal fold nodules is higher in the male population (Kilic, Okur, Yildirim, Guzelsoy, 2003). The incidence of vocal fold nodules in children has a male-to-female ratio of approximately 2 to 1. In adults, vocal nodules are found

predominantly in females (Kilic, et al., 2003). This age and gender interaction may occur for a variety of reasons, including but not limited to: voice use, lack of appropriate diagnosis, voice changes during puberty, vocal fold vibratory pattern, vocal fold size, or speed of vocal fold vibration. Voice use and behavior vary among prepubescent boys and girls. The behavior of boys, diagnosed with vocal fold nodules is typically more impulsive and aggressive than that of girls. This behavior may directly impact the phonatory mechanisms, resulting in vocal misuse or abuse (Martins, et al., 2012, pp. 18). The glottis configuration changes significantly following male adolescence. The adult male glottis configuration is characterized by an increase in the length of the vocal folds and an increasingly acute angle of the thyroid cartilage. (Martins, et al., 2012). The symptoms of voice disorders in males do not often persist beyond puberty (Martins, et al. 2012). The percentage of reported prevalence of voice complaints may vary between males and females. While many reasons for differences in pre- and post-puberty voice disorders exist, no such explanation is proven. It is essential to recognize and understand the interaction between age, gender, and perceived voice quality, in order to provide appropriate, individualized intervention for bilateral vocal lesions.

The purpose of this study serves to provide quantitative data to support the phenomena of higher rates of prepubescent males and postpubescent females experiencing perceived poor vocal quality related to possible presence of bilateral vocal fold lesions. The pVHI was used to collect pre- and post-puberty data in perceived vocal quality related to bilateral vocal fold lesions. This study prompts better understanding of voice mechanisms and outcomes in relation to the physical, functional, and emotional domains of the pVHI. This research would contribute to

further studies of mechanisms that could lead to changes in vocal quality and gender involvement.

Research Questions and Hypothesis

This study utilized the pVHI in order to determine if physical, functional, and emotional complaints of bilateral vocal fold lesions change following puberty. This study also addressed the shift in prevalence that occurs amongst males and females related to the complaints of bilateral vocal fold lesions following puberty. In this longitudinal study, we hypothesized that males will demonstrate marked improvement in vocal quality related to these outlined perceptual factors and females will exhibit an improvement to a far lesser extent. These research questions and hypotheses are explicitly defined below:

1. Do patients' physical, functional, and emotional complaints of bilateral vocal fold lesions change following puberty?
2. Is there a marked shift in the prevalence amongst genders regarding the complaints of bilateral vocal fold lesions following puberty?
3. If a shift in prevalence is present in complaints of bilateral vocal fold lesions; it is hypothesized that:
    a. Males will demonstrate greater improvement in perceived vocal quality following puberty.
    b. Females will exhibit a change in perceived vocal quality to a lesser extent than males.

METHODS

This study addressed the research questions by having research participants complete the adapted pVHI, via mail. Information regarding perceived voice quality from two data points, prior to and after the onset of puberty, was analyzed using descriptive statistics. This outlined study and procedures were approved by the Institutional Review Board and permitted as follow-up care through the Voice Registry at the Center for Pediatric Voice Disorders (CPVD) at Cincinnati Children's Hospital Medical Center in Cincinnati, Ohio.

Participants

This study included 6 participants, which was comprised of 4 males and 2 females. Research participants were recruited primarily through manual review of data in the CPVD patient charts. An offsite database, Redcap, at Cincinnati Children's Hospital Medical Center was also used to identify qualified study participants. The selection of participants was done in reverse chronological order, selecting patients who fit the inclusion criterion (described in the next paragraph) and were most recently seen for initial intake. All participants were pediatric during initial intake and ranged from the ages of 8 to 19. Data collection was procured by Stephanie Zacharias, PhD, CCC-SLP and staff.

Involvement with the CPVD at Cincinnati Children's Hospital Medical Center was a requirement for inclusion in this study. The primary inclusion criterion indicates that participants must have completed the pVHI in their initial history intake forms. Participants had to be identified and officially diagnosed as a child with "bilateral vocal fold lesions" to participate. All participants received a diagnosis of bilateral vocal fold lesions from a trained and certified professional at Cincinnati Children's Hospital Medical Center. All participants received a

stroboscopic exam, acoustic, and aerodynamic measures to confirm the presence of bilateral vocal fold lesions, prior to diagnosis. In this two-part study, participants had to be younger than nine years of age during the pre-puberty survey and older than fifteen during the post-puberty survey. It was determined that these age ranges would provide clear data sets for the onset of puberty and voice change. Participants with occurring voice or medical diagnoses were excluded from the study. Participants who were no longer living at the same address or who had changed their phone number would be excluded from the study, as it was determined to be unreasonable and too time consuming to attempting to locate a forwarding address or new telephone numbers for these individuals.

Procedure

This study included the use of retrospective and prospective data collection and analysis. Data from the retrospective, pre-puberty data set were utilized and analyzed from approximately 2006 to the year 2011. This initial data set focused on subjects with bilateral vocal fold lesions prior to the onset of puberty. A form of the pVHI was administered at this time and has been stored in the Redcap system or in hard copies in patient charts. These data were retrieved and analyzed. Analysis will be discussed later in this document.

Prospective, post-puberty data were collected from the same participants to provide direct comparisons of perceived vocal quality before and after the onset of puberty. Prospective data on post-puberty outcomes were collected through a mail survey. The survey was provided to 25 total participants, in select cohorts of 8-9 participants. Prior to sending the adapted pVHI survey, a phone call was conducted in order to inform the participant and/or parent of the

purpose of the study and notify them of the inbound survey. The script for the initial phone call can be found in the appendices.

A packet containing a description sheet, the adapted pVHI survey, and a pre-postage envelope was sent to participants. The description sheet and the adapted pVHI survey can be found in the appendices.

After the initial 8 questionnaires were distributed, the participants received a second, follow-up phone call in order to assure maximal response and participation. This follow-up phone call allowed participants to ask questions related to the survey, and were prompted to follow through with completion of the survey. Additional groups of 8-9 participants were selected and contacted based on reverse chronological order; according to their initial intake completion with the CPVD at Cincinnati Children's Hospital Medical Center.

This study utilized an adapted version of the pVHI to capture parent response related to their perception of their child's current voice disorder. The pVHI is a quantifiable measure which has been developed to identify important perceptual aspects of voice disorders. The pVHI is highly comparable to the adult targeted, VHI and provides a high internal consistency and test-retest reliability (Zur, et al., 2006). This study included four questions, in addition to the traditional pVHI format. These additional questions included: "please describe your child's current voice quality", "has your child undergone the start of puberty (voice change)?", "have your child's voice problems resolved?", and "please indicate any type of treatment or surgery your child has received to treat his/her voice disorder". These additional questions provided additional relevant and important information related to the study.

Data Analysis

The data were collected and analyzed using descriptive statistical analysis. This study aimed to demonstrate differences between males and females in perceived emotional, physical, and functional voice quality, following the onset of puberty. Descriptive statistics were used to determine the mean and percentage of change between the functional, physical, and emotional subtest scores collected before and after puberty. These measures were used to determine whether the mean of two groups were markedly different from each other and if patient's complaints in each of the subtest areas changed following puberty. It was hypothesized that the males would show significant improvement following puberty in all areas (total pVHI, emotional, physical, and functional), while females would experience a change to a lesser extent. All of the analyzed data were place in tables, line charts, or bar graphs to ease visual comparisons of the data sets.

RESULTS

All male and female participants' total pVHI score and scores on each of the subtests (functional, physical, and emotional) were analyzed using descriptive statistics. The mean and standard deviation of the 6 participants' pre-puberty and post-puberty pVHI scores were evaluated. The mean of the total pVHI score decreased from 26.33 (pre-puberty) to 10.17 (post-puberty). This indicates an improvement in total pVHI scores of 61.37%. The percent change between pre-puberty and post-puberty surveys for each subtest is shown in Table 1 and described in the corresponding paragraph. The total pre-puberty scores for the all participants included a standard deviation of 6.1. The total post-puberty scores for all participants revealed a standard deviation of 8.5.

The study included 6 participants, 4 males and 2 females. Participant's ages at the time of the pre-puberty pVHI survey ranged from 8 years, 2 months to 8 years, 11 months. At the time of the post-puberty survey, the participants ranged in age from 15 years, 0 months to 19 years, 1 month. Surgical intervention was used to manage the bilateral vocal fold lesions in 2 of the participant's cases. Of the 6 participants, 5 participants received voice therapy with a speech-language pathologist at Cincinnati Children's Hospital Medical Center. The duration of voice therapy, varied amongst participants. One of the male participants received voice therapy for 9 years. One of the female participants received no form of formal treatment. Table 1, below, displays the individual subtest and total scores of the pVHI before and after puberty. The table also provides additional data regarding participant age, gender, and treatment.

Table 1: Individualized data regarding participants' gender, age, pVHI subtest and total scores, type of treatment, and duration of treatment. The first row indicates the patients' ID.

Participants	*1*	*2*	*3*	*4*	*5*	*6*
Gender	Male	Female	Male	Male	Female	Male
Pre pVHI age	8:9	8:11	8:2	8:3	8:9	8:2
Pre functional	8	7	8	8	9	7
Pre physical	18	16	18	14	19	10
Pre emotional	0	5	4	1	9	0
Pre total	26	28	29	23	35	17
Post pVHI age	19:1	17:7	15:11	15:3	15:0	15:8
Post functional	0	1	4	0	8	2
Post physical	6	12	0	1	14	6
Post emotional	0	2	2	0	3	0
Post total	6	15	6	1	25	8
Treatment	Therapy	Therapy	Surgery/ Therapy	Surgery/ Therapy	None	Therapy
Duration of Tx	Unknown	Unknown	10 mos.	9 years	N/A	2 years

The first proposed research question in this study attempted to determine if a patient's physical, functional, and emotional complaints changed following puberty. Participant's scores in the outlined subtests decreased an average of 61.37% overall. The majority of available responses (4/5) revealed that parents perceived their child's voice problem as being resolved at the time of the post-puberty survey. Participants displayed a 67.41% decrease in the functional subtest, 63.09% decrease in the emotional subtest, and 58.06% decrease in the physical subtest, when comparing pre and post-puberty data sets. These decreased pVHI scores indicate improvement in perceived voice quality following puberty. Table 2 and Figure 2 illustrate the total change in pVHI subtests and total scores from pre-puberty and post-puberty surveys.

Table 2: Pre-puberty and post-puberty mean scores of the total and subtest pVHI data. Percent change of the pVHI scores is shown for each subtest and total.

	Pre-Puberty pVHI	*Post-Puberty pVHI*	*Percent Change*
Functional Mean	7.83	2.50	67.41%
Emotional Mean	3.17	1.17	58.06%
Physical Mean	15.83	6.50	63.09%
Total Mean	26.33	10.17	61.37%

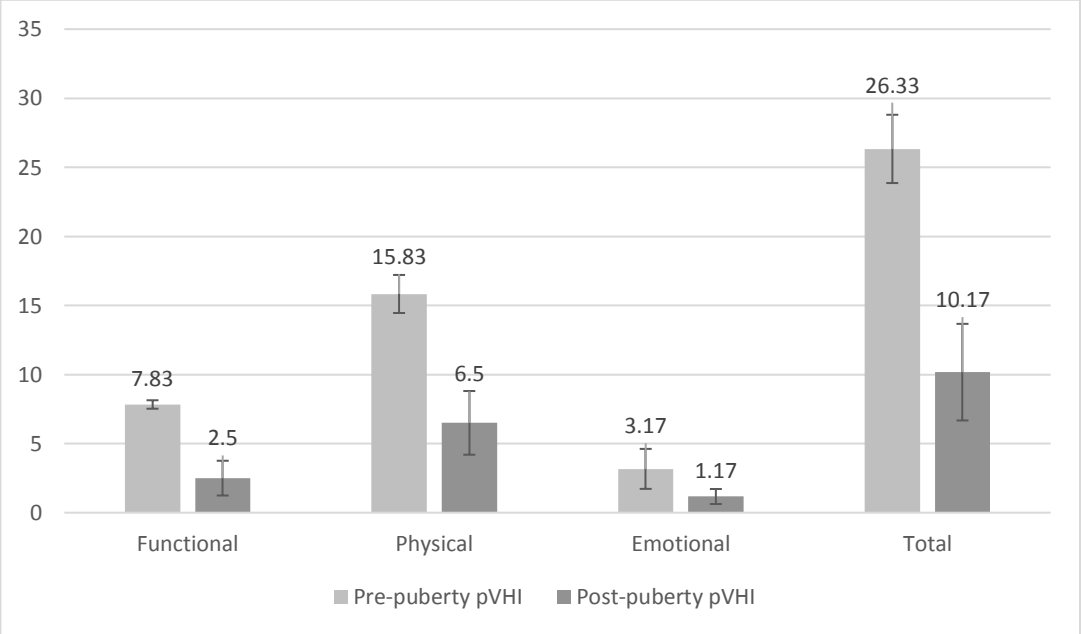

Figure 2: Bar graph with error bars displaying pVHI subtest and total scores before and after puberty.

After calculating the descriptive statistics, it was determined that the mean of the total pVHI score for males decreased. The initial total score average for males was 23.75; the post-puberty total score decreased to 5.25. This decrease revealed a total percent change of 77.9%. The total pVHI score for females also revealed a decrease from the pre-puberty total score to the post-puberty total score. The average pre-puberty total pVHI for females was 31.5, which decreased to 20 in the second, post-puberty survey. This change demonstrated a 36.5% total change. For females, the standard deviation was 5 between the pre-puberty surveys and 7.1 in post-puberty surveys. For males, the standard deviation was 5.1 in pre-puberty surveys and 3 in post-puberty surveys. The bar graphs in Figure 4 and Figure 5 show variations in pVHI subtest scores in pre-puberty and post-puberty surveys between males and females.

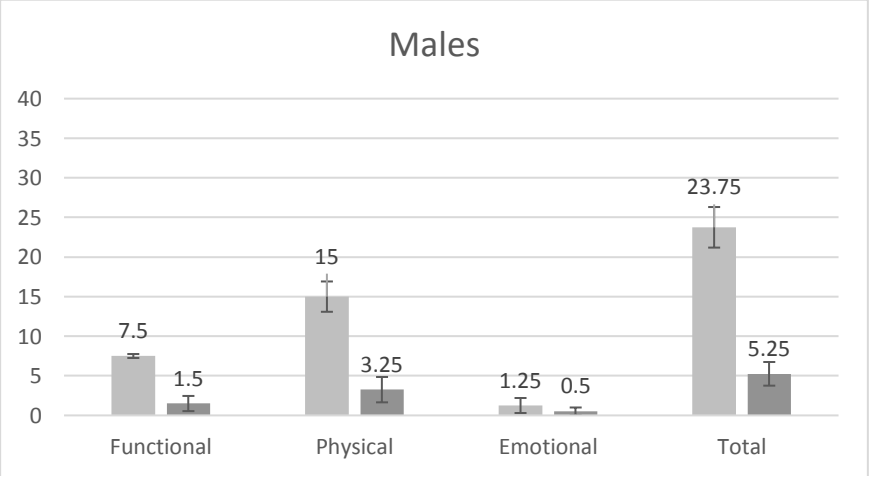

Figure 3: Bar graph with standard error bars providing male pVHI subtest and total scores pre- and post-puberty.

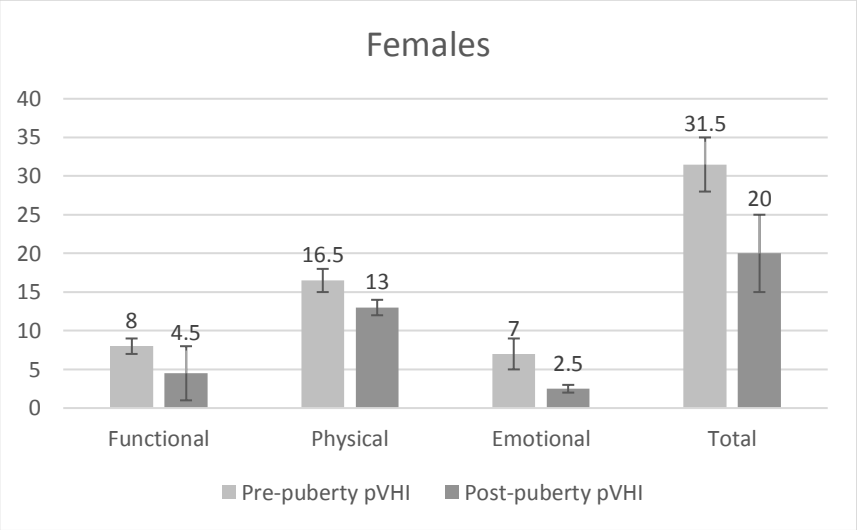

Figure 4: Bar graph with standard error bars providing female pVHI subtest and total scores pre- and post-puberty.

The final research question and hypotheses suggested that males would experience a significant improvement in perceived vocal quality, while females would experience improvement to a lesser extent. Males perceived vocal quality on the pVHI improved by 77.9%. Females perceived vocal quality on the pVHI improved by 36.5%. The line chart (Figure 5) below demonstrates this variation between genders in total mean pVHI percentage change. Standard error bars are included in the line chart to demonstrate variability of the data.

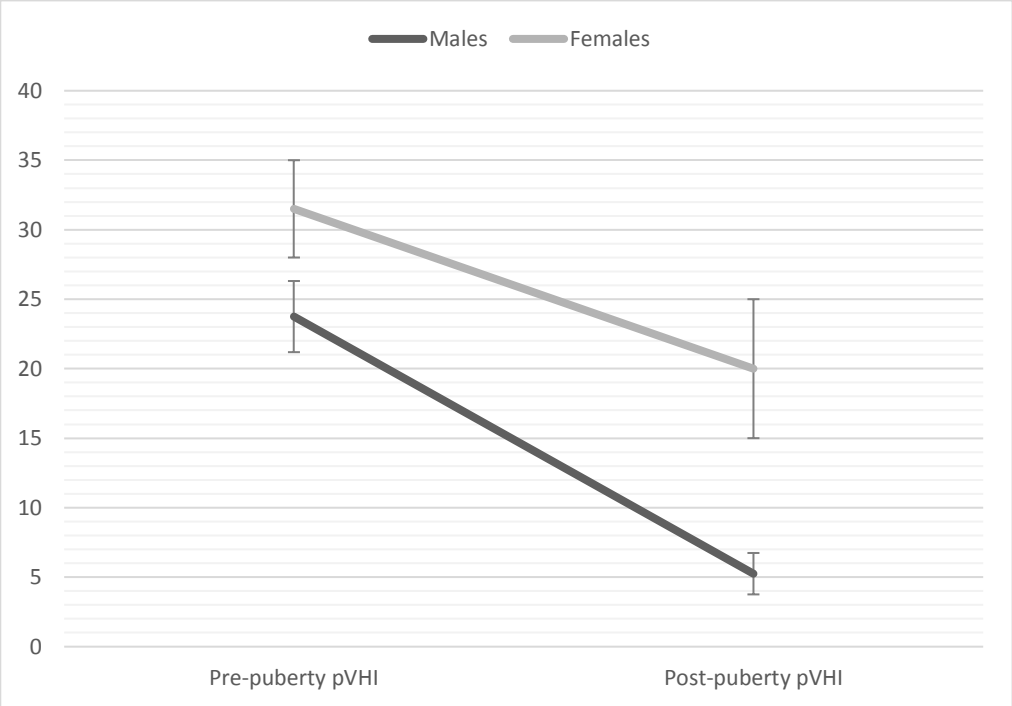

Figure 5: Line chart with standard error bars showing male and female total pVHI score changes, pre-puberty and post-puberty.

DISCUSSION

The results of this study revealed marked changes in the patient's physical, functional, and emotional complaints following puberty. Descriptive statistical analysis showed that all participants had a decrease in pVHI functional, physical, and emotional subtest scores, as well as, the total pVHI scores. It can be noted that in Table 1, the pVHI subtest scores and total scores decrease from the pre-puberty survey to the post-puberty survey amongst all participants. This analyzed data acknowledges that perceived vocal quality in the areas of functional voice, physical/anatomical features, and negative emotion change during puberty.

Determining whether there was a shift in prevalence between males and females in the complaints of bilateral vocal fold lesions following puberty was the purpose of the second research question. Figures 3, 4, and 5 illustrate the variation in pVHI score changes between males and females. The line chart in figure 5 reveals an increasing angle or distance between the male and female post-puberty total pVHI scores. There was a substantial variation between male and female perceived vocal quality following puberty. This descriptive statistical analysis provided preliminary quantitative data to confirm the phenomena that complaints of bilateral vocal fold lesions vary amongst gender.

In the final research question, it was hypothesized that both males and females would demonstrate improvement in perceived vocal quality (decrease in total pVHI score), however, males would demonstrate improvement to greater extent. In the total pVHI, males demonstrated a score decrease (perceived vocal quality improvement) of 77.89%. The female participants also demonstrated a score decrease (36.5%), but to a lesser extent than males. These changes are illustrated in the line chart in figure 5. The above results indicate that perceived poor vocal quality

more frequently persists beyond puberty for females. It is known that males experience more discernable changes in vocal fold length and thickness during puberty. Previous research has also revealed functional differences in male and female voice use prior to and following puberty.

Limitations of the study include small sample size and self-reported data. The study included a small number of participants (4 males, 2 females), which limited statistical testing. This small sample size may not be representative of a generalized distribution of the population. This study used data collected from parent report, which may contain biases. Continued research in this area should be completed to support the findings that males experience a more marked change in perceived voice complaints following puberty. A larger sample size and utilization of more quantitative measures (stroboscopic, acoustic, and aerodynamic measures) would be beneficial to generalize findings and to determine the specific cause of this trend.

This study has provided preliminary quantitative data to support the phenomena of higher rates of prepubescent males and postpubescent females with bilateral vocal fold lesions describing a perceived poor vocal quality. The results of this study have prompted better understanding of perceived voice outcomes in relation to the physical, functional, and emotional domains of the pVHI. The findings of this preliminary research may contribute information to future studies about the prevalence of perceived bilateral vocal fold lesions amongst males and females.

APPENDICES

APPENDIX A: Adapted pVHI survey used in active data collection for participants post-puberty.

<table>
<tr><td colspan="2">Patient Number:</td><td>Date:</td></tr>
<tr><td>Please describe your child's current voice quality:
Check all that apply.

____ Hoarse
____ Raspy
____ Low-pitched
____ Breathy
____ None
____ Other
_____.</td><td>Has your child undergone the start of puberty (voice change)?

____ Yes
____ No
____ Unsure</td><td>Have your child's voice problems resolved?
____ Yes
____ No
At what age? _____.

This form was completed by:
____ Parent
____ Patient (child)
____ Other:
_____.</td></tr>
<tr><td colspan="3">Please indicate any type of treatment or surgery your child has received to treat his/her voice disorder:
Please circle any that apply:
• Surgery
• Voice Therapy
• None</td></tr>
<tr><td colspan="3">I would rate my child's talkativeness as the following (circle response):

Quiet listener 0 1 Average talker 2 3 Extremely talkative 4</td></tr>
</table>

Instructions: These are statements that many people have used to describe their voices and the effects of their voices on their lives. Circle the response that indicates how frequently you (your child) have the same experience.

	Never	Almost Never	Sometimes	Almost Always	Always
Part I - F					
My child's voice makes it difficult for people to hear him/her.	0	1	2	3	4
People have difficulty understanding my child in a noisy room.	0	1	2	3	4
At home, we have difficulty hearing my child when he/she calls through the house.	0	1	2	3	4

My child tends to avoid communicating because of his/her voice.	0	1	2	3	4
My child speaks with friends, neighbors, or relatives less often because of his/her voice.	0	1	2	3	4
People ask my child to repeat him/herself when speaking face-to-face	0	1	2	3	4
My child's voice difficulties restrict personal, educational, and social activities.	0	1	2	3	4

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Part II - P

	Never	Almost Never	Sometimes	Almost Always	Always
My child runs out of air when talking.	0	1	2	3	4
The sound of my child's voice changes throughout the day.	0	1	2	3	4
People ask, "what is wrong with your child's voice?"	0	1	2	3	4
My child's voice sounds dry, raspy, and/or hoarse.	0	1	2	3	4
The quality of my child's voice is unpredictable.	0	1	2	3	4
My child uses a great deal of effort to speak (e.g. straining)	0	1	2	3	4
My child's voice is worse in the evening.	0	1	2	3	4
My child's voice "gives out" when speaking.	0	1	2	3	4
My child has to yell in order for others to hear him/her.	0	1	2	3	4

Part III - E

My child appears tense when talking to others because of his/her voice.	0	1	2	3	4
People seem irritated with my child's voice.	0	1	2	3	4
I find other people don't understand my child's voice problem.	0	1	2	3	4
My child is frustrated with his/her voice problem.	0	1	2	3	4
My child is less outgoing because of his/her voice problem.	0	1	2	3	4
My child is annoyed when people ask him/her to repeat.	0	1	2	3	4
My child is embarrassed when people ask him/her to repeat.	0	1	2	3	4

APPENDIX B: Phone script for the initial phone call to inform participants of the study.

"Hello, is Mr./Mrs. _____ available?

Hi Mr./Mrs. _____. My name is Skyler Nellesen, I'm calling on behalf of follow-up clinical for the Pediatric Voice Center at Cincinnati Children's Hospital. How are you today?

One of your children was identified as being previously seen at Cincinnati Children's Hospital for complaints of a hoarse voice.

We plan to send you a document, asking some questions about your child's voice. The questionnaire should take about 5-10 minutes to fill-out. This will allow us to continue to improve voice care for children at Cincinnati Children's Hospital.

I would like to schedule another phone call, in case you have any questions about the questionnaire. (schedule for 2 weeks)

The questionnaire will come in a white envelope with Cincinnati Children's Hospital's letter head out the outside within the next week or two.

Thank you very much! Have a nice night."

APPENDIX C: Informational letter included with mail pVHI surveys.

<Date>

<Contact Name>
<Company>
<Address>
<City, State, Zip>

Dear XX,

You are receiving this questionnaire on behalf of follow-up care for the Pediatric Voice Center at Cincinnati Children's Hospital. One of your children was identified as being previously seen at Cincinnati Children's Hospital for complaints of a hoarse, raspy, or breathy voice.

The enclosed document asks questions related to your child's voice and the impact their voice has on their daily life. This questionnaire should about 5-10 minutes to complete. A pre-stamped and pre-addressed envelope is included for the return of the survey.

The information you provide will allow us to continue to improve voice care for children at Cincinnati Children's Hospital. Your participation is greatly appreciated. You will be contacted in 1 to 2 weeks, should you have any remaining questions related to this form.

Thank you,

Skyler Nellesen

Pediatric Voice Center

Cincinnati Children's Hospital Medical Center

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