Feasibility of Intensive Voice Therapy for Pediatric Vocal Fold Nodules Delivered via Telepractice: Pilot Study

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Abstract: Purpose. The aim of this study is to assess the feasibility of an intensive voice therapy delivered via telepractice for pediatric vocal fold nodules (VFNs).

Method. Ten children with VFNs (mean age = 6 years, range = 5-8 years) were recruited in this study. Assessments including stroboscopic ratings, acoustic parameters, aerodynamic and auditory perceptual measures, and parent-reported Pediatric Voice Handicap Index were administered pretreatment and within 1 week post treatment. Eight resonant voice therapy sessions were provided three times a week via a secure online platform, which were completed within 3 weeks. The assessments were conducted in a clinical face-to-face modality in China, whereas the therapy sessions were all conducted online, with the participants and their caregivers in China and the speech-language pathologist in Taiwan.

Results. All participants completed the therapy sessions as scheduled, and there were no dropouts. Statistical analyses showed that significant improvements in acoustic and aerodynamic parameters, as well as stroboscopic and auditory-perceptual ratings.

Conclusion. This study provides positive preliminary results indicating intensive voice therapy delivered via telepractice may be feasible and effective for the pediatric VFN population. Service providers and families may consider this delivery modality for ease of access when voice therapy is recommended.

Key Words: Pediatric vocal fold nodules–Intensive voice therapy–Telepractice.

INTRODUCTION

Pediatric vocal fold nodules (VFNs) are the most common cause of dysphonia in childhood. Impact of pediatric VFNs may vary from individuals to individuals. Children with minimal sequelae may experience no interference with their communication or quality of life. In severe cases, however, children can have issues with frequent periods of aphonia, painful phonation, and poor communication, affecting self-esteem and relationships with others.[1] Children with dysphonia can be negatively judged by their peers and adults on ratings of physical, social, and personality factors based on recordings of their voices alone.[2] VFNs often leads to poorly developed communication skills and psychosocial abilities that are frequently associated with poor self-esteem.[3–5] Furthermore, chronic voice disorder can negatively affect a child's verbal communication and limit classroom participation, extracurricular activities, and occupational choice, leading to reduced quality of life.[6–9]

Voice therapy has been found to be beneficial in children with VFNs, as it may significantly improve voice quality, acoustic measures, and voice-related quality of life.[5,10,11] Despite this, not all children diagnosed with VFNs receive therapy. Several significant factors are associated with whether children with VFNs receive therapy or not; these include the patient's age, overall dysphonia severity, and distance to therapy.[12] Additionally, there is difficulty accessing needed voice therapy as there can be limited access to qualified speech-language pathologists (SLPs) experienced in pediatric dysphonia.[9] Like the adults, there are therapy adherence challenges in which there have been reports of an inability to remember how to perform the voice exercises, leaving their homework paper at home, forgetting to record when they did the exercises, and forgetting to do the exercises.[13] Patient's adherence to recommendations and compliance with practice frequency and duration can affect therapy effectiveness. Furthermore, treatments can be very family driven, as there may be reluctance to commit time and energy to a non-life-threatening pathology.[12]

It is known that a main aim of voice therapy is to learn voice motor skills.[14] Therefore, when designing an effective voice therapy for pediatric VFNs, motor learning principles need to be taken into account. These principles refer to the motor skills that are permanently changed through practice, retained, and/or transferred to a new behavior.[15] The area of practice distribution, that is, massed (intensive) versus distributed practice, has not been explored in the pediatric VFN population. However, it has been demonstrated through various voice disorders in the adult population that intensive training can provide efficient and effective restoration of the best possible voice within a short duration.[16–19] Thus, a short-term intensive voice therapy program may also be applicable to the families or caregivers of children with VFNs.

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In the COVID-19 pandemic and postpandemic circumstances where means to interact with others are limited, telepractice has become an alternative to the traditional face-to-face voice therapy. A study conducted in a tertiary pediatric institution noted anecdotal evidence of positive parental feedback and gains made via teletherapy provide promising initial data regarding the efficacy of voice therapy delivered via videoconferencing software.[12] A case-based report also supported the use of telepractice for pediatric voice care as it promotes a natural opportunity for the generalization of skills, that is, the patients were comfortable in their homes, resulting in ease with doing voice tasks that can sometimes cause embarrassment or uncertainty in person, and the use of home items or activities to work on informal conversation could be implemented; eased the rapport building between SLP and patient and families; and family members were readily available for patient assistance, hence were actively participating in the therapy.[9]

Despite the consistent report of the need to overcome the barriers of therapy completion, to the best of our knowledge, no research to date has been conducted to assess the feasibility and efficacy of intensive voice therapy delivered via telepractice in the pediatric population. Hence, the aim of this study is to determine whether telepractice application is feasible and effective when delivering intensive resonant voice therapy to children with VFNs.

METHODS

Subjects

A total of 10 participants (including nine males and one female) diagnosed with VFNs were recruited in the study. Approval was obtained from the Institutional Review Board of The Sixth Medical Center of PLA General Hospital, China (Approval No.: HZKY-PJ-2021-19). Prior to the data collection, each participant's parents gave informed consent. Presence of VFNs was confirmed via endoscopy performed by otolaryngologists. The inclusion criteria for participants were that they had to be aged between 4 and 12 years; had normal resonance and language ability; had normal hearing at ≦40 dB HL at four frequencies 500, 1000, 2000, and 4000 Hz; had no previous formal speech training, voice therapy, or laryngeal surgical treatment. Severity of dysphonia was determined from a recorded speech sample (a standard Mandarin passage) and rated using the "Grade" scale from the GRABS scale[20] (where 0 = normal, 3 = severe). A single SLP experienced in the assessment and treatment of voice disorders but blind to the study purpose conducted the severity rating.

Procedure

Following recruitment, each individual attended the clinic in person for a comprehensive baseline assessment of their voice and speech production. Stroboscopic examinations, auditory perceptual ratings, acoustic and aerodynamic measurements, and parents' perception questionnaires were collected. While all stroboscopic examination were performed by several otolaryngologists blinded to the study (same specialist per patient pretreatment and post treatment), auditory perceptual ratings, acoustic, and aerodynamic analysis were performed by one SLP experienced in voice disorders and blinded to the therapy protocol of this study. The participants then completed eight sessions of intensive voice therapy delivered via telepractice from their home, accompanied by a family member. Therapy sessions were provided by an SLP not involved in the assessment process. Reassessment was performed at the clinic, which took place within a week following completion of the final session of online therapy.

Stroboscopic examination

The stroboscopic recordings were performed during the sustained phonation of the vowel /i/ produced at a comfortable loudness and pitch. The examination procedure was conducted by one otolaryngologist per participant, pretherapy and post-therapy assessment. The stroboscopic ratings involved paired image comparison (pretreatment and post treatment) of the glottal closure (−1 = wider; 0 = no difference; 1 = smaller); nodule size (−1 = larger; 0 = no difference; 1 = smaller); and surrounding edema (−1 = larger; 0 = no difference; 1 = smaller).

Voice recordings

The participants' voice samples were collected in a clinical room where the environment noise was less than 48 dB, with a microphone placed at a fixed distance of 10 cm from the patient.[21] This study utilized a SHURE moving coil microphone (model: SV100C), produced by Shure Electronics (Suzhou) Company Ltd. Also, an external sound card (creative) and an audial interface (model: Scarlett), produced by Focusrite, were used in this study. The sampling rate was set at 44.1 kHz.

All participants were required to produce a sustained vowel /a/ for more than five seconds at a comfortable pitch and loudness level with a steady airflow. In addition, a passage in Mandarin Chinese,[22] with a normal speech rate was either read to or read by the participant. Three voice recordings were collected after one practice. The recordings were used for both acoustic analysis and auditory perceptual ratings.

Auditory perceptual ratings

All speech samples were subsequently analyzed perceptually by one certified SLP in Taiwan with over 3 years' experience assessing voice disorders and blinded to the study. To validate the reliability of the primary rater, a second SLP with over 10 years' experience assessing voice disorders and blinded to the research listened to and rated a random set of two paired samples (20% of the total voice samples, a total of four samples). Inter-rater reliability was calculated using the Percent Exact Agreement (PEA) and the Percentage Of Close Agreement (PCA—where raters differed by no more than one scale point). Intra-rater reliability was calculated by having the primary rater rerate 20% of the sample a second time, one month following the initial assessment.

Participants' voice quality was assessed using the GRBAS scale[20] which consists of five perceptual parameters: grade (G), roughness (R), breathiness (B), asthenia (A), and strain (S). GRBAS scale is an auditory-perceptual evaluation, which can indirectly reflect the basic features of vocal folds during phonation—the degree of vocal fold vibration, glottis closure, and vocal folds muscle tension.[23,24]

In order to detect any subtle differences between paired samples, GRBAS data was analyzed using the Comparison Mean Opinion Score Process[25] adapted from Fu et al.[18] This process involved voice samples being put into pairs (pre-post therapy), and then, to avoid any prediction bias, the order of the two samples in each pair was randomized. The procedure was performed by a research assistant independent of the rating process. The rater compared and listened to 10 paired speech samples (two samples per participant). After listening to each pair, the rating clinician evaluated sample 2 in relation to sample 1 on a scale of −3, −2, −1, 0, +1, +2, +3, in which 0 indicates the samples are equal for each GRBAS parameter. If the value was negative, it indicated that sample 2 was worse than sample 1 (−1 mildly worse, −2 worse, and −3 severely worse) and vice versa. The rater was allowed to listen to the paired samples as many times as needed. Once the paired samples were rated, the research assistant revealed the order of the two samples and transposed the scores to reflect the temporal order of the speech samples, such that any positive score indicated an improvement over time and negative values indicated deteriorating function.

Acoustic analysis

For acoustic analysis, Praat V6.0.43 (voice analysis software), a cross-platform multi-function professional phonetics software, was used to analyze Jitter, Shimmer, and harmonic-to-noise ratio (HNR). Sample frequency used was 44.1 kHz. In addition, Matrix Laboratory (MATLAB), a mathematical software, was used for algorithm development, data visualization, acoustic data analysis, and numerical calculation. Acoustic measures of spectrum convergence ratio (SCR), nonlinear energy difference ratio (NEDR), and voice type component (VTC) were yielded through the customized MATLAB. Jitter (%) demonstrates the differences in frequency during the vibration cycle in the acoustic signal. Shimmer evaluates the amplitude variation degree of each period in decibels (dB). SCR is an indicator of the convergence of the voice, which can be calculated by dividing the voice signal into multiple segments and then comparing the similarity or chaos between each segment.[26] NEDR reflects the irregularity and divergence of voice energy distribution.[27] VTC measures the chaos and eigen dimensions of the signal, which consists of four components, VTC1, VTC2, VTC3, and VTC4. Variable VTC1 represents periodic component, VTC2 represents quasi-periodic component, VTC3 represents chaotic component, and VTC4 represents stochastic component.[28]

Aerodynamic analysis

An aerodynamic measure of maximum phonation time (MPT) was administered by asking the participants to sit up, take a deep breath, and produce a sustained vowel /a/ for as long as possible at a comfortable pitch and loudness level. Three trials were performed, and the longest phonation time was selected for analyzes.

Parents' perspective of quality of life Pediatric Voice Handicap Index (pVHI)

The Mandarin version of the pVHI[29] (Table 6) was used to quantify parents' perception of their children's voice dysfunction, identifying multifactors on daily life affecting their children's voice and measuring treatment efficacy before and after voice therapy. The pVHI is a questionnaire with 23 items that are divided into three subscales: functional, physical, and emotional. Each item is scored from 0 to 4, and the higher the total score, the poorer voice-related quality of life.

Therapy program protocol

All participants completed eight therapy sessions over a 3-week period, delivered via telepractice. All participants received three telepractice sessions per week. In addition to the therapy sessions, all participants were required to complete homework activities using resources provided via WeChat app. Participants were instructed to complete this homework practice in two 15-minutes sessions per day on a non-treatment day and in one 15-minute session on a treatment day.

The online voice therapy was provided by an SLP who was not involved in assessment of the participants. The SLP was trained and certified to provide the therapy program, which was adapted from the Lessac-Madsen Resonant Voice Therapy developed by Verdolini Abbott.[30] The program was modified with the use of interactive online board games designed with age-appropriate forward resonant /m/ sound words so that the participants would be motivated to practice during and after the sessions. Components of the Vocal Function Exercises program developed by Stemple[31] were also incorporated in the speech tasks. The therapy contained an interactive vocal hygiene session using pictures shared on the screen, relaxation exercises followed by basic training gestures as described by Verdolini Abbott.[30] The sessions of direct facilitation of speech tasks proceeded in stages to a conversational level and real-life applications outside the therapy room. The participants' accompanied family members were well informed and joined in the sessions to ease the carryover of learned vocal techniques.

The telepractice system

The telepractice system used to conduct the therapy sessions consisted of two laptops or tablet computers (one at the clinician end and one at the participant end) with a web camera and microphone embedded and had to be equipped with encrypted videoconferencing software (VooV Meeting). VooV Meeting platform was implemented in this study as this is a readily available and widely used platform in China. Participants were required to have an account with WeChat app for communication before, during and after the sessions with the clinician and research assistant. All aspects of treatment were delivered remotely by one SLP with over 15 years of experience in voice disorders.

Statistical analysis

The Statistical Product and Service Solutions (IBM SPSS) version 25 was used for all statistical analysis, and the level of significance was set at $P < 0.05$. To determine whether significant changes occurred in perceptual parameters (grade, roughness, breathiness, asthenia, strain) and stroboscopic ratings (glottal closure, nodule size, and surrounding edema), after therapy, a one-sample t test (two-tailed) was, where 0 was taken to indicate no difference between the sample pairs. Comparisons between pretreatment and post treatment conducted for acoustic parameters (F_0, Jitter, Shimmer, HNR, SCR, NEDR, VCT1-4), aerodynamic parameter (MPT) and pVHI (total score) were analyzed using the Wilcoxon signed-rank test.

RESULTS

Demographics of subjects

Ten children (mean age = 6 years, range = 5-8 years) diagnosed with VFNs and mild-moderate dysphonia were included in the study. Table 1 shows detailed demographics of subjects. Severity of dysphonia was determined from a recorded speech sample with a standard Mandarin passage[22] read and rated using the "Grade" scale from the GRABS scale[20] (where 0 = normal, 3 = severe). An SLP experienced in the assessment and treatment of voice disorders but blind to the study conducted the severity rating. None of the subjects dropped out from this study; hence, there was 100% participation rate.

TABLE 1.
Demographics of Participants

	Participants ($n = 10$)
Mean age (year)	6
Sex	
Male	9
Female	1
Severity of dysphonia	
Mild	5
Moderate	5
Duration of symptoms (years)	
< 1	1
1-3	3
> 3	6

TABLE 2.
Results of the Stroboscopic Ratings—After Treatment

Parameters	Mean	t test	P value
Vocal nodule size	0.7	4.583	0.001*
Surrounding edema	0.7	4.583	0.001*
Glottal closure	0.7	4.583	0.001*

Notes: Mean of > 0 indicates improvements after treatment.
*$P > 0.05$.

Stroboscopic examination

A one-sample t test was used to analyze the stroboscopic examination ratings. Comparison between baseline and post-treatment stroboscopic ratings demonstrated the VFN sizes, surrounding edema, and glottal closure significantly decreased after therapy (shown in Table 2). With regard to the size of VFNs, out of the 10 participants, six (60%) had reduced the size of VFNs, two (20%) had complete resolution of VFNs, two (20%) had no changes in the size of nodules. As for the surrounding edema and glottal closure, seven (70%) had reduced edema, and three (30%) had no changes. For the glottal closure, seven (70%) had increased glottal closure, and three (30%) had no changes.

Auditory perceptual ratings

A one-sample t test was used to analyze the auditory-perceptual parameters. Comparison between baseline and post-treatment perceptual ratings demonstrated significantly reduced ratings of the overall grade, roughness, breathiness, and strain, indicating significant improvement (shown in Table 3). However, there were no changes in asthenia of voice post therapy. Out of the 10 participants, eight (80%) had reduced ratings in overall grade and roughness, seven (70%) had reduced breathiness, seven (70%) had reduced asthenia, and five (50%) had reduced strain of voice.

Inter-reliability and Intra-reliability of the auditory-perceptual judgment

The reliability of the primary rater was determined through a second SLP with over 10 years' experience assessing voice disorders who rated a random set of four samples (20% of the total samples). Inter-rater reliability was calculated using PEA and PCA. Findings revealed PEA was 80% and

TABLE 3.
Results of the Auditory Perceptual Ratings—After Treatment

Parameters	Mean	t test	P value
Grade	1.20	6.000	0.000*
Roughness	0.80	6.000	0.000*
Breathiness	1.10	4.714	0.001*
Asthenia	0.00	NA	NA
Strain	0.60	1.964	0.081

Notes: Mean of > 0 indicates improvements after treatment.
*$P > 0.05$.

PCA was 100%, respectively. Intra-rater reliability was calculated by having the primary rater rerate 20% of the sample a second time, one month following initial assessment. The PEA calculated for intra-rater reliability was 70%, while PCA was 100%. These indicate high inter- and intra-rater reliability.

Acoustic analysis

The results showed that acoustically, the Jitter and Shimmer were significantly lower after treatment (P = 0.005 and P = 0.022, respectively), and HNR and SCR were significantly higher after training (P = 0.009 and P = 0.013, respectively). With the VTCs, VTC1 was significantly higher after training (P = 0.007) and VTC3 was significantly lower after training (P = 0.005). There was no significant difference in F_0, NEDR, VTC2 or VTC4 after training (as shown in Table 4).

Aerodynamic analysis

The results as shown in Table 5 demonstrated that aerodynamically, the MPT was significantly increased after treatment (P = 0.005).

pVHI

The Wilcoxon signed-rank test was performed to analyze the parents' perception of their children's voice-related quality of life before and after the treatment. Results showed there was no significant increase in the total score of pVHI post therapy (P = 0.169) (see Table 4).

TABLE 5.
Results of MPT Before and After Treatment

	Pretreatment		Post treatment		
	Mean	SD	Mean	SD	*P* value
MPT (seconds)	6.620	2.874	9.954	3.929	0.005**

**P < 0.01.

TABLE 6.
Results of pVHI Before and After Treatment

	Pretreatment		Post treatment		
pVHI	Mean	SD	Mean	SD	*P* value
Total score	27.8	6.893	22.90	8.634	0.169

DISCUSSION

At present, voice therapy has been proven to effectively resolve or improve the voice quality, vocal fold function, and vocal fold endurance of children with benign vocal fold lesions and patients with muscular tension dysphonia. Voice therapy also reduces compensatory vocal behaviors and is recognized as the first-line treatment for VFNs and muscular tension dysphonia.[10,32–34] Meanwhile, many studies on voice therapy delivered via telepractice for adults have proven to be effective.[17,35–38]

The results of this study showed that after the subjects underwent direct voice therapy delivered via telepractice, the size of the VFNs significantly decreased in some children, the surrounding edema noticeably improved, and the degree of glottal closure was markedly enhanced. This demonstrated the physiological effectiveness of remote voice therapy, which is similar to findings in the adult VFNs population.[18]

After the children underwent remote voice therapy, the overall severity, roughness, and breathiness of their voices significantly improved. This indicated that after the participants underwent voice therapy, the vibration of the vocal folds became more regular, the closure of the vocal folds significantly improved, the clarity of the voice increased, the breath support was more stabilized, and the overall voice quality enhanced. None of the participants in this study exhibited voice weaknesses. The findings of this study are consistent with those by Akın Şenkal and Özer.[39] They provided behavioral voice therapy and medications to 75 children, aged 7-14, who reported hoarseness in their

TABLE 4.
Results of Acoustic Analysis Before and After Treatment

	Pretreatment		Post treatment		
Parameters	Mean	SD	Mean	SD	*P* value
F_0 (Hz)	243.246	18.453	252.553	24.851	0.203
Jitter (%)	0.848	0.15	0.437	0.12	0.00588**
Shimmer (dB)	0.569	0.340	0.283	0.137	0.022**
HNR	15.152	4.844	20.072	3.744	0.009**
SCR	0.219	0.165	0.389	0.196	0.013*
NEDR	0.069	0.014	0.057	0.015	0.074
VTC1	0.159	0.144	0.369	0.181	0.007**
VTC2	0.246	0.121	0.285	0.150	0.333
VTC3	0.464	0.209	0.164	0.075	0.005**
VTC4	0.132	0.044	0.179	0.241	0.501

*P < 0.05, **P < 0.01 (pretraining compared to end of training).

voices. The specific interventions were tailored based on the patients' needs. Auditory perceptual assessment of voice was conducted before and after the interventions. The study revealed significant improvements in the children's overall voice quality, hoarseness, and breathiness following the interventions.[39]

Acoustic findings indicate that there were no significant changes in the F_0 of the subjects before and after vocal intervention. The F_0 represents the basic frequency of vocal fold vibration, which refers to the lowest frequency at which the vocal folds vibrate periodically. Linguistically, this frequency manifests as the pitch of the voice, and physiologically, it is indicative of the speed of vocal fold vibration.[20] In this study, the lack of notable change in the F_0 might be due to the fact that the overall severity of the voice disorders in the 10 pediatric subjects was not particularly pronounced prior to receiving therapy, hence no significant differences were observed. In the present study, there was a noticeable decline in the values of Jitter and Shimmer and a significant increase in the HNR. This suggests that the vibrations of the subjects' vocal folds were becoming more regular, with improved glottal closure conditions. These findings are similar to those of Salderay et al.[40] Their study, which involved 30 children with VFNs, implemented behavioral voice therapy that included voice hygiene education for both the patients and their parents over an 8-week period. The study revealed that after voice therapy, there was a marked improvement in the subjects' jitter local and jitter local abs.[40] Our study also aligns with the findings of Pribuisiene et al,[41] who conducted voice training on 262 children with voice anomalies. Their results demonstrated that after voice training, there were marked enhancements in the average Jitter and Shimmer for children who underwent voice training.[41]

In the present study, after participants received remote voice training, the SCR values markedly increased, indicating that their voices became more periodic and orderly, progressively trending toward stability. These findings align with those of Liu et al.[42] Both groups underwent resonant voice therapy and voice hygiene education. Acoustic assessment of the voice was conducted for both groups before and after the intervention. The study results revealed that the SCR values significantly increased for participants in both groups after the voice interventions, suggesting that both telepractice and in-person voice interventions notably enhanced the stability of the participants' vocal signals.[35]

In the current study, there was no notable difference in NEDR before and after voice training. This may be attributed to the fact that after the training, the majority of changes in voice quality occurred within the same type of range. Given the NEDR's efficient differentiation capability between types and the limited variations within a particular type, the differences in NEDR were not discernible, resulting in no statistical significance. Another potential factor may be the relatively mild severity of vocal disorders among the subjects in this study, leading to less evident manifestation of disordered acoustic signals. The results of this study align with the findings of Liu et al.[42] In their study, 34 female primary school teachers with self-reported voice disorders were categorized into two groups. Their results indicated no significant improvement of the voice quality for either group after the interventions in comparison to their preintervention statuses.[42]

The findings of this study revealed a significant increase in VTC1 and a notable decrease in VTC3, indicating a growing prominence of periodic components and a diminishing presence of chaotic components in the participants' vocal signals. This suggests a trend towards greater regularity and stability in the vocal signals. While VTC2 did not exhibit significant changes before and after vocal training, the results did show some improvement, indicating an enhancement in quasi-periodic components in the participants' vocal signals. This suggests increased stability and regularity in the vocal signals following training. VTC4 did not show significant changes before and after vocal training. These findings align with a study by Liu et al,[42] which observed a significant increase in VTC1 and noticeable decreases in VTC3 and VTC4 for the group receiving vocal training, indicating a substantial enhancement in the stability of the participants' vocal signals after training.

This study's findings indicated that following vocal training, participants exhibited a significant increase in the MPT. This suggested that the participants, through training, had acquired proficient abdominal breathing skills. As a result, there was a notable improvement in breath support, enhanced stability, and an extended duration of breathing. This had consequently reduced the strain on the larynx, enabling a consistent and stable airflow, which facilitated regular vocal fold vibration. This observation parallels the findings of Akın Şenkal and Özer,[39] where their study similarly noted a significant extension of MPT in pediatric patients following phonation interventions.[39]

The results of this study indicated a decrease in the pVHI scores for participants after vocal training compared to before the training, suggesting that parents perceive an improvement in their children's voice-related quality of life. However, no significant difference was observed. Two potential reasons can be posited for this outcome: firstly, the overall sample size of this study was limited, and the voice disorder symptoms observed were relatively mild; secondly, it was noted in the findings that scores for five participants actually increased after the voice intervention. This increase might be attributed to an initial lack of parental awareness regarding the severity of their child's voice disorder. After receiving vocal hygiene education, parents became more cognizant of certain voice symptoms of their child, leading to heightened sensitivity to the issue. Consequently, higher scores were observed in the post test compared to the pretest, resulting in the absence of a significant difference in pVHI scores before and after the voice intervention.

The results of this study show that intensive voice training can effectively improve the voice quality of children, consistent with several other research findings.[43–46]

Intensive voice training involves rapid and repetitive stimulation methods to induce patients with voice disorders to produce the correct voice, thereby rapidly improving voice quality.[43] Studies have shown that compared with the traditional voice intervention methods, intensive voice training can improve motor learning and behavior change more quickly, thus enhancing the effectiveness of the intervention.[44–46]

In this study, the full cooperation of parents of children with VFNs may also be one of the reasons for the remarkable intervention effect of remote voice training. Starting from the second voice training session, the SLP would ask the parents before each voice training whether they supervised their child's completion of the previous session's training tasks in accordance with the requirements of family independent training. After receiving a positive response, the SLP would check whether the child has fully mastered the previous session's training tasks before moving on to the next training task. Therefore, whether in telepractice or in-person behavioral voice interventions, active collaboration from the parents is essential for achieving optimal prognostic effect. This finding suggests a promising avenue in future studies.

LIMITATIONS

Due to limitations in the COVID-19 restricting conditions at the time of the data collection, the number of participants in this study was limited, and no control group was set up. In subsequent research, the number of participants can be increased and a control group can be established to enhance the precision and objectivity of the study. Additionally, the future direction of the study could be to conduct the same type of remote voice therapy within other cultural settings to determine whether the results remained consistent among children from other countries and cultures.

CONCLUSION

Remote behavioral voice intervention can have a relatively good prognostic effect on children with VFNs. It can alleviate the severity of voice disorders in pediatric patients and improve their voice-related quality of life. Remote behavioral voice intervention can save time, transportation, and financial costs for both the children and their parents. It enhances the children's adherence to training, thus improving the treatment efficiency. As a result, remote behavioral voice intervention is a clinical intervention method for children's voices that may be widely promoted and applied.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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