Outcome of stuttering therapy on Egyptian school-aged children using the speak freely program

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Received 01 December 2014
Accepted 22 January 2015

The Egyptian Journal of Otolaryngology
2015, 31:188–195

Background
The training program presented depends on improving the physical dimension for stutters by teaching both stuttering modification and fluency-shaping techniques based on the Speak Freely Program.

Aim of the work
This study is designed to adapt and apply the 'Speak Freely Program' of stuttering intervention for Arabic-speaking school-aged stuttering children and to explore its effectiveness as a therapeutic tool.

Subjects and methods
The present work was carried out on 25 stuttering children of both sexes in the age range of 7–18 years. The participants were divided into two age groups: group I (7–12 years) and group II (12.1–18 years). Each participant was subjected to the protocol of stuttering evaluation as follows: (a) assessment of history and analysis of complaints; (b) observation of features of stuttered speech (core behavior, secondary reactions, devices to cancel stuttering, escape, antiexpectancy) and overt behaviors; (c) Stuttering Severity Instrument (SSI-3) was used to assess moments of stuttering in a speech sample and reading aloud; (d) psychometric battery was used to compare between pretherapeutic and post-therapeutic anxiety and depression scale; (d) two objective evaluations were used: first, spectral analysis to measure the voice onset time, formant transition, and vowel duration for all participants' fluent productions of monosyllabic words with initial /t/ and /d/, and second, Visipitch to measure fundamental frequency, relative average perturbation, amplitude, shimmer, voiced percent (voiced%), voiceless%, and pause% in an automatic, reading, and spontaneous.

Results
The study showed that the younger stutterers achieved better outcome with the therapeutic program. The results of the SSI-3 and the anxiety and the depressive state of the studied children, respectively, showed a highly significant difference between the pretherapeutic and the post-therapeutic values of the two groups studied. Formant transition of the (voiced and voiceless) and the vowel duration of (voiceless) monosyllabic words showed a difference after therapy. Both groups showed higher post-therapeutic values for the voiced%, voiceless%, and the amplitude measurements.

Conclusion
To conclude, stuttering therapy alters the acoustic properties of stutterers' fluent speech concomitant with reducing stuttering frequency speech samples.

Keywords:
speak freely, stuttering, treatment of stuttering

Egypt J Otolaryngol 31:188–195

1012-5574

Introduction

Stuttering is a diagnostic label referring to a clinical syndrome characterized most frequently by abnormal and persistent dysfluency in speech accompanied by characteristic affective, behavioral, and cognitive patterns [1]. Stuttering affects ~4–5% of the preschool children. The natural course of developmental stuttering is spontaneous resolution by age 16 in 80% of children. However, some children continue to stutter and the prevalence of developmental stuttering in the adult population is 1% [2]. Although stuttering often resolves before adulthood, it can cause significant anxiety for children and their families [3]. Methods for working with the physical dimension of stuttering have typically been divided into two categories: stuttering modification and fluency shaping. Stuttering modification strategies reduce physical tension during stuttering and enable individuals to stutter more easily. Fluency-shaping strategies directly improve the fluency of speech. These approaches have their unique, complementary benefits and should be incorporated into school-age therapy [4]. The Speak Freely Program is a comprehensive direct intervention for stuttering that incorporates both stuttering modification and fluency-shaping strategies, offering the benefits of both approaches. It provides detailed instructions and materials that facilitate the development of specific stuttering

modification and fluency-enhancing strategies. It aims to help clinicians develop practical and effective clinical tools for working with school-age stutterers aged 7–18 years [4]. The lack of a stuttering training program addressing Arabic-speaking stutterers that offers a well-integrated progression of therapeutic procedures led to the present research.

Aim

The aim of this study is to provide a stuttering training program based on integrating stuttering modification techniques and fluency-shaping techniques for school-age children who stutter.

Participants and methods

The present study was carried out on 25 stuttering children of both sexes in the age range of 7–18 years, recruited from among cases attending the Unit of Phoniatrics, Faculty of Medicine, Alexandria University. The selection criteria were as follows: children diagnosed to have stuttering on the basis of the following:

(i) Clinical criteria: patient or parent complaint;
(ii) Definitive diagnostic criteria: on the basis of the Stuttering Severity Instrument (SSI-3).

The exclusion criteria were as follows:

(i) Children with mental subnormality;
(ii) Children with psychiatric problems; and
(iii) Children with hearing or visual impairments.

The participants were divided according to their age range into two groups: group I: age range from 7 to 12 years, and group II: age range from 12.1 to 18 years. An informed consent was obtained from all participants of the study.

Methods

The present study proceeded according to the following steps.

Formulation of the remediation program

The remediation program aims to improve the physical dimension for stutters by teaching both stuttering modification and fluency-shaping techniques based on the Speak Freely Program [4].

The program was translated into Arabic and a number of modifications were made to the words, phrases, sentence levels, and reading paragraphs on the basis of differences between Arabic and English sounds.

(1) The modifications made to the sounds of slow stretched speech were as follows:
   (a) Substituting the English voiced fricative /v/ by the Arabic ones /ðˤ/,/ɣ/.
   (b) Adding the Arabic semivowel /ʕ/.
   (c) Excluding the voiced affricates /dʒ/.
(2) The modifications made to the sounds of light contact were as follows:
   (a) Substituting the English stop /p/ by the emphatic Arabic sounds /tˤ/, /q/, /dˤ/.
   (b) Adding Arabic voiceless fricative sounds /sˤ/, /ħ/, /x/.
   (c) Excluding the English voiceless affricates /tʃ/.

Initial assessment

Each participant was subjected to the following protocol of assessment:

(1) Elementary diagnostic procedure: this included complete assessment of history. Auditory perceptual assessment to determine the severity of stuttering; overt behaviors including eye contact, associated movements, breathing, and skin reactions were noted.
(2) Clinical diagnostic procedures: this included SSI-3 [5] to assess stuttering moments in a speech sample and while reading aloud.
(3) Language assessment: the Comprehensive Arabic Language Test (CALT) [6] was used for formal assessment of the language.
(4) Psychometric evaluation: this was carried out using the Stanford Binet test [7], Children's Anxiety Scale (CAS) [8], Children's Depression Scale (CDS) [9], the Children Behavior Rating Scale (CBRS) [10], and the Taylor Manifest Anxiety Scale (TMAS) [11].
(5) Additional instrumental diagnostic measures were performed using spectral analysis of the patient's speech using Kay CSL (Model 4300B, version 3, USA). All participants' perceptually fluent productions of monosyllabic words with initial interdental sounds /t/ and /d/ were acoustically analyzed. The voice onset time (VOT), formant transition (FT), and vowel duration (VD) were measured for voiced and voiceless stop consonants /t/ and /d/.
(6) Visipitch: using the Kay CSL-Pitch program (Model 433) to measure fundamental frequency, relative average perturbation (RAP), amplitude, shimmer, voiced, voiceless, and pause percentage in automatic, reading, and spontaneous speech samples.

Intervention

The program was applied to all the participants for a duration of 20 h, and the sessions were scheduled individually, each for about 30 min twice weekly.

The program is divided into three phases:

Phase I: learning about speech and stuttering:

It includes teaching children about the body parts involved in producing speech as well as understanding and identification of fluency and stuttering moments.

(1) Anatomy of speech system: in language appropriate to the child's conceptual level, the child is introduced to the anatomy and physiology involved in voice production and what 'happens' during stuttering.
(2) Types of dysfluencies: these were described to the child. The child was asked to identify the type of stuttering that he/she has.
(3) Catching the stutter: child identifies the moment of stuttering and signals it by closing their hand. They are instructed to attempt to match the tension level of the hand to the tension level of the dysfluency.
(4) Relaxing the stutter: it involves having the child purposefully stutter on a word with 100% tension, observe the dysfluency, and then repeat the word with decreased tension.

Phase II: integration of stuttering modification and fluency-shaping strategies

(1) Stuttering modification strategies: these strategies aim to reduce physical tension during stuttering and enable individuals to stutter more easily.
    (a) Slide: children catch themselves during a moment of stuttering and then 'slide out' of the dysfluency gradually.
    (b) Easy stuttering: the child intentionally produces relaxed, controlled repetitions of sounds, syllables, or words.
    (c) Cancellation: the child pauses for a couple of seconds after a moment of stuttering (to acknowledge and analyze the dysfluency), and then say the stuttered word again with less tension.
(2) Fluency-shaping strategies: these aim to improve the production of a more fluent, controlled, and less effortful output.
    (a) Relaxed breath: the child learns to use relaxed diaphragmatic breathing as he/she speaks.
    (b) Slow stretched speech: the child prolongs individual syllables to ~10 times their normal duration. Stretchable consonants are m, n, l, r, w, j, ð, z, $ð^ˤ$, ʕ, ɣ.
    (c) Smooth movement: it is achieved by slowing, exaggerating, and blending transitional articulatory movements at the syllable level and then the word level.
    (d) Easy voice: children initiate the production of vowel sounds in a relaxed and gentle manner.
    (e) Light contact: children touch their speech articulators together gently when producing stops (b, d, t, g, k, $t^ˤ$, q, $d^ˤ$) and voiceless fricatives (f, θ, s, $s^ˤ$, ʃ, h, ħ, x).
    (f) Stretched speech: stretched speech requires prolonging syllables by increasing the rate of the slow stretched speech (increases the rate to approximately one second per syllable).
    (g) Linked relaxation rhythm: this is a rhythmic speech pattern in which relaxed, continuous phonation is maintained. Oscillation of loudness is produced on each syllable, infusing periodic cycles of relaxation within the connected speech.
    (h) Extra intonation: the child exaggerates rising and falling inflections, and adds variation and flexibility to the rhythm of their speech. Extraintonation enables the child to speak in a more spontaneous and free-flowing manner while integrating previously learned fluency skills.
    (i) Nearly natural speech: this is a usage of a more normal intonation increasing speech rate, reducing the exaggerated quality of extraintonation.
    (j) Natural speech: it is a controlled production speech modification that children use when they choose to do so.

Phase III: carry-over with appropriate expectations:

(1) Children use these stuttering modification and fluency-enhancing skills during structured activities, which gradually increase the length of utterance and linguistic complexity.
(2) Children should continue to practice their skills to keep them accessible.

Re-evaluation

Participants were re-evaluated after the application of the remediation program using the same protocol of initial assessment.

Results

In the present study, 92% of the participants in group I were males and 75% of the participants in group II were males. This is in agreement with several studies reporting a predominance of males. Nearly 24% of

stuttering children in both groups had a positive family history for older relatives who were stutterers. In addition, a significant relation was observed between family history and the percent of change in the severity of stuttering. Stutterers with a negative family history showed better results post-therapeutically.

The current study showed a pattern of improvement across all items of SSI-3, showing a highly significant difference between the pretherapeutic and the post-therapeutic values of the two groups studied. In addition, group I showed a higher percentage of change post-therapeutically in all items of SSI-3 compared with group II, with a significant difference in the duration of the stuttering moment item in favor of group I. The significant negative correlation between the age of the child and the percentage of change in the total score of stuttering severity indicated that better improvement is to be expected in the younger age group (Tables 1 and 2).

In group I, the younger age group, the psychometric evaluation tools used were the CAS and CDS to evaluate the anxiety and the depressive state, respectively, of the children studied. The results showed a significant difference between the pretherapeutic and the post-therapeutic scores (Table 3). Moreover, there was a

Table 1 Comparison of stuttering severity instrument test items in group I before and after therapy

Test items	Minimum	Maximum	Mean	SD	*t*	*P*
Frequency						
Pretherapy	6	18	15.54	3.479	8.617	0.007*
Post-therapy	0	18	10.15	5.625		
Length						
Pretherapy	3	4	3.46	0.519	20.339	<0.001**
Post-therapy	0	4	1.92	1.115		
Associated movements						
Pretherapy	1	10	4.92	2.929	19.68	<0.001**
Post-therapy	0	2	1.15	0.899		
Total						
Pretherapy	16	32	23.92	4.786	20.102	<0.001**
Post-therapy	0	24	13.23	7.143		

t, paired *t*-test, *Statistically significant at $P \leq 0.01$, **Statistically highly significant at $P \leq 0.001$.

Table 2 Comparison of stuttering severity instrument test items in group II before and after therapy

Test items	Minimum	Maximum	Mean	SD	*t*	*P*
Frequency						
Pretherapy	7	18	15.75	3.494	5.102	0.034*
Post-therapy	4	16	12.5	3.555		
Length						
Pretherapy	2	4	3.42	0.669	11.702	0.002**
Post-therapy	2	3	2.58	0.515		
Associated movements						
Pretherapy	3	12	6.17	2.588	21.699	<0.001***
Post-therapy	0	5	2.17	1.467		
Total						
Pretherapy	13	33	25.33	5.365	15.268	0.001***
Post-therapy	6	22	17.25	4.751		

t, paired *t*-test, *Statistically significant at $P \leq 0.05$, **Statistically significant at $P \leq 0.005$, ***Statistically highly significant at $P \leq 0.001$.

Table 3 Comparison between pretherapeutic and post-therapeutic values of children's anxiety scale and children's depression scale in group I

Psychometric tests	Minimum	Maximum	Mean	SD	*t*	*P*
CAS						
Pretherapy	6	37	20.92	9.954	5.114	0.033*
Post-therapy	6	23	13.77	5.57		
CDS						
Pretherapy	15	41	23.92	7.836	9.123	0.006**
Post-therapy	12	21	16.2	2.9		

t, paired *t*-test; CAS, Children's Anxiety Scale; CDS, Children's Depression Scale, *Statistically significant at $P \leq 0.05$, **Statistically highly significant at $P \leq 0.01$.

significant positive correlation between percentage of change in CAS and CDS and the percentage of change in SSI-3 scores. This indicates that a decrease in anxiety and depressive state is associated with an improvement in stuttering severity. Children learned to improve their ability to manage stuttering and the accompanying fear, anticipatory stress, and self-concept.

In group II, anxiety was evaluated using the TMAS and the results obtained showed a significant improvement in the post-therapeutic TMAS scores compared with the pretherapeutic TMAS scores (Table 4). It is clear that effective treatment that reduces stuttering symptoms with a consequential decrease in avoidance and escape behavior will also result in a reduction in anxiety as a result of the decreased stuttering.

Treatment of stuttering frequently affects changes in the overall speech pattern, resulting in a situation in which successfully treated individuals who stutter are relatively fluent, but their phonemes are slow, paced, or monotonous and can be discriminated from normal speech [103].

Spectrographic analysis showed that stuttering therapy alters the acoustic properties of stutterers' fluent speech concomitantly with reducing stuttering frequency.

There are higher post-therapeutic spectrographic values. In group I, a significant difference was found between pretherapeutic and post-therapeutic values in the FT of the (voiced and voiceless) and the VD of (voiceless) of monosyllabic words (Tables 5 and 6). In group II, a significant difference was found between pretherapeutic and post-therapeutic values in the VD and FT of both (voiced and voiceless) of monosyllabic words (Tables 7 and 8). Furthermore, a significant negative correlation was found between the percentage of change in VD (voiced) and percentage of change in the total SSI-3 in both groups (Table 9). The therapeutic program taught children to cognitively produce easy onset of phonation, prolong syllables, gentle transition between sounds, and to reduce the articulatory tension.

VOT has been one of the most extensively studied areas of motor control in stuttering. The increased duration

Table 4 Comparison between pretherapeutic and post-therapeutic values of Taylor Manifest Anxiety Scale in group II

Tests	Minimum	Maximum	Mean	SD	*t*	*P*
TMAS						
Pretherapy	16	38	28.42	6.882	5.21	0.032*
Post-therapy	13	37	22.33	6.155		

t, paired *t*-test; TMAS, taylor manifest anxiety scale, *Statistically significant at $P \leq 0.05$.

Table 5 Comparison of voiced monosyllabic words in spectrographic analysis in group I before and after therapy

Voiced	Minimum	Maximum	Mean	SD	*t*	*P*
VOT						
Pretherapy	0.02	0.16	0.0862	0.04445	0.236	0.818
Post-therapy	0.02	0.3	0.0915	0.09459		
VD						
Pretherapy	0.17	0.6	0.2923	0.13977	1.610	0.133
Post-therapy	0.06	1.1	0.4315	0.33454		
FT						
Pretherapy	0.04	0.08	0.0485	0.01068	2.365	0.05*
Post-therapy	0.03	0.06	0.0511	0.012		

FT, formant transition; *t*, paired *t*-test; VD, vowel duration; VOT, voice onset time, *Statistically significant is at $P \leq 0.05$.

Table 6 Comparison of voiceless monosyllabic words in spectrographic analysis in group I before and after therapy

Voiceless	Minimum	Maximum	Mean	SD	*t*	*P*
VOT						
Pretherapy	0.03	0.9	0.0692	0.2362	1.124	0.283
Post-therapy	0.05	0.13	0.1385	0.0292		
VD						
Pretherapy	0.12	0.6	0.223	0.122	1.941	0.05*
Post-therapy	0.13	0.6	0.35	0.1905		
FT						
Pretherapy	0.03	0.06	0.0462	0.01044	2.436	0.017*
Post-therapy	0.02	0.8	0.1591	0.28504		

FT, formant transition; *t*, paired *t*-test; VD, vowel duration; VOT, voice onset time, *Statistically significant is at $P \leq 0.05$.

Table 7 Comparison of voiced monosyllabic words in spectrographic analysis in group II before and after therapy

Voiced	Minimum	Maximum	Mean	SD	*t*	*P*
VOT						
Pretherapy	0.04	0.9	0.0508	0.3187	1.910	0.082
Post-therapy	0.03	0.09	0.2217	0.0215		
VD						
Pretherapy	0.1	0.29	0.2008	0.0669	5.557	<0.001**
Post-therapy	0.2	0.6	0.4358	0.1412		
FT						
Pretherapy	0.04	0.08	0.0500	0.0147	2.292	0.05*
Post-therapy	0.04	0.06	0.0558	0.0066		

FT, formant transition; VD, vowel duration; VOT, voice onset time, *Statistically significant at $P \leq 0.05$, **Statistically highly significant at $P \leq 0.001$.

Table 8 Comparison of voiceless monosyllabic words in spectrographic analysis in group II before and after therapy

Voiceless	Minimum	Maximum	Mean	SD	*t*	*P*
VOT						
Pretherapy	0.03	0.3	0.0642	0.1004	0.712	0.492
Post-therapy	0.05	0.08	0.0858	0.0108		
VD						
Pretherapy	0.11	0.29	0.179	0.0650	2.495	0.030*
Post-therapy	0.13	0.50	0.301	0.1614		
FT						
Pretherapy	0.03	0.8	0.053	0.29317	1.986	0.05*
Post-therapy	0.02	0.07	0.1725	0.01894		

FT, formant transition; VD, vowel duration; VOT, voice onset time, *Statistically significant at $P \leq 0.05$.

Table 9 Comparison between the two groups studied in the percentage of change in spectrographic analysis post-therapeutically in voiced monosyllabic words

Voiced	Mean ± SD	*t*	*P*
VOT			
% of change in group I	25.16 ± 105.72	2.355	0.033*
% of change in group II	−47.27 ± 32.12		
VD			
% of change in group I	57.88 ± 116.45	1.785	0.087
% of change in group II	142.56 ± 120.63		
FT			
% of change in group I	7.12 ± 29.72	0.956	0.349
% of change in group II	18.13 ± 27.70		

FT, formant transition; VD, vowel duration; VOT, voice onset time, *Statistically significant at $P \leq 0.05$.

of VOT reported in the present study can be attributed to the practice of smooth articulatory movement between sounds and the light contacts of articulators during stops and the production of fricative sounds.

Difference in FTs is a fairly consistent finding among younger children who stutter. The increased duration of FT reported could be related to the slow stretched speech and the smooth articulatory movement techniques that stutterers acquired during the training program.

With reference to the Visipitch analysis, both groups showed increased post-therapeutic values of the voiced%, voiceless%, and amplitude. However, decreased post-therapeutic values of the silence%, RAP%, and shimmer were found. This can be attributed to instruction to stuttering children to prolong voiced sounds and produce easy onset of phonation.

Discussion

Group I showed a higher percentage of change post-therapeutically in all items of SSI-3 compared with group II, with a significant difference in the duration of the stuttering moment item in favor of group I. This would indicate that better improvement is to be expected in the younger age group. Healy and Scott [12], who used an integrative approach for treating school-age children who stutter, reported that many children treated in their program achieved increased levels of fluency on the basis of pretherapeutic and post-therapeutic stuttering frequency data as the criteria for success. They found that ~20% of the children who had completed the treatment program showed steady reductions in the frequency and duration of their stuttering as well as secondary behaviors [12]. Using the CAS and CDS to evaluate the anxiety and the depressive state of the studied children, respectively, the results showed a significant difference between the pretherapeutic and the post-therapeutic scores. This is in agreement with the study of Davis *et al.* [13], who reported a significant difference in state anxiety in the persistent stuttering group than controls and the recovered from stuttering group, but no significant

differences were found between the three groups studied with respect to trait anxiety [13]. Moreover, the present study showed a significant positive correlation between percentage of change in CAS, CDS, and the percentage of change in the severity of stuttering. This indicates that a decrease in anxiety and depressive state is associated with an improvement in stuttering severity. This may be attributed to the improved ability to manage stuttering and the difficulties that accompany stuttering, such as fear, anticipatory stress, and self-concept [14]. Evaluation of anxiety in group II was carried out using the TMAS and the results obtained were in consistency with previous researches showing a significant improvement in the post-therapeutic TMAS scores compared with the pretherapeutic TMAS scores. It is clear that effective treatment that reduces stuttering symptoms, with a consequential decrease in avoidance and escape behavior, will also, to some degree, result in a reduction in anxiety as a result of the decreased stuttering. This is in agreement with the work of Yaruss JS, (2010), who reported that the group means showed a decrease in psychic anxiety and somatic anxiety immediately after treatment and further decreased to a statistically significant level 6 months after treatment [14]. Treatment of stuttering frequently affects changes in the overall speech pattern, resulting in a situation where successfully treated individuals who stutter are relatively fluent, but their phonemes are slow, paced, or monotonous and can be discriminated from the speech of non-stutterers [15]. The results of this study were consistent with previous research indicating that stuttering therapy alters the acoustic properties of stutterers' fluent speech concomitant with a reduction in stuttering frequency [16]. The present study showed a higher post-therapeutic spectrographic value in all the items tested. In group I, a significant difference was found between pretherapeutic and post-therapeutic values in the FT of the (voiced and voiceless) and the VD of (voiceless) of monosyllabic words. In group II, a significant difference was found between pretherapeutic and post-therapeutic values in the VD and FT of both (voiced and voiceless) monosyllabic words. Furthermore, a significant negative correlation was found between the percentage of change VD (voiced) and percentage of change in the total SSI-3 in both group I and II. This may be attributed to the fact that the children participating in the therapeutic program were required to cognitively produce easy onset of phonation, prolong syllables, make a gentle transition between sounds, and to reduce the articulatory tension. The significant increase in VD post-therapeutically was in agreement with the result of Riley and Ingham [17], who found a significant increase in VD after therapy. They speculated that the increased VD s allow more time for speech motor planning and that stuttering is reduced moderately as a byproduct of longer VDs [17]. However, this was in contrast to the results of Lisa Brown *et al.* (2008), who reported that the acoustic signal of all participants was altered following treatment. However, no consistent pattern of change was observed [18]. Moreover, Onslow *et al.* [19] found no significant increase in the VD post-therapeutically. VOT has been one of the most extensively studied areas of motor control in stuttering. The increased duration of VOT reported in the present study may be attributed to the practice of smooth articulatory movement between sounds and the light contacts of articulators during stops and production of fricative sounds. The findings corroborated those of Metz *et al.* [20], who reported protracted VOTs and VD s in the perceptually fluent speech of post-treatment stutterers compared with nonstutterers. Differences in FTs are a fairly consistent finding among younger children who stutter. The increased duration of FT reported in the present study may be because of the slow stretched speech and the smooth articulatory movement techniques that stutterers acquired during the training program. The present finding was in agreement with Prakash *et al.* (2002), who found that stuttering children showed a shorter FT duration than their normally nonfluent peers. Howell and Vause [21] noted that the fluent speech of their group who stuttered was characterized by a delay of F2 transitions between the initial consonant and the following vowel [111]. However, this finding was in contrast to the results of Yaruss and Conture [22], who did not find any statistical significance. With reference to the Visipitch analysis, in the present study, both groups showed higher post-therapeutic values of the voiced%, voiceless%, and the amplitude. However, lower post-therapeutic values of the silence%, RAP%, and shimmer were found. This can be attributed to instructing stuttering children to prolong voiced sounds and producing easy onset of phonation. The majority of results of the previous studies suggested that post-treatment fluency of stutterers can be characterized by a general pattern of increased duration of voiced speech segments and decrease in the duration of silent intervals. Dehqan *et al.* [23] showed that therapy resulted in decreasing irregularity in the shimmer. In other words, the therapy increases the steady state of the laryngeal system. This steady state involves an even maintenance of such forces as vocal fold tension, mass, length, and subglottic pressures, and it also maintains the supralaryngeal articulatory adjustments required for the production of sounds. This parameter can be used as an index for the effectiveness of therapy [23]. In addition, the results obtained were in agreement with the results obtained by Salihovic *et al.* [24], who reported that shimmer values were significantly higher in stuttering individuals than in normally fluent speakers. It was determined that stuttering individuals have variable, sometimes even chaotic subglottal pressure. It is believed that this

is caused by muscle incoordination of respiratory tract. Stuttering children were considered to have weaker laryngeal neuromuscular control and greater disturbances in integrating respiratory and laryngeal control, which justifies measurements of voice disturbances [24].

Conclusion

The presented program provides participants with strategies that significantly improve their speech behavior. The participants in this study showed significant clinically measurable gains on all objective clinical measures of stuttering severity and attitude change. The younger age group showed better outcome with the therapy program. Improvement in stuttering is associated with increasing values of spectral parameters and improvement in Visipitch values.

Acknowledgements

Conflicts of interest

None declared.

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