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ORIGINAL ARTICLE

The normative study of acoustic parameters in normal Egyptian children aged 4–12 years

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KEYWORDS

Childhood voice;
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analysis

Abstract The study of normative data of childhood voice is very important to aid in the identification of pathological voices in this age group.

Objectives: The aim of this study was to establish a database of the normal acoustic parameters in children aged 4–12 years.

Methods: The study was carried out at the Unit of Phoniatics, Faculty of Medicine, Alexandria Main University Hospital, on one hundred normal children of both sexes aged from 4 to 12 years, all children were subjected to computerized acoustic analysis using Multidimensional voice program software. The vocal samples were obtained from the children by holding a microphone 10 cm in front of their mouth and producing sustained phonation. The analyses of the vocal parameters were carried out with the sustained/a/vowel, with elimination of the irregularities in the beginning and end of utterance. The studied acoustic parameters were the fundamental frequency, shimmer and jitter disturbance measures, and the harmonic/noise ratios.

A full informed consent was taken from all subjects contributing to the study.

Results: The mean Fundamental frequency was around 260.46 Hz. Jitter and jitter % were around 81.8% and 1.9% in boys and 62.8% and 1.6% in girls.

Conclusion: The inclusion of computerized acoustic analyses makes the vocal assessment more accurate and less subjective, thus representing an important tool for vocal screening, for it is a simple, fast and reliable method.

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To construct a representative database of normal children, we recommend the recruitment of large number of subjects, inclusion of younger age group, and covering other acoustic parameters.

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1. Introduction

Many authors have studied abnormality in the childhood voice, but fewer studies investigated the normal childhood voice, and the evolution of the voice before larynx maturation has very rarely been investigated. According to Freitas et al.,¹ a good vocal quality is important for social relations to happen effectively. Voice change during childhood may affect the child's school, social and emotional performances.² Voice problems during childhood may reflect on the development of proper capacity to communicate in the adult life. Children vocal disorders are relatively frequent, affecting 6–23% of the children population.^{3–5} Vocal nodules are the main laryngeal lesions found in children, which pathophysiology is directly associated with vocal abuse.^{6,7}

The value of computerized acoustic vocal analysis has been constantly recognized, since, besides providing qualitative data, it also allows for a quantitative analysis of vocal parameters. Computer software, through the use of vocal assessment parameters, is able to provide different vocal assessment parameters, and the most studied ones are the fundamental frequency, shimmer and jitter disturbance measures, and the harmonic/noise ratios. The fundamental frequency (f_0 -Hz) corresponds to the number of glottic cycles per second, and 80–150 Hz are considered normal for men, 150–250 Hz are normal for women and above 250 Hz is normal for children aged 12. Jitter represents the variation in frequency periodicity and shimmer represents the periodicity variation in amplitude. Harmonic/noise variation ratios provide an index which associates the harmonic component and the noise component of the acoustic wave.⁸

Computer-based voice analysis software has normative values for these parameters for the adult population considering both genders; however, not for the pediatric population. The need to establish comparative parameters with the normal values of the acoustic analysis in children has been approached by numerous authors. Behlau et al.⁹ assessed 30 children between 8 and 12 years and found a jitter of 2.3% and a shimmer of 2.5%. Linders et al.¹⁰ analyzed vocal samples from 71 children with ages between 7 and 15 years and noticed mean f_0 jitter values around 244 Hz and 9.7 for girls and 250 Hz and 10.3 for boys.

The lack of homogeneity in the results from many studies shows the importance of doing additional studies with larger samples. Moreover, it is equally important to include children from lower age ranges in the normative studies since the child's larynx suffers deep and constant changes from birth to adolescence and, consequently, vocal quality changes with growth, being clearer among males. The goal of the present study was to determine the normative vocal parameters in children between 4 and 12 years so that it can be used as a reference by other authors.

2. Aim of the work

To establish a prototype database of the normal acoustic parameters in normal Egyptian children.

3. Subjects and methods

- This study was carried out on 100 normal children aged from 4 to 12 years, from both genders, attending the out patient clinic in the Unit of Phoniatics during the year 2012. These children came to the unit, either with a sibling who was enrolled in the therapy for speech or language problem, or with a parent who came for laryngoscopic assessment in the unit.
- This study was approved by the ethics committee in the Alexandria Faculty of Medicine.
- All parents provided informed consent before their child was included.
- In the case of girls, parents were asked to confirm that their daughter was premenarchal at the moment of the study.
- Children with any language, speech or voice problems were excluded.
- Special emphasis was given to history taking on the exclusion of any vocally abusive or misusive behaviors. Auditory perceptual assessment of the voices of included children was also done using the GRBAS scale. Children who had any voice abnormality were excluded.
- Acoustic analysis:
 - All children were subjected to computerized acoustic analysis using Multidimensional voice program software. Model 5105.
 - The vocal samples were obtained from the children by holding a microphone 10 cm in front of their mouth and producing sustained phonation. The room for sampling is situated away from noise.
 - The analyses of the vocal parameters were carried out with the sustained/a/vowel, with elimination of the irregularities in the beginning and end of utterance.
- The studied acoustic parameters were:
 - fundamental frequency
 - shimmer in dB and %
 - Jitter absolute and %
 - harmonic/noise ratio

4. Statistical analysis

Statistical analysis was done using Statistical Package for Social Sciences (SPSS/version 15) software and mean (\bar{X}), standard deviation (SD), Student's *t*-test and (ANOVA) or (*F* test) were computed,

5. Results

- We included 100 children distributed by age in three subgroups as follows: Group I (4–6.11 years); Group II (7–9.11 years) and Group III (10–12 years)

- The comparison between the different values of F0 among the three groups is shown in **Graph 1**: The mean Fundamental frequency was around 260.46 Hz. F0 decreased with age from 276.7 to 230.9 Hz in boys and from 289.6 to 253.2 Hz in girls (P 0.016).
- The comparison of the studied acoustic parameters in the 3 age groups is shown In **Table 1**:
 - The present series confirmed that F0 is lower in boys than in girls, even before puberty, and decreases with age.
 - Jitter and jitter % were around 81.8% and 1.9% in boys and 62.8% and 1.6% in girls.
 - Jitter and jitter % showed the same decline behavior as age increased with no significant difference as regards gender.
 - Shimmer and Shimmer % values recorded were around 0.31% and 3.7%.
 - Shimmer and Shimmer % decreased insignificantly with age and they did not differ with gender.
 - Harmonic to noise ratio was 0.13 and it did not differ between genders until the age of 12.

6. Discussion

Vocal assessment in children has particularities which differ from those in adults, such as the little cooperation in tests, the small sizes of laryngeal structures and the vocal characteristics of the similarities between genders and pre-school aged children, the change in vocal parameters near the time of voice

change and the difficulties in defining normative parameters for the vocal samples in the different age ranges. This is extremely important in order to avoid interpretation errors during vocal quality analyses.¹⁰

The mean Fundamental frequency was around 260.46 Hz. F0 decreased with age from 276.7 to 230.9 Hz in boys and from 289.6 to 253.2 Hz in girls (P 0.016) this is similar to what was observed in Bennett’s study.¹¹

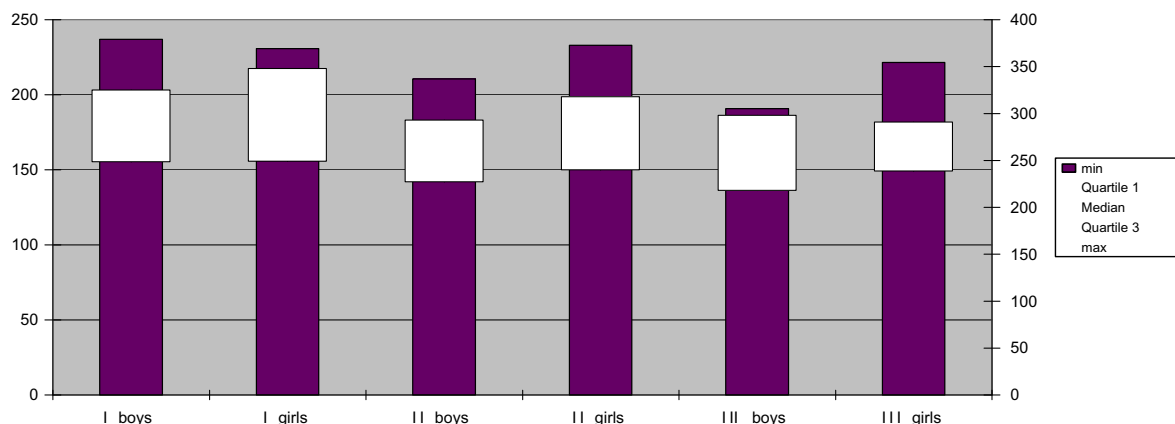
The present series confirmed the established findings that F0 is lower in boys than in girls, even before puberty, and decreases with age. The F0 drop analysis in the different age ranges indicates the growth in laryngeal structures with age, and such fact was also stressed by Wertzner et al.¹²

In our study the Jitter and jitter % values were around 81.8% and 1.9% in boys and 62.8% and 1.6% in girls. Behlau et al.¹³ reported a lower jitter % of 2.3% in children aged 8–12 years.

Jitter and jitter % showed the same declining behavior as age increased with no significant difference as regard gender.

Shimmer and Shimmer % values recorded were around 0.31% and 3.7%. In Tavares et al.¹⁴ study, the mean value of the jitter % presented was 1.21%, mildly lower than what was found in this study, however, the shimmer % was higher, around 8%.

Shimmer and Shimmer % decreased insignificantly with age and they did not differ with gender which is similar to what was found by Nicollas et al.¹⁵ Harmonic to noise ratio was 0.13 and it did not differ between genders until the age of 12. These findings may be attributed to the fact that the stability of laryngeal dynamics increases with age.



Graph 1 Box plot presentation of the comparison between different values of F0 among the three groups.

Table 1 Comparison of the studied acoustic parameters in the 3 age groups.

MDVP Parameters	Group I		Group II		Group III	
	Boys (n = 14)	Girls (n = 20)	Boys (n = 12)	Girls (n = 21)	Boys (n = 16)	Girls (n = 17)
F ₀	276.69 ± 34.16	289.59 ± 42.23*	244.89 ± 36.95	279.39 ± 33.09*	230.93 ± 30.06	253.17 ± 23.73*
Jitter	81.51 ± 35.36	68.07 ± 16.43	93.99 ± 45.76	57.55 ± 28.44	79.56 ± 40.87	66.39 ± 19.94
Jitter %	2.18 ± 0.76	1.62 ± 0.77	2.04 ± 0.73	1.54 ± 0.67	1.66 ± 0.79	1.69 ± 0.49
Shimmer	0.24 ± 0.16	0.36 ± 0.10	0.42 ± 0.26	0.37 ± 0.12	0.25 ± 0.09	0.32 ± 0.13
Shimmer %	4.09 ± 1.18	3.51 ± 1.05	5.34 ± 1.90	4.98 ± 1.97	2.95 ± 0.78	3.75 ± 1.30
H/N ratio	0.13 ± 0.16	0.13 ± 0.04	0.18 ± 0.06	0.13 ± 0.04	0.12 ± 0.02	0.13 ± 0.03

F₀: Fundamental Frequency, H/N ratio: Harmonic to noise ratio.
 * P value = 0.016 significant.

7. Conclusion and recommendation

The inclusion of computerized acoustic analyses makes the vocal assessment more accurate and less subjective, thus representing an important tool for vocal screening, for it is a simple, fast and reliable method.

To construct a representative database of normal children, we recommend the recruitment of large number of subjects, inclusion of younger age group, and covering other acoustic parameters.

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