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COMPARISON OF ASTHMA AND HEALTHY PERSONS USING VOICE ANALYSIS

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ABSTRACT
Asthma affects the airways to and fro from human lungs, due to blockage of air breathing problem also occurs. People suffering from this disease are said to be asthmatic. In this paper , For comparison of asthma and healthy persons speech records of five vowels /a/, /i/, /e/, /o/, /u/ have been used then a PRAAT software is used for extracting similar features in asthmatic patients and normal human being. The various voice parameters Jitter , noise to harmonic ratio (NHR), harmonic to noise ratio (HNR) are used for the comparison of asthma and healthy persons. of no more than 200 words (10pt Times New Roman, Justified).

KEYWORDS: Jitter, HNR, NHR, voice, asthma, disease, feature extraction

INTRODUCTION
The speech is an acoustic signal, hence, it is a mechanical wave that is an oscillation of pressure transmitted through solid, liquid or gas and it is composed of frequencies within hearing range[1]. So Speech can be defined as a mean of delivering thoughts and ideas with the help of vocal sounds[2]. Speech is produced by vocal folds. It involves the interaction of various body parts[3]. The production of voice mainly includes lungs, larynx and vocal tract. With the help of lungs air pressure are produced for the larynx. Larynx converted the airflow as an input given by the lungs[4]. Nowadays There are number of medical conditions that largerly affect the voice and these conditions are primarily originated in the vocal system. Due to many kinds of changes in the shape of vocal tract, the intensity of partes laryngea muscles, pathological changes of vocal folds even the abnormal feedback of central nerve causes the pathological disorders in voice production organs[5]. Voice disorders are mainly arises due to the physiological disease, accident or surroundings affecting the vocal folds have a deep impact on the lives of patients. With the help of speech we will extract various information about the speaker, gender, language, emotions and health[3]. So from a health science standpoint, analysis of acoustic signals of human voice has many significant prospects and nowadays this becomes a very valuable technique for speech pathology detection[5]. Acoustic analysis of the vocal signal has been applied to almost every area of voice care including the evaluation of surgical procedures, voice therapy, radiotherapy, medical therapy, screening of laryngeal diseases, and vocal pathology differential diagnosis. So various diseases can be detected with the help of acoustic analysis of voices. The measurements of acoustic parameters is to be useful in describing the characterstics of vocal folds[3]. In this paper asthma disease is detected with acoustic voice parameters. Asthma is a lung disease that affects airflow to and fro from lungs[6]. It is a complex disorder caused by interactions between multiple genes of small to modest effect and equally important environmental factors[7]. When asthmatic patient breathes a whistling sound comes. Major symptoms of asthma are chest stiffness, breathe shortness, cough production during night and morning etc. When the asthmatic person's airways starts working then the muscles around airways becomes tight and less air can flow into the lungs and when these airways becomes blocked then asthma attack may occur. It has no cure, just it can be controlled [2]. The major risk factors of asthma are bedding dust, carpet, furniture dust, also family history or allergy. During asthma stages, it can be controlled by doing long term meditation daily, regular check up by doctor in case of serious patients, when asthma attack came taking some drugs through inhalers etc[6]. In this paper, acoustic parameters are analyzed to differentiate the asthma and healthy

METHODS AND METHODOLOGY
A. DATA ANALYSIS
In this paper, an acoustic analysis of healthy and asthmatic person's voices are presented. For this

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purpose speech recordings of 25 asthmatic patients and healthy persons having age between 40 to 65 years were performed in a quiet room with a low ambient noise level using a microphone M27 having specifications (Sensitivity: -58db±3db, S/N ratio: more than 60db & frequency response: 100Hz~16kHz) situated approximately 3 cm from the participants' mouth. The audio data were sampled at 16 kHz. . No time limits were imposed for the completion of the recording procedure.Each participant was asked to speak each vowels (a,e,I,o,u) atleast five times.Then the results of both the groups that were asthma and healthy persons were compared. A database was created which consisted of a sustained phonation of vowels (a,e,i,o,u).

B. ACOUSTIC ANALYSIS

For acoustic analysis PRAAT software was used.The following parameters were analyzed: Jitter (frequency perturbation local,%), Shimmer (amplitude perturbation –local, %), Harmonic to noise ratio (HNR – dB), Pitch, Mean autocoorelation, Noise to harmonic ratio (NHR). The set of various acoustic parameters is presented below :

Jitter: The values of jitter can be measured in different parameters such as absolute and relative absolute.

Jitter absolute*:* It is the cycle to cycle variation of fundamental frequency that is the average absolute difference between consecutive periods.It can be expressed as

$$\text{jitta}=\frac{1}{N-1}\sum_{i=1}^{N-1}|T_i - T_{i-1}| \qquad (1)$$

Jitter (rap): It is defined as the relative average perturbation that is the average absolute difference between a period and the average of it and its two neighbours divided by the average period. It can be expressed as a percentage:

$$\text{rap}=\frac{\frac{1}{N-1}\sum_{i=1}^{N-1}\left|T_i-\left(\frac{1}{3}\sum_{n=i-1}^{i+1}T_n\right)\right|}{\frac{1}{N}\sum_{i=1}^{N}T_i}*100 \qquad \textbf{(2)}$$

Shimmer

Shimmer: It can be defined as the variability of the peak to peak amplitude that is the average absolute base-10 logarithm of the difference between the amplitude of consecutive periods, multiplied by 20:

$$\text{Shimmer}=\frac{1}{N-1}\sum_{i=1}^{N-1}|20 * \log(\frac{A_{i+1}}{A}) \qquad (3)$$

Shimmer relative: It is defined as the average absolute difference between the amplitudes of consecutive periods,divided by the average amplitude, expressed as a percentage:

$$\text{Shim}=\frac{\frac{1}{N-1}\sum_{i=1}^{N-1}|A_i - A_{i+1}|}{\frac{1}{N}\sum_{i=1}^{N}A_i} * 100 \qquad (4)$$

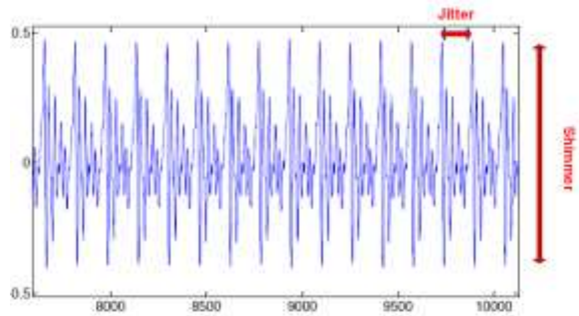

Fig.1. Jitter and Shimmer perturbation measures in speech signal

Harmonic to Noise ratio (HNR): It can be defined as the overall periodicity of the voice signal by quantifying the ratio between the periodic and aperiodic components.

$$\text{HNR}=10*log_{10}\frac{AC_V\,(T)}{AC_V(0)-AC_V(T)} \qquad (5)$$

Pitch: Pitch is the fundamental period of the speech signal. It the perceptual correlate of fundamental frequency. It represents the vibration frequency of the vocal cords during the sound productions for example vowels.

Mean Autocoorelation: The autocorrelation of a random process describes the correlation between values of the process at different times, as a function of the two times or of the time lag.

$$R(s,t)=\frac{E[(X_t-\mu_t)(X_s-\mu_s)]}{\sigma_t\sigma_s}$$

RESULTS AND DISCUSSION

We recorded 25 phonation spoken by the asthmatic patients and 25 phonation by healthy persons. For the acoustic analysis 12 phonation of vowels (a,e,i,o,u) per person were considered. Following graphs shows the results obtained by acoustic analysis using PRAAT software.

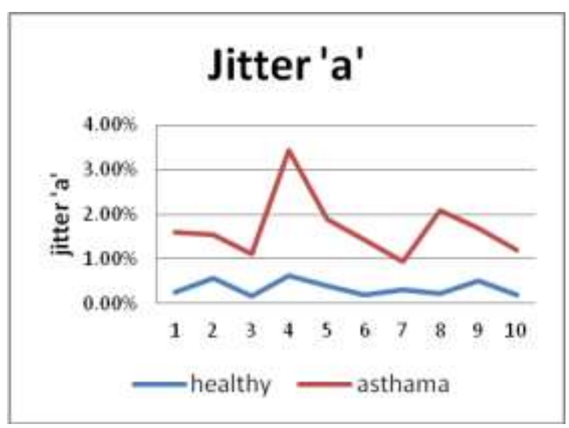

Fig.2. Jitter for vowel 'a'

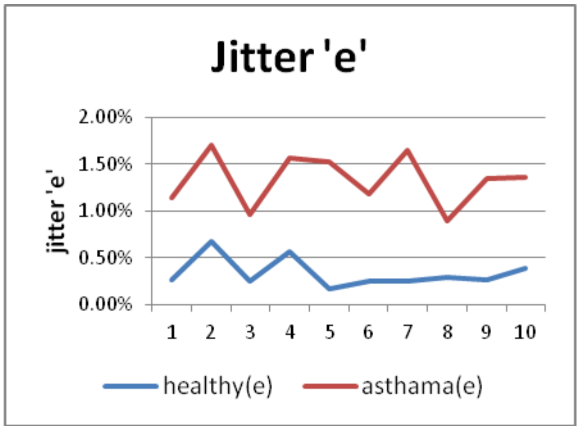

Fig.3. Jitter for vowel ‘e’

In the above graphs an analysis of five vowels (a,e,i,o,u) for males and females are presented for various voice parameters like JITTER, HNR and NHR of different asthma and healthy persons are considered. The graphs in Fig 2,3,4 shows that the value of voice parameter that is jitter for different vowels a, e, i of asthma persons and healthy persons. From these graphs it was observed that the jitter values of asthma and healthy persons for three vowels a,e,i are different. The value of voice parameter that is jitter is high for asthma patients and low for healthy persons in case of each vowel.

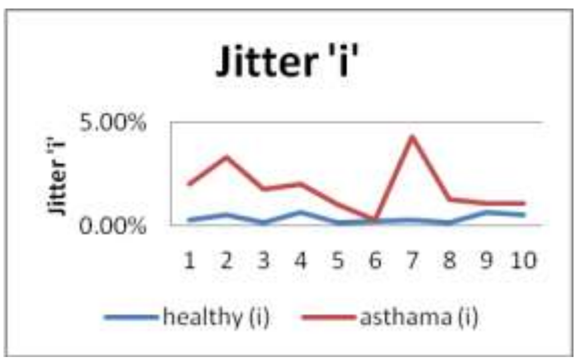

Fig.4. Jitter for vowel ‘i’

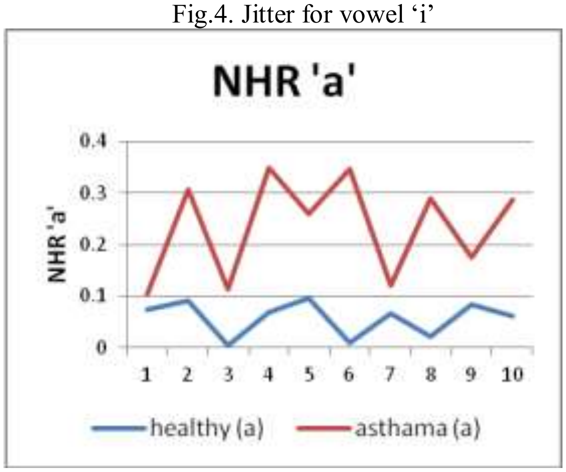

Fig.5. Noise to Harmonic ratio for vowel ‘a’

In the above graphs the voice parameter noise to harmonic ratio (NHR) that shows the overall periodicity of the voice signal for different vowels a,e,i are compared for asthma and healthy persons. It was observed that the value of HNR for asthma patients are high and for healthy persons are low for each vowel that is a, e, i.

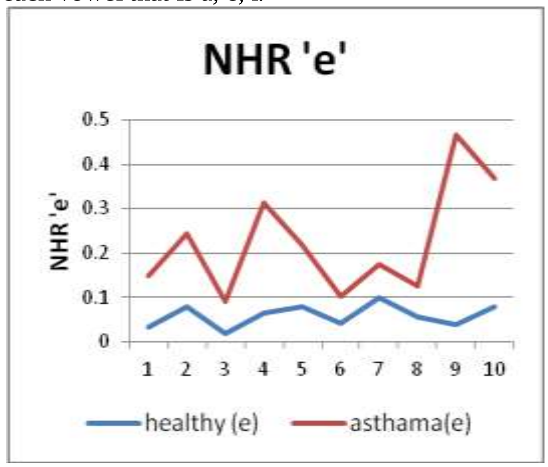

Fig.6. Harmonic to Noise ratio for vowel ‘e’

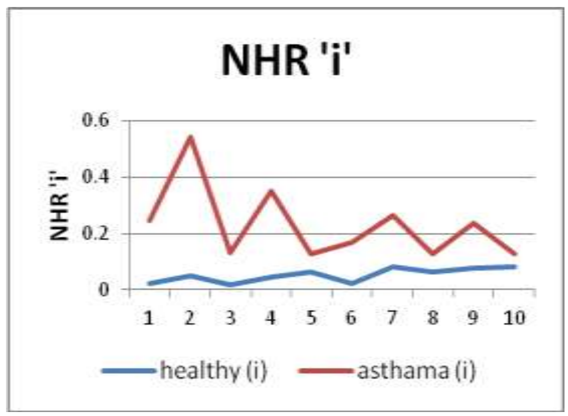

Fig.7. Noise to Harmonic ratio for vowel ‘i’

For vowel ‘I’ the value of NHR for healthy persons is very low as compared to the asthma persons.

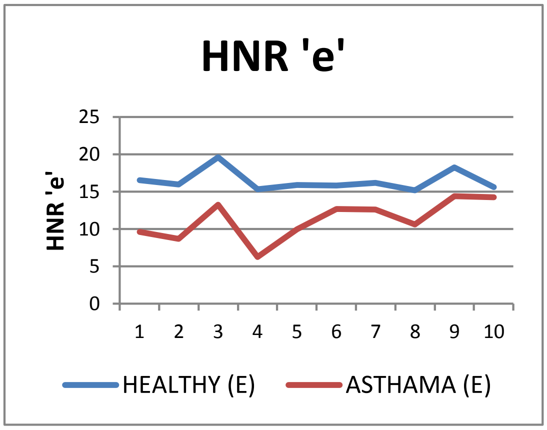

Fig.8. Harmonic to Noise ratio for vowel ‘e’

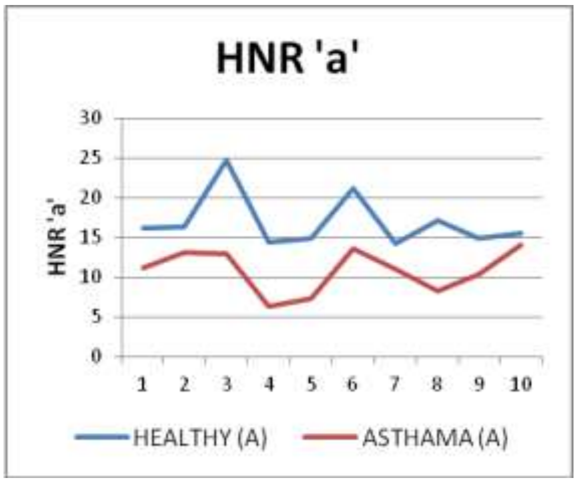

Fig.9. Harmonic to Noise ratio for vowel ‘a’

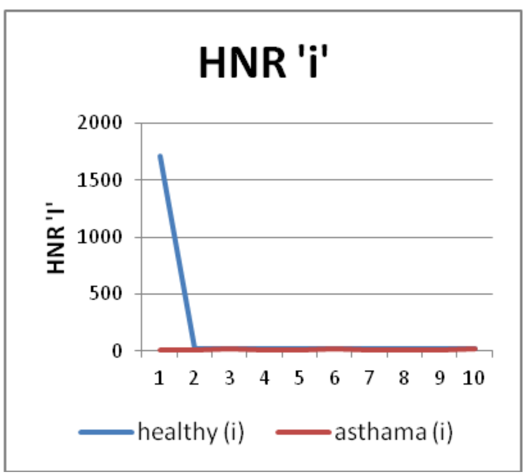

Fig.10. Harmonic to Noise ratio for vowel ‘i’

In Fig 7,8 and 9 the voice parameter harmonic to noise ratio (HNR) for different vowels a,e,I are compared for healthy and asthma persons. As the result for vowels a and e of voice parameter HNR are different from NHR values. In case of vowels a and e the HNR values are high for healthy persons and low for asthma persons. For vowel ‘i’ there is no comparison between the healthy and asthma persons. So there is no result for vowel ‘i’ for parameter HNR.

CONCLUSION

The pathogenesis of asthma, a complex disease, involvesgene-gene interactions as well as gene-environment interactions. In this paper acoustic analysis is used for the detection of asthma disease. In this analysis some standard features such as jitter, HNR and NHR are consindered. Each voice parameter is compared for each vowel that is a,e,I to differentiate the healthy and asthma persons. In case of Jitter a comparison is made for each vowel that is high for asthma persons and low for healthy persons. As in the case of NHR and HNR results are different for healthy and asthma persons. The value of HNR is high for healthy persons and low for asthma persons and the value of NHR is high for asthma persons and low for healthy persons.There is no result of voice parameter HNR for vowel ‘i’.

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