Spirometric Reference Values with using Artificial Neural Network Classification

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***Abstract*— in this paper pulmonary measurement of an extensive range of ages for Caucasians ancestry in the third National Health and Nutrition Examination Survey (NHANES III) reference value study with Artificial Neural Network (ANN) is presented. For this study, 3 types of spirometric data (Forced expiratory volume in 1 second (FEV1), Forced Vital Capacity (FVC) and FEV1/FVC data) were obtained from reference values for Caucasians, 16 to 80 of age were developed from 6800 asymptomatic, nonsmoking participants. Accuracy of classification of ANN is 93.4%. This result helps when comparing with Hankinson database in clinical decisions for decision makers. Also predict accuracy of ANN is acceptable for obstruction and normal cases.**

***Keywords*— Flow–volume spirometry ; Spirometric patterns . Spirometric refence values. Artificial Neural Network (ANN) . Classification accuracy.**

I. INTRODUCTION

Dynamic Spirometry reference values play an important role in daily clinical practice for the assessment of lung function. Abnormality of Pulmonary function test results is comparing with different kind of reference values. There are lots of reference values is available according to different country, which is currently endorsed by several respiratory societies such as the ERS and the American Thoracic Society (ATS) [1,5] . However, GLI (The Global Lung Function Initiative) reference values may not suitable for whole world countries [6, 10]. There some factors affect spirometric measurements results such as environmental, ethnic, age ranges and socioeconomic factors. [11]. In addition to this, Pulmonary function test results should be standardized according to recommended rules and guidelines. Also, Spirometry reference values must be updated continuously. In most reference models predicted values are depend on ethnicity, sex, height and ages. Some studies show that Caucasians (European ancestry) have much more lung volumes according to other ethnicities / races [12, 16].

Hsu and his friends made a study about pulmonary function between 7 and 20 ages is same criteria in NHANES III [17]. Schwartz and his friends made a study age between 6 to 24 for NHANES II survey which is about predictive equations according to data collected on African-American and Caucasian participants [18]. Recent study is done by Wang and his friends they made study on ventilatory function in African-American and Caucasian children between 6 and 18 years of age [19,20]. Knudson (5), Crapo (6) and his friends made study for Caucasian adults separately [21, 22]. However, no recent study has collected pulmonary measurements for both sexes across an extensive range of 18 and 65 ages for Caucasians with ANN.

The aim of this study estimate new updated FVC, FEV1 and FEV1/FVC reference values for Caucasians ancestry with ANN. Validity of our updated reference model compared with Hankinson reference values.

Pulmonary function tests (PFT) is a physiological test, which determines how a person's breathing air according to time that measure lung function numerically. Pulmonary function tests are done with an equipment that is called spirometry. Spirometry device is used usually for controlling respiratory function. Therefore accurate results of spirometry device are important for different types of lung abnormalities. [23]. Obstructive and restrictive are two major abnormalities of respiratory function. Many factors of obstructive are emphysema such as airflow obstruction of the peripheral airways and mucus hypersecretion. Spirometry predicted values are depends on sex, age and height. Forced expiratory volume in 1 second (FEV1), Forced Vital Capacity (FVC) and FEV1/FVC parameters are measured with spirometry. The evaluation of pulmonary function tests is based on comparison value of the measured values obtained from healthy sources (expected value / predicted value). Expected values were derived from "normal" or

"healthy" individuals in studies that have same anthropometric (age, gender, height) and the ethnic characteristics. Evaluation of patient's PFT appropriate maneuver is started firstly assessment as a classical spirometry testing. Firstly, it should be consulted forcibly exhaled in the first second. This time should not be less than six seconds. This time as shown volume-time graph or FET (forced exhalation time) in tests. The result of the short-term maneuver than six seconds is not healthy. The second step is to examine the flow volume curve. This curve give ideas about adaptation to patient testing, and type of probable pathology as well. Then, respectively, FEV1 / FVC ratio and FVC value are categorized according to the FVC value that can be redirected to possible pathology diagnosis. If FEV1 / FVC ratio decreased and FVC value normal, this means that obstructive disorder. If FEV1 / FVC ratio value normal and FVC value decreased, this means that restrictive disorder. If FEV1 / FVC ratio value and FVC value decreased this means mixed type. It has obstructive and restrictive disorders. [24] [25].

TABLE 1. Changes in pulmonary function parameters in the differentiation of types of obstructive, restrictive and mix type pathology.

	Obstructive	Restrictive	Mix
FEV_1	Decreased	Decreased	Decreased
FVC	Normal	Decreased	Decreased
FEV_1/FVC	Decreased	Normal or Increased	Decreased

In ANN signal, image and data have been used for estimation and classification successfully [26]. ANN is flexible in modelling and it has high accuracy of prediction. Therefore, for different medical diagnosis and classification method ANN have been used such as radiology, ophthalmology, oncology, neurology and in respiratory measurements. [27–29]. Simplest mean of (ANNs) is modelling as the human brain. ANN are the building blocks of neurons. There are approximately 100 billion neurons in the human brain. Within the multilayer neural network has neurons arranged similarly to human brain. Each neuron is connected to other neurons by certain coefficients. During the training, distributed network connection is used for learning information.

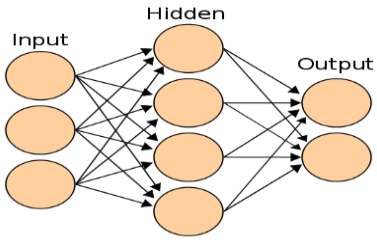

Fig. 1. *Neural network layers*

ANN consists of three layers including input layer, hidden layer and output layer. In order to carry the detection procedure the neural network needs to be trained from input layer to output layer (1).ANN has interesting properties such as storing the entire network information, ability to work with incomplete information, having error tolerance, having distributed memory, gradual deterioration, ability to machine learning, parallel processing capability, [30,31]. These properties give high accuracy of prediction.

II. METHODOLOGY

Up to now there are many studies have done according to variety of wide age ranges and ethnic-race groups. In our proposed study data is obtained from (NHANES III) reference values between 6800 lifelong nonsmoking participants. We used Hankinson reference values 5000 data for training, 1800 data for testing with using ANN [32]. 3 types of spirometric data (Forced expiratory volume in 1 second (FEV1) as shown at Fig 2., Forced Vital Capacity (FVC) and FEV1/FVC data) were obtained for this study.

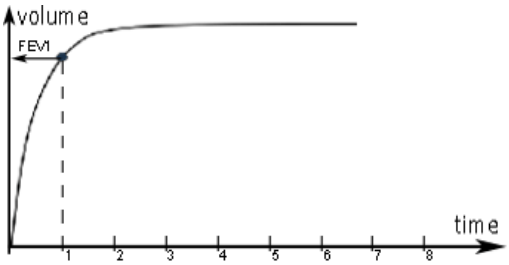

Fig. 2. *Curve of Flow–volume for normal subject*

The data used is obtained between 16 and 80 ages ranges from 1800 patients from Hankinson reference model. The measurement of volume V(t) and the flow rate of air Q(t) dependency formula is given below, The electronic integration of the airflow Q(t) allows us to obtain the volume V(t) [33].

$$V(t)=\int Q(t)dt$$

Standard deviation, standard error and mean value were calculated. In this proposed work sigmoid transfer function was used. Data were normalized between 0 and 1 then it is used for training the network. This work has been implemented in a laptop which has Intel Core i7 4510U processor, 4 GB of RAM and Windows 10 operating system. Application code is written in MATLAB R2015a program.

III. CONCLUSION

Spirometry reference values play an important role in daily clinical practice for the assessment of lung function. Therefore test result has to be in high accuracy. In medical system high accuracy results is possible only with trustworthy health care system. In this study new updated FVC, FEV1 and FEV1/FVC reference values presented for Caucasians ancestry with ANN classification. Validity of our updated reference model compared with Hankinson reference values. Total accuracy of ANN was 93, 4 %. This result helps when comparing with Hankinson database in clinical decisions for decision makers. Also predict accuracy of ANN is acceptable for obstruction and normal cases.

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