



# A survey of levels of oxygen saturation and spirometric parameters among suspected asthmatics referred to the respiratory clinics in the Niger Delta University Teaching Hospital (NDUTH), South-South, Nigeria.

Jumbo Johnbull<sup>1</sup>, Edefe Emmanuel Auch<sup>1</sup>,  
Ambakederemo T. E<sup>1</sup>

Department of Internal Medicine, Faculty of Clinical Sciences, Niger Delta University, Bayelsa State, Nigeria.

## ARTICLE INFO

**Article No.:** 112822099

**Type:** Research

**Full Text:** [PDF](#), [HTML](#), [PHP](#), [EPUB](#)

**Received:** 28/11/2022

**Accepted:** 02/12/2022

**Published:** 09/12/2022

### \*Corresponding Author

Dr. Jumbo Johnbull

**E-mail:** [johnbulljumbo@gmail.com](mailto:johnbulljumbo@gmail.com)

**Keywords:** Spirometric parameters, Suspected Asthmatics, Oxygen saturation, Pulse oximeter.

## ABSTRACT

**Background:** Objective and reliable diagnosis of bronchial asthma is usually done by carrying out spirometry. The parameters assessed include Forced Expiratory Volume in One Second (FEV<sub>1</sub>), Forced Vital Capacity (FVC) and FEV<sub>1</sub>/FVC ratio. FEV<sub>1</sub>/FVC ratio reflects the degree of bronchial obstruction.

Pulse oximeter not invasive, simple, user friendly, portable and affordable device used in the measurement of blood oxygen concentration.

It is very useful in assessing the need for oxygen administration and monitoring of asthmatic patients on emergency admission for acute exacerbations.

Making diagnosis of bronchial asthma based on clinical symptoms without carrying out spirometry and pulse oximeter could lead to misdiagnosis and poor assessment of bronchial asthma respectively.

Therefore, this study aimed at carrying out a survey of levels of oxygen saturation and spirometric parameters among suspected asthmatics referred to the respiratory clinics in the NDUTH.

**Methodology:** This was an observational cross-sectional descriptive study carried out among suspected asthmatics referred to the Chest Clinic of the NDUTH. A total of 150 suspected bronchial asthmatics referred to the Chest Clinic of the NDUTH between January 2017 and December 2020 were recruited for the study.

The research was done in the cardio-respiratory laboratory of the department of internal medicine, NDUTH. Global Initiative for Asthma (GINA) criteria was used to make diagnosis of asthma so all participants underwent spirometry and pulse oximeter in the cardio-respiratory laboratory of the department of internal medicine. Data was documented and Statistical Package for Social Sciences (SPSS) version 22 was used to analyze the data. Descriptive statistics was performed for socio-demographic characteristics while Pearson's correlation was used to compare spirometric parameters and levels of oxygen saturations among the participants. A p-value of less than or equal to 0.05 was considered statistically significant for all relevant tests.

**Results:** The study participants were more in the age range of 18-44 years, males had more participants than females. Fifty seven constituting 38.2% of the study subjects had FEV<sub>1</sub>/FVC ratio % predicted of <0.75, 59 (39.2%) had bronchodilator reversibility of ≥12% and obstructive spirometric pattern, 139 (93.92%) had oxygen saturation (SPO<sub>2</sub>) of ≥92% while 9 (6.08%) had oxygen saturation (SPO<sub>2</sub>) of < 92%. The correlation between oxygen saturation and FEV<sub>1</sub>, FVC and FEV<sub>1</sub>/FVC was statistically significant.

**Conclusion:** Only a proportion of the suspected asthmatics were confirmed by spirometry and correlation between oxygen saturation and FEV<sub>1</sub>, FVC and FEV<sub>1</sub>/FVC among the participants was statistically significant.

## BACKGROUND

Asthma could result in abnormalities in gas exchange that lead to hypoxemia from when acute exacerbation occurs. A decrease in SpO<sub>2</sub> suggests hypoxemia. Arterial blood gas analyzer machine which is used in the assessment of blood gases is the gold standard in quantification of carbon dioxide and oxygen concentration in the blood<sup>1</sup>.

Oxygen saturation measurement using arterial blood gas analysis is reliable and accurate but it would require sending blood samples to a medical laboratory with facility to carry out the investigation.<sup>1</sup> However, the arterial blood gas analysis facilities are not available in most hospitals in Nigeria and the procedure is painful and could result in local hematoma, infection and occlusion or embolization.<sup>2</sup> Therefore the need for simple device for objective quantification of oxygen concentration is paramount in the management of acute exacerbations of asthma.

Pulse oximeter not invasive, simple, user friendly, portable and affordable device used in the measurement of blood oxygen concentration. The pulse oximeter calculates the quantity of light of two wavelengths absorbed from a source in the probe when put onto a finger or toe.<sup>3</sup> It is very useful in assessing the need for oxygen administration and monitoring of asthmatic patients on emergency admission for acute exacerbations. So oxygen saturation could be assessed using pulse oximeters device thus reducing the need for arterial blood gas analysis. Although some patients in acute asthmatic exacerbation could be at the risk for respiratory failure, hypercapnea or metabolic acidosis, assessment of oxygen levels could suffice and may not always require analysis blood gas.<sup>4,5,6</sup>

Pulse oximeters values could be 2% or 4% lower or higher than the person's actual oxygen saturation levels. A number of factors can reduce the accuracy and reliability of the pulse oximetry reading and these include nail varnish or nail polish, some dyes, shivering, shaking, or other bodily motions, skin temperature, skin thickness, tobacco smokes and skin pigmentation.<sup>6</sup>

However, British Thoracic Society guidance on oxygenation<sup>7,8</sup> states that pulse oximetry is the "fifth vital sign" together with temperature, pulse, blood pressure and respiratory rate so it should be carried out for all patients presenting with acute breathlessness in primary care.

In acute asthma, oxygen saturation is used as part of a comprehensive assessment to guide selection of appropriate treatment. In the management of acute severe asthma in adults, oxygen saturation is key in differentiating moderate asthma from acute severe asthma and life threatening asthma.<sup>9</sup> Pulse oximetry is commonly used in acute severe asthma or other asthma exacerbations in the emergency room.<sup>10</sup>

Objective and reliable diagnosis of bronchial asthma is usually done by carrying out spirometry.<sup>11,12</sup> The parameters assessed include Forced Expiratory Volume in One Second (FEV<sub>1</sub>), Forced Vital Capacity (FVC) and FEV<sub>1</sub>/FVC ratio. FEV<sub>1</sub>/FVC ratio is a reflection of the degree of bronchial obstruction. FEV<sub>1</sub> correlates well with quality of life measures.<sup>13</sup> The measured or predicted value of FEV<sub>1</sub> is a reflection of the severity of the asthma exacerbation and the level of asthma control.<sup>14</sup>

However, in our setting asthma has been misdiagnosed by some practitioners by relying only on clinical features without objective assessment and there is paucity of knowledge of the relationship between oxygen saturation and spirometric parameters among asthmatics.

Therefore, this study seeks to know the proportion of suspected asthmatics that were confirmed by objective spirometric assessment to determine if clinical diagnosis can be used as an alternative in making diagnosis of bronchial asthma in settings where spirometry services are not available. The study also seeks to explore the relationship between SpO<sub>2</sub> and spirometer parameters among these patients.

## METHODOLOGY

### Study design, location and population.

This was an observational cross-sectional descriptive study carried out among suspected asthmatics referred to the Chest Clinic of the NDUTH.

NDUTH is located in Okolobiri, a suburb community of Yenagoa, the capital city of Bayelsa State, South-South, Nigeria. The NDUTH sub-serves residents of Bayelsa state and neighboring states of Delta and Rivers States.

A total of 150 suspected Bronchial Asthma asthmatics referred to the Chest Clinic of the NDUTH between January 2017 and December 2020 were recruited for the study.

Inclusion criteria include all adult suspected asthmatics who gave consent and were fit to carry out spirometry, and exclusion criteria include suspected asthmatics not willing to participate in the study, acute severe and life threatening asthma.

### Methods

The research was done in the cardio-respiratory laboratory of the department of internal medicine, NDUTH. GINA criteria was used to make diagnosis of asthma so all participants underwent spirometry in the cardio-respiratory laboratory of the department of internal medicine, NDUTH following medical history taking, general and respiratory system examinations.

Spirometry was performed according to the American Thoracic Society(ATS)/European Respiratory

Society(ERS) guidelines.<sup>16</sup> Before the procedure, participants were instructed to abstain from vigorous exertion, such as running and swimming for at least one hour, and eating of large meals for at least two hours.<sup>16</sup> Their heights were measured to the nearest centimeter using a tape measure on a flat surface, while their weights were measured to the nearest 0.1 kilogram using a portable weight machine after zero calibration check. Body mass index was calculated accordingly.<sup>17</sup> Participants stood comfortably while they inspired fully, occluded their nostrils with one hand, placed the mouthpiece of the spirometer in their mouth, and sealed their lips tightly around the mouthpiece to prevent air leaks.<sup>16</sup>

These maneuver were done both before and after administration of 400 micrograms of inhaled short acting B-agonist (salbutamol). Administration of inhaled salbutamol was done by first vigorously shaking the metered-dose salbutamol inhaler, followed by removing the cap from the mouthpiece of the inhaler. Then, the inhaler was primed by releasing a puff into the atmosphere before it was inserted through its mouthpiece to a receiver end of a spacer device. Participants were told to breathe in and out slowly, and insert the mouthpiece of the spacer device into their mouth and breathe in through their mouth while two (2) puffs of inhaled salbutamol were released by depressing the canister of the metered-dose inhaler.<sup>16</sup>

Spirograms that met the ATS/ERS criteria<sup>16</sup> for acceptability were used. The following measurements were obtained from spirometry ( $FEV_1$ ) Forced Expiratory Volume in one second ( $FEV_1$ ), defined as the maximal volume of air forcefully exhaled in the first second from total lung capacity, Forced Vital Capacity, defined as the maximal volume of air forcefully exhaled following maximal inspiration (FVC) and Ratio of  $FEV_1$  to FVC ( $FEV_1/FVC$ ).<sup>18</sup>

A portable pulse oximeter (Gurin GO -410 Finger Pulse Oximeter) was used to measure oxygen saturation of the study participants with a Gurin Finger

Pulse Oximeter, the right thumb of each participant was inserted into the groove after parting the lips of the instrument. The "power" button was then pressed down and the machine came on. Reading of the oxygen saturation began automatically, and after a few seconds, the values for both oxygen saturation and pulse rate appeared on the mini-screen of the instrument and the values were recorded. Participants found to have oxygen saturation less than 92% where admitted to the emergency for further management.

### Data analysis

Data was documented and analyzed using the Statistical Package for Social Sciences (SPSS) version 22.<sup>19</sup> Descriptive statistics was performed for socio-demographic characteristics while Pearson's correlation was used where applicable. The results were presented as percentages and tables as appropriate. A p-value of less than or equal to 0.05 was considered statistically significant for all relevant tests

### Ethical consideration

Ethical approval for the study was obtained from the Research and Ethics Committee (REC) of the NDUTH, Okolobiri.

### RESULTS

The study participants were more in the age range of 18-44 years, males had more participants than females. Fifty seven constituting 38.2% of the study subjects had  $FEV_1/FVC$  Ratio% predicted of  $<0.75$ , 59 (39.2%) had bronchodilator reversibility of  $\geq 12\%$  and obstructive spirometric pattern, 139 (93.92%) had oxygen saturation ( $SPO_2$ ) of  $\geq 92\%$  while 9 (6.08%) had oxygen saturation ( $SPO_2$ ) of  $<92\%$  as shown on table 1 below.

**Table 1: Socio-demographic characteristics, levels of oxygen saturation and spirometric parameters of the study subjects**

Variable	Number	Percentage
Age in Years		
< 18	11	7.2
18-44	52	54.2
45-64	57	37.5
>65	30	19.7
Sex		
Male	81	54
Female	69	46
FEV <sub>1</sub> % Predicted		
<30	5	3.3
30-59	39	26
60-79	48	32
>80	58	38.7
FVC % Predicted		
<30	3	2.0
30-59	20	13.4
60-79	41	27.5
>80	85	57.1
FEV <sub>1</sub> /FVC Ratio% Predicted		
30-50	23	15.4
51-74	34	22.8
75-89	76	51.1
>90	16	10.7
PEF Spirometer Value in L/min		
<1	3	20.1
1-2.9	45	30.2
3-5.9	55	36.8
6- 8.9	44	29.5
≥9	5	3.4
Reversibility		
Reversible	59	39.3
Not reversible	91	60.7
Spirometric Pattern		
Normal	54	36
Obstructive	59	39.3
Restrictive	11	7.3
Mixed	26	17.3
Oxygen saturation(SPO <sub>2</sub> )		
<92%	9	6.08
≥92%	139	93.92

There was a statistically significant correlation between oxygen saturation and FEV<sub>1</sub>, FVC and FEV<sub>1</sub>/FVC. However, there was a negative correlation between age of the study subjects and oxygen saturation as shown on table 2 below.

**Table 2: Pearson's correlation between oxygen saturation and spirometric parameters**

Variables	Oxygen saturation (SPO2%)	
	Pearson Correlation	P-value
FEV <sub>1</sub> % Predicted	0.399	0.000
Post-FEV <sub>1</sub> Measured	0.357	0.000
FVC % Predicted	0.377	0.000
Post- FVC Measured	0.370	0.000
FEV <sub>1</sub> /FVC Ratio% Predicted	0.272	0.001
PEF Measured Value	0.131	0.112
PEFR measured with PEF Meter	0.142	0.085
Weight	0.254	0.002
Height	0.166	0.043
Age	-0.073	0.381

## DISCUSSION

In spite of its limitations<sup>3</sup> monitoring of oxygen saturation using pulse oximeter is very useful in the management of acute disease conditions including acute bronchial asthma in the emergency rooms, anesthesia departments and critical care management of patients.<sup>6</sup> The level of oxygen saturations is a useful guide in the administration of oxygen to patients especially in setting where arterial blood gas monitoring of patients is not available.

The gold standard in making diagnosis of bronchial asthma is assessment of Forced Expiratory Volume in one second (FEV<sub>1</sub>), Forced Vital Capacity (FVC) and FEV<sub>1</sub>/FVC ratio by carrying out spirometry.<sup>15</sup> Peak Expiratory Flow Rate (PEFR) using Peak Expiratory Flow Meters is useful in the emergency room management of bronchial asthma and monitoring of asthmatic patients.<sup>15</sup>

Some asthmatics are poor perceivers<sup>20</sup> so may not have severe clinical manifestations necessitating admission into the emergency room but these patients could have poor spirometric indices and possible low levels of oxygen saturation. Without thorough evaluation of the spirometric indices and oxygen saturation status of these patients, misdiagnosis and improper assessment could occur.

Relying only on patients symptoms to make diagnosis of bronchial asthma without carrying out spirometry could have pitfalls including misdiagnosis of bronchial asthma.

This index study was carried out to assess the levels of oxygen saturation using pulse oximeter, and spirometric indices and the relationship between them among suspected bronchial asthmatics referred to Chest Clinic of the NDUTH.

In this study, 57 participants constituting 38.2% of the study subjects had FEV<sub>1</sub>/FVC ratio % predicted of <0.75, and 59 (39.2%) had bronchodilator reversibility of >12% thereby fulfilling the criteria for the objective diagnosis of bronchial asthma. This was higher compared to a hospital based study carried out among patients who presented in the emergency department of a hospital in Ethiopia which showed a lower percentage (29.6%).<sup>21</sup> This difference could be attributed to the fact that our study was carried out among suspected asthmatics as opposed to this study which was done among patients that presented at an emergency department.

One striking finding of this study was that the same number of participants, 59 (39.3%) had obstructive spirometric pattern and bronchodilator reversibility of equal to or greater than 12%.

There was a positive correlation and significant relationship between most of the spirometric parameters and oxygen saturation as shown on table 2. This finding was similar to the works done by Usha et al.,<sup>22</sup> who carried out an assessment of PEFR and oxygen saturation among the residents in a mine tailing community.

However, the result of this index study was in contrast to the finding of a research carried out by Renee et al.<sup>23</sup> among adults with cerebral palsy where

he found no statistically significant relationship between lung vital capacity and oxygen saturation, and between chest expansion and oxygen saturation. In this study oxygen saturation was within the normal range in all persons, in the face of decreased values of the measured lung parameters. The major difference between these two studies was the difference in the study population. This study was done among adult cerebral palsy patients while our study was done among suspected asthmatics.

Monitoring of oxygen saturation is recommended only for patients with acute severe disease conditions, but routine pulse oximetry among suspected asthma can identify those who might benefit from oxygen therapy.

The result of our study may have clinical relevance because nine patients that had spirometric evidence of bronchial asthma that did not meet clinical criteria for acute severe asthma were found to have low (<92%) SPO2 and were admitted into the emergency room for further management based on the low level of oxygen saturation. This finding reiterates the need to have proper evaluation of all patients with respiratory symptoms by carrying out pulse oximetry.

Therefore, the clinical implication of the finding of this study is the need to carry out routine assessment of oxygen saturation among suspected asthmatics even in the outpatient setting.

## CONCLUSIONS

Only a proportion of the suspected asthmatics were confirmed by spirometry and there was a statistically significant correlation between oxygen saturation and FEV1, FVC and FEV1 /FVC among the participants.

## RECOMMENDATION

All suspected asthmatics should undergo pulmonary function tests including pulse oximetry in order to have an objective diagnosis and proper evaluation of the patients.

## LIMITATION

Arterial oxygen measurement was not done in this study, that would have added more value to the findings as it would have enabled us to use it as a standard to assess how reliable and accurate the pulse oximeter measured SPO2 values were.

## ACKNOWLEDGEMENT

The authors wish to express our profound gratitude to all staff of the Cardiorespiratory unit, Department of Internal Medicine, Niger Delta University Teaching

Hospital, Bayelsa State for their meaningful contributions.

## REFERENCES

1. Carruthers 1995 Carruthers DM, Harrison BDW. Arterial blood gas analysis or oxygen saturation in the assessment of acute asthma? *Thorax* 1995; 50(2):186-8.
2. Kelly AM, McAlpine R, Kyle E. How accurate are pulse oximeters in patients with acute exacerbations of chronic obstructive airways disease? *Respir Med* 2001; 95:336-40.)
3. Steve Holmes, Pulse oximetry: not an infallible test – use clinical judgment. *Primary Care Respiratory Update* issue 22 July 2021; 29-31.
4. El-Sberbihiy RR, El-Ezz AA, El-raouf YM, Taha AM. Pulse oximetry in comparison to arterial blood oxygen saturation in children with bronchial asthma coming to the emergency room. *Tanta Med J* 2018;46:93-8
5. Collins, J.A, Rudenski, A., Gibson, J., Howard, L., O'Driscoll, R. Relating Oxygen Partial Pressure, Saturation and Content: The Haemoglobin–Oxygen Dissociation Curve. *Breathe*. 11(3), 2015, 194-201
6. Mustafa Mahmood Eid The reliability of Oxygen saturation compared with arterial blood gas analysis in the assessment of respiratory failure in acute asthma. *Int J Crit Care Emerg Med* 2020, 6: 101vol 6 issue 2.
7. Sotirios Fouzas Kostas N Priftis Michael B Anthracopoulos. Pulse Oximetry in Pediatric Practice *PEDIATRICS* 2011; 128(4):740-52
8. British Thoracic Society Standards of Care Committee. *BTS Guidelines for the Management of Community Acquired Pneumonia in Adults*. *Thorax* 2001; 56 (Suppl 4):iv1–64.  
<https://doi.org/10.1136/thorax.56.suppl-4.iv1>
9. Lim WS, Baudouin SV, George RC, et al. *BTS guidelines for the management of community acquired pneumonia in adults: update 2009*. *Thorax* 2009; 64 (Suppl 3):iii1–55.  
<https://doi.org/10.1136/thx.2009.121-434>.
10. *BTS/SIGN British Guideline on the Management of Chronic Asthma*; 2014.
11. Renaud Louis, Imran Satia, Inigo Ojanguren, Florence Schleich, Matteo Bonini, et.al. *European Respiratory Society Guidelines for the Diagnosis of Asthma in Adult* *European Respiratory Journal* 2022; DOI: 10.1183/13993003.01585-2021
12. Brian L. Graham, Irene Steenbruggen, Martin R. Miller, Igor Z. Barjaktarevic, et.al; on behalf of the American Thoracic Society and the European Respiratory Society. *American Thoracic Society document: Standardization of*

- Spirometry 2019 Update. An Official American Thoracic Society and European Respiratory Society Technical Statement.
13. Brice Touilloux, Alexandra Lenoir, Jean-William Fitting, Peter Vollenweider, Marie-Pierre F. Strippoli, Martin Preisig, Laurent P. Nicod . The association of FVC with quality of life – The Pneumo Laus|PsyCoLaus study. *European Respiratory Journal* 2020 56: 1662; DOI: 10.1183/13993003.congress-2020.166.
  14. Ribeiro de Andrade MC, Duarte P. Camargos. Correlation between pulse oximetry and peak expiratory flow in acute asthma. *Cardiovascular, Respiratory and Sports Medicine. Braz J Med Biol Res*20074; 40 (4). <https://doi.org/10.1590/501000-879x200700040006>.
  15. Global Initiative for Asthma (GINA) Global strategy for Asthma Management and Prevention 2021. Available from [www.ginasthma.org](http://www.ginasthma.org)
  16. Brian LG, Irene S, Miller MR, Igor ZB, Brendan GC, Graham LH, et al. Standardization of spirometry 2019 update: An official American Thoracic Society and European Respiratory Society Technical Statement. *American Journal of Respiratory and Critical Care Medicine*, 2019; 200:8.
  17. Wang Y. Chapter 2: “Use of percentiles and z-scores in Anthropometry”. *Handbook of Anthropometry*. New York: Springer, 2012; p. 29.
  18. Moore VC. Spirometry: step by step. *Breathe*, 2012; 8: 232-240.
  19. IBM SPSS Data Collection Divestiture, 2016.
  20. Magadle R, Berar-Yanay N, Weiner P. The risk of hospitalization and near-fatal asthma in relation to the perception of dyspnea. *Chest*. 2002; 121: 329-333.
  21. Sisay Shine, Sindew Muhamud, Alebachew Demelash . Prevalence and associated asthma among adult patients in Derre Berhan Referral Hospuital, Ethiopia 2018: a cross-sectional study. *BMC Research Notes* 12 Article number: 608 (2019)
  22. Usha G Shenoy and Karthiyanee Kutty.\_ Peak Expiratory Flow Rate, Blood Oxygen Saturation, and Pulse Rate among a Mine Tailing Community. *Indian J Community Med*. 2018 Oct-Dec; 43(4): 294–297. doi: 10.4103/ijcm. IJCM 18518 PMID: PMC6319286.
  23. Renée Lampe, Tobias Blumenstein, Varvara Turova, and Ana Alves-Pinto.\_ Lung vital capacity and oxygen saturation in adults with cerebral palsy. *Patient Prefer Adherence*. 2014; 8: 1691–1697. doi: 10.2147/PPA.S72575 PMID: PMC4267512 , PMID: 25525345.

**Cite this Article:** Jumbo, J; Edafe, EA; Ambakederemo, TE (2022). A survey of levels of oxygen saturation and spirometric parameters among suspected asthmatics referred to the respiratory clinics in the Niger Delta University Teaching Hospital (NDUTH), South-South, Nigeria. *Greener Journal of Medical Sciences*, 12(2): 185-191.