ANALYSIS OF LUNG FUNCTION TESTS AT A TEACHING HOSPITAL

D.A. ANTWI[1], G. E. GBEKLE[2], H. K. COSMOS[2], I.E. ENNIN[1], E.A. AMEDONU[3], C. ANTWI-BOASIAKO[1], M.K. CLOTTEY[1] AND F.K. ADZAKU[1]

[1]Department of Physiology, University of Ghana Medical School, Korle-Bu, Accra, Ghana.[2]University of Ghana Medical School, Korle-Bu, Accra, Ghana.[3]School of Allied Health Sciences, College of Health Sciences, Korle-Bu, Accra, Ghana

Corresponding Author: *Dr. D.A. Antwi* ***Email:*** *dantwi@ug.edu.gh*

Conflict of interest: *None declared*

SUMMARY

Objective: To report on the proportions of restrictive, obstructive and combined types of respiratory diseases in patients referred to respiratory units at the Korle Bu Teaching Hospital.

Method: This was a retrospective study of lung function test (LFT) data on patients who were referred from clinics both in and outside KBTH. A spirometer was used to assess various lung volume parameters.

Results: One quarter of total subjects (25.5%) had obstructive, 14.8% restrictive and 11.7% exhibited combined forms of respiratory disease. The rest showed none of the above conditions and were classified as normal. We also found differences in proportions of the disorders for subjects in different age and weight categories. Whereas obstructive respiratory disease occurred more in obese patients, and patients who were 35 years and above, restrictive and combined respiratory diseases occurred more in underweight patients, and patients below age 35 years. The respiratory diseases suggested in our study were found not to be sex-dependent.

Conclusion: Our study indicates that obstructive lung disease was the most predominant respiratory lung ailment among patients referred to the respiratory units of Korle Bu Teaching Hospital.

Keywords: Lung function tests, restrictive,, obstructive respiratory diseases.

INTRODUCTION

Lung function tests, using spirometric techniques, are particularly effective in diagnosing the type and the severity of respiratory diseases in hospitals.[1,2]The two broad types usually diagnosed are restrictive and obstructive respiratory diseases. Besides these, there are cases comprising a combination of both types. These tests are also able to differentiate reversible obstructive disease (e.g. asthma) from irreversible or chronic obstructive pulmonary disease (e.g. emphysema) by the use of bronchodilators.[3]

Restrictive Respiratory Disease refers to the condition in which lung compliance is impaired. The lung's characteristic property of compliance is a measure of its distensibility, which normally facilitates the expansion and contraction of lung space. The lungs tend to stiffen and cannot expand normally thereby causing reductions in lung volumes. Restrictive respiratory diseases[4,5], broadly defined, include Sarcoidosis, Tuberculosis, Pnuemonectomy, Pneumonia, fibrosis,scoliosis, kyphosis, ankylosing spondylitis, pleural effusion, pregnancy, gross obesity, tumors, ascites, and some Neuromuscular Diseases (e.g. muscular dystrophy)

Obstructive Respiratory Disease refers to a condition of constricted airways, with increased airway resistance. The patient inspires normally but finds difficulty in expiration.[6] Flow through the tubular passageways of the lung can be reduced due to bronchial smooth muscle contraction as is the case in asthma, narrowing of the airways due to inflammation and swelling of bronchial mucosa and the hypertrophy and hyperplasia of bronchial glands as is the case in bronchitis, material inside the bronchial passageways physically obstructing the flow of air as is the case in excessive mucus plugging, and inhalation of foreign objects or the presence of pushing and invasive tumors .

Other causes include destruction of lung tissue with the loss of elasticity and hence the loss of the external support of the airways as is the case in emphysema, and external compression of the airways by tumors and trauma. Obstructive respiratory diseases may be reversible[6,7] (e.g. asthma) or irreversible[7,8] (e.g. emphysema).

Measurements in LFT's: The following measurements are routinely taken during lung function tests:[2,4]

VC (vital capacity)
FVC (forced vital capacity)
FEV_1 (forced expiratory volume in one second)
$FEF_{25\% - 75\%}$ (Forced Expiratory Flow)
PEF (Peak Expiratory Flow)

It is common in healthy individuals to be able to expel 75% - 80 % of their vital capacity in the first second of the FVC test. Hence, FEV_1 is a pulmonary function value that is highly diagnostic of obstructive disease, i.e. if an individual's FEV1 is low compared to the predicted FEV_1 in the normal population, the individual may have an obstructive lung disease. FEV_1 is also expressed as a ratio or a percentage of the FVC and is written as $\%FEV_1$ or as FEV_1/FVC. If the individual being tested displays a low FEV_1 and the $FEV_1\%$ is low, then the presence of an obstructive pathology is suspected[1]. In obstructive lung disease, $FEF_{25\%-75\%,}$ is reduced, likewise PEF, due to an increase in airway resistance.

In patients with restrictive lung disease, $FEV_1$and FVC are both lower than predicted normal values[8]. Since both of these values may equally be affected in restrictive disease, the %FEV1 may well be calculated to be between 85% and 100% of normal. Hence, restrictive pathology is suspected if FEV1 and FVC are low and the %FEV1 is 85% or greater.[13]

To distinguish between reversible and irreversible obstructive, FEV_1 is measured during a post-bronchodilator test, using a β_2–selective sympathomimetic agent. An increase of 10-15% over the pre-test FEV_1 confirms a reversible obstructive disorder. The purpose of the study was to report on the proportions of restrictive, obstructive and combined types of respiratory diseases in patients referred to respiratory units at the Korle Bu Teaching Hospital.

METHOD

This was a retrospective study using data on patients who took LFT's in the Departments of Physiology and Medicine of the Korle Bu Teaching Hospital from January 2006 to July 2009. Information gathered included VC, FVC, FEV_1 and FEV_1 ratio, PEF, $FEF_{25\% - 75\%}$, age, sex, height, and weight. By kind permission of the respective departments, a total of 794 subjects' records were available for the purposes of our study, out of which a total of 762 subjects' data were analyzed, 394 were from males, and 363 from females. Records that were not included in the analysis were either incomplete or were not signed by an attending specialist. Ages varied from 6 yrs to 87 yrs (median age of 35 yrs) whereas weights ranged between 18kg to 126kg (median weight of 62 kg). Lung volumes were obtained by using a vitalograph, (Vitalograph Alpha by Vitalograph Plc, Buckingham, England) which is essentially a spirometer consisting of a mouthpiece, tubing, and a recording device. The test procedure was explained to all subjects and procedure carried out following a demonstration of the technique and patients' consent.

Each subject took a full inspiration and then breathed out slowly by blowing air into the disposable mouthpiece of the vitalograph, giving the VC. This step was repeated but breathed out quickly with maximum effort. This effort gave the FVC curve on the vitalograph, from which FEV_1, FEV_1/FVC ratio, PEF, and $FEF_{25\% - 75\%}$ were derived. Each test was repeated a minimum of 3 times and maximum 5 times with adequate rest after each manoeuvre for best results. Each effort was graded automatically by the spirometer on a scale of A to F, and only grades A to C considered as acceptable effort. The device was calibrated for subjects' race, height, sex, and age. Subject Body Mass Indices (BMI) was obtained by dividing body weight (kg) by the square of the subject's height (m). .

***Statistical analysis*:** The data were analyzed using Z test for two proportions and binary logistic regression analyses. Z test was used to analyze the differences in the occurrence of the respiratory diseases in our study population. P values less than 0.05 were considered significant. Binary logistic regression analysis was used to analyze lung conditions in paired BMI groups[2], and also age categories of <35 and ≥35 years (median age at time of test in this study). Odds ratios (OR) >1 and <1 were considered positive and negative associations respectively. The significance or otherwise of values of odds ratios was tested by respective values of confidence intervals. The Ethical and Protocol Review Committee of the University of Ghana Medical School approved the protocol for the study.

RESULTS

Table 1 shows that three hundred and sixty-six (48.0% of subjects) were normal (191 males and 175 females), 194 (25.5%) had obstructive respiratory disease (97 males and 97 females), 113 (24.8%) had restrictive respiratory disease (57 males and 56 females) and 89 (11.7%) had combined (54 males and 35 females).

Table 1 Proportions of Respiratory Diseases in Subjects

Respiratory disease	No. Of subjects (% of Total)	No. Of subjects	
		Male	Female
Obstructive	194 (25.5)	97	97
Restrictive	113 (14.8)	57	56
Combined	89 (11.7)	54	35
Normal	366 (48.0)	191	175
Total	762 (100)	399	363

Out of 762 subjects who undertook spirometry, 314 had information recorded on both weights and heights from which their BMIs were calculated and data analyzed (Table 2). Odds ratio analyses were performed for paired conditions and results presented in Table 3.

From Table 2, it would appear that obstructive respiratory diseases are as prevalent in obese as it is in normal subjects but odds ratio analysis (Table 3) however shows that obese patients had a higher risk of getting obstructive respiratory disease while the underweight were more at risk of getting restrictive respiratory disease.

Table 2 Distribution of Lung condition among BMI categories

	(% OF TOTAL)			
BMI[9,10,11]	Obstructive	Restrictive	Combined	Normal
Underweight (<18.5)	6.8	20.6	20.6	51.7
Normal (18.5-24.9)	19.2	14.0	16.0	50.8
Overweight (25-29.0)	10.7	13.0	5.9	70.2
Obese (≥30)	19.5	13.7	8.0	58.6

Table 3 Odds Ratio Analysis of Respiratory Disease in Relation to BMI and Age

	Obstructive	**Restrictive**	**Combined**
Paired Categories	**Odds Ratio (95% confidence interval)**		
Obese : Overweight	2.0238 (0.8469 to 4.8362)	1.0618 (0.4407 to 2.5582)	1.3825 (0.4210 to 4.5399)
Obese : Normal	1.0156 (0.5017 to 2.0557)	0.8533 (0.3871 to 1.8810)	0.5359 (0.2102 to 1.3664)
Obese : Underweight	3.2786 (0.7092 to 15.1562)	0.6133 (0.2071 to 1.8162)	0.3354 (0.1026 to 1.0969)
Overweight : Normal	0.5018 (0.2181 to 1.1546)	0.8037 (0.3577 to 1.8058)	0.3877 (0.1361 to 1.1046)
Overweight : Underweight	1.6200 (0.3290 to 7.9767)	0.5776 (0.1923 to 1.7345)	0.2426 (0.0678 to 0.8677)
Normal : Underweight	3.2283 (0.7133 to 14.6105)	0.1719 (0.2566 to 2.0132)	0.6259 (0.2207 to 1.7751)
AGE /years			
≥ 35 : < 35	1.7581 (1.2107 to 2.5531)	0.7118 (0.4709 to 1.0759)	0.9889 (0.6169 to 1.5852)

These differences were, however, not statistically significant (OR=0.3354; 95% CI 0.1026 to 1.0969). Our analysis also revealed that, for age below 35 years, 6.1% of them had obstructive, 5.8% restrictive and 3.8% combined, while in subjects 35 years and above, 19.4% were obstructive, 9.1% restrictive and 7.9% combined

DISCUSSION

One of the highlights of our analysis is that, among all subjects studied, obstructive lung disease was most prevalent (>25%) with equal distribution among the sexes. Restrictive and combined respiratory diseases follow in that order at nearly 15% and 12% respectively with similar sex distribution.

Our study also found nearly half of subjects' lung function to be normal, given that both respiratory units handle referred patients and also individuals seeking physical examination for purposes including travel, employment, and admission to various types of public and private institutions. The study suggests that more of the respiratory diseases occur in subjects 35 years and above, with most of them indicated for obstructive lung conditions.

On the other hand, people below age 35 years had about equal preponderance towards restrictive and combined respiratory diseases.

We show that there is a significant difference between underweight compared to overweight individuals who had both obstructive and restrictive conditions. Previous studies have also reported associations between body weight and various respiratory diseases. The weight of evidence suggests an association between obesity and obstructive lung disease[13,14,16], except in very severe obesity (BMI>40)[19,20] where restrictive patterns emerge due to the impact of fat on respiratory function. On the other hand, underweight may predispose to restrictive or chronic obstructive forms of respiratory disease.[15,17,18]

The maneuvers undertaken in these tests are also largely dependent on patient's cooperation and effort, and they are normally repeated at least three times to ensure reproducibility. Also, due to the subjective nature of the test, vitalograph can only be used on children old enough to comprehend and follow instructions given and only on patients who are able to understand and follow instructions – thus, this test is not suitable for patients who are unconscious, or have limitation that would interfere with vigorous respiratory efforts.

We can conclude from our data gathered from the respiratory units of Ghana Medical School and KBTH that obstructive respiratory diseases are the most prevalent among the subjects, that respiratory diseases occurred more in patients who were 35 years and above, and that patients below age 35 years are at higher risk of combined restrictive and obstructive disease. Moreover, the overweight are at the highest risk of obstructive lung disease whiles the underweight have the highest risk of getting restrictive and combined conditions. Respiratory diseases do not appear to be sex-biased as the odds of their occurrence are the same in both male and female.

REFERENCES

1. Fishbach FT, Dunning MB III, eds. Laboratory tests and diagnostic procedures 7th ed. 2004. Philadelphia. Lippincott Williams & Wilkins.
2. Pagana KD, Pagana TJ. *Mosby's Manual of Diagnostic and Laboratory Tests*, 3rd ed. 2006. St.Louis. Mosby.
3. Caramori G, Contoli M, Papi A. Treatment of bronchial asthma in adults: Current advances. *Rec Prog Med* 2009; 100 (4):171-9
4. Guyton A. C. & Hall J. E. *Text Book of Medical Physiology*. 11th edition. 2006. Reed Elsevier, India Private Ltd. New Delhi, India. Pp 525-6
5. Aaron SD, Dales RE, Cardinal P. How accurate is spirometry at predicting restrictive pulmonary impairment? *Chest* 1999; 115 (3): 869-73.
6. Varkey B. Obstructive, occupational and environmental diseases. *Curr Opin Pulm Med.* Mar 2004; 10 (2): 97
7. US Department of Health and Human Services, NIH 3rd *Expert panel on the diagnosis and management of asthma*. National Heart, Lung and Blood Institute, National Asthma Education and Prevention Program, 2007. Washington DC. US DHHS; Aug 28 2007:1-404
8. Whittle A. COPD guidelines. *Thorax.* April 1999; 54 (4):375-6
9. Chinn DJ, Cotes JE, Reed JW. Longitudinal effects of change in body mass on measurements of ventilatory capacity. *Thorax* 1996; 51: 699-704.
10. Obesity: Preventing and managing the global epidemic. Report of a WHO Consultation. WHO Technical Report Series 894. Geneva: World Health Organization, 2000.
11. Lewis CE, McTigue KM, Burke LE, Poirier P, Eckel RH, Howard BV, Allison DB, Kumanyika S, Pi-Sunyer FX. Mortality, Health Outcomes, and Body Mass Index in the Overweight Range (American Heart Association Science AdvisoryReview).***Circulation*** **2009;119:3263-3271**
12. Pellegrino R, Viegi G, Brusasco V, Crapo RO, Burgos F, Casaburi R, Coates A, van der Grinten, Gustafsson P, Hankinson J, Jensen R, Johnson DC, MacIntyre N, McKay R, Miller MR, Navajas, D, Pedersen OF, Wanger J. Interpretative strategies for Lung Function Tests. *Euro Resp J* 2005; 26(5):948-964.
13. Jordan JG. Jr, Mann, JR. Obesity and Mortality in Persons with Obstructive Lung Disease Using Data from the NHANES III. *Southern Med J* 2010; 103(4): 323-330.
14. Saxena Y, Sidhwani G, Upmanyu R. Abnorminal obesity and pulmonary function in young Indian adults: a prospective study. *Indian J Physiol Pharm* 2009; 53(4):318-20.
15. Bowen RE, Scaduto A A, Banuelos SRN. Decreased Body Mass Index and Restrictive Lung Disease in Congenital Thoracic Scoliosis. *J Ped Orthop* 2008; 28(6):665-668.
16. Negri E, Pagano R, Decarli A, La Vecchia C. Body weight and the prevalence of chronic diseases. *Community Health* 1988; 42:24-29.
17. Reilly KH, Gu D, Duan X, Wu X, Chen CS, Huang J, Kelly TN, Chen J, Liu X, Yu L, Bazzano LA, He J. Risk Factors for Chronic **Obstructive** Pulmonary **Disease** Mortality **in** Ch**in**ese Adults. *American Journal of Epidemiology* 2008; 167(8):998- 1009.
18. Slinde F, Svensson A, Gronberg AM, Nordenson A, Hulthena L, Larsson S. Reproducibility of indirect calorimetry in underweight patients with chronic obstructive pulmonary disease. *The Eur e-Journal Clin Nutr Metab* 2008; 3(2):e40- e45.
19. Weiner P, Waizman J, Weiner M, Rabner M, Magadle R. Influence of excessive weight loss after gastroplasty for morbid obesity on respiratory muscle performance. *Thorax* 1998; 53:39–42.
20. Poulain M, Doucet M, Major GC, Drapeau V, Sériès F, Boulet L-P, Angelo Tremblay A, Maltais F.The effect of obesity on chronic respiratory diseases: pathophysiology and therapeutic strategies. *CMAJ* 2006; 174 (9):1293-1299.