Current pattern of spirometry utilisation in a sub-Saharan African country

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Abstract

Spirometry is recommended in the assessment of respiratory diseases. It was however reported to be underutilised in Nigeria. This study assessed current patterns in spirometry utilisation in terms of frequency and sources of referral, the indications for referral and patterns of ventilatory function when compared with a similar study 6 years ago in the same centre. The results will enable us to address gaps in spirometry utilisation. Consecutive subjects underwent spirometry in the University of Nigeria Teaching Hospital (UNTH), Ituku Ozalla, Enugu between January 2013 and June 2015 and were retrospectively studied. Demographic, anthropometric, and spirometric data were obtained from the spirometry register. Data were analysed to determine the mean age, sex distribution, and body mass index (BMI) of the study participants. Data on frequency and sources of referral for spirometry, indications and pattern of ventilatory function were obtained. The number of patients visiting different clinics in the hospital on a monthly basis was recorded. A total of 226 subjects had acceptable spirometry; 120 (53.1%) were males with a male to female ratio of 1.13:1; mean age was 48.51±18.13 years. Of the participants, 180 (79.6%) were referred from the Department of Medicine and 24 (10.6%) from the Department of Surgery, while 12 (5.3%) were referrals from peripheral hospitals. Bronchial asthma was the indication for spirometry in 89 study participants (65.9%) followed by chronic obstructive pulmonary disease (COPD) in 35 (15.5%) and pre-operative spirometry assessment in 33 (14.6%). Normal ventilatory pattern was found in 82 study participants (37.6%), restrictive pattern in 62 (27.4%), obstructive pattern in 57 (25.2%) and a mixed pattern in 22 (9.7%). In conclusion, we found an increase in spirometry utilisation with a comparably wider spread of doctors involved in referring patients from both within and outside the hospital. Bronchial asthma remains a dominant indication for spirometry. The incidence of a restrictive ventilatory pattern appears to be increasing and needs further evaluation.

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Introduction

Worldwide, about 334 million people have asthma and the prevalence is on the increase, especially in middle- and low-income countries.[1] Asthma remains the most common chronic lung condition in children[2] while chronic obstructive pulmonary disease (COPD) affects 300–600 million people with increasing prevalence and mortality.[3] For proper diagnosis, global and national guidelines[4,5] recommend spirometry as the gold standard for accurate and repeatable measurement of lung function; it is the preferred initial test to assess the presence and severity of airflow obstruction in asthma patients,[2,6] and assists in gathering proper epidemiological data of these diseases.

Spirometry as an investigative tool is used for assessing ventilatory function which can be categorised into four types: normal, obstructive, restrictive, and mixed patterns.[7] Obstructive lung diseases such as asthma and COPD constitute the dominant indications for spirometry in Nigeria.[8,9] Although spirometry is a simple, inexpensive, and non-invasive procedure it is underutilised by healthcare practitioners even when indicated.[10–12] This may lead to underdiagnosis, over-diagnosis, or misdiagnosis of asthma or COPD,[13–17] resulting in increased economic costs and medication risks.[18,19] Studies on spirometry utilisation in sub-Saharan Africa are scarce. Desalu et al8 documented poor spirometry utilisation in Ilorin, Nigeria. A previous study done at the current centre in Enugu, Nigeria, six years ago when spirometry was first introduced in the hospital, showed a low rate of spirometry referrals and there was no referral from peripheral hospitals.[10] We conducted this study as a follow-up to assess for the current pattern of utilisation in terms of frequency and sources of referral for spirometry and the indications for spirometry. This will enable us to understand and subsequently address gaps in spirometry utilisation. This study also aimed to assess the ventilatory pattern prevalent in our centre to better understand the epidemiology of respiratory diseases in our locality.

Methods

Consecutive subjects who had spirometry at the University of Nigeria Teaching Hospital (UNTH), Ituku Ozalla, Enugu between January 2013 and June 2015 were retrospectively studied. The information gathered for each subject included biodata, anthropometry, source of referral, indication for spirometry, and details of the ventilatory measurements taken. The number of patients, on a monthly basis, attending clinics in the medical out-patient (MOP), surgical out-patient (SOP), childrens' out-patient (CHOP), and general out-patient departments (GOPD) over the study period was also retrieved.

All spirometry tests were done using Spirolab III (Medical International Research, Italy) and were conducted by respiratory

Age range (years)	Male n (%)	Female n (%)	Total n (%)
<20	4 (3.3)	4 (3.8)	8 (3.5)
20–30	20 (16.7)	20 (18.9)	40 (17.7)
31–40	19 (15.8)	20 (18.9)	39 (17.3)
41–50	14 (11.7)	21 (19.8)	35 (15.5)
51–60	22 (18.3)	16 (15.1)	38 (16.8)
60 and above	41 (34.2)	25 (23.6)	66 (29.2)
Total	120 (100.0)	106 (100.0)	226 (100.0)
χ^2=4.214, p=0.519.			

Table 1: Age and sex distribution of patients referred for spirometry in UNTH, Enugu, Nigeria.

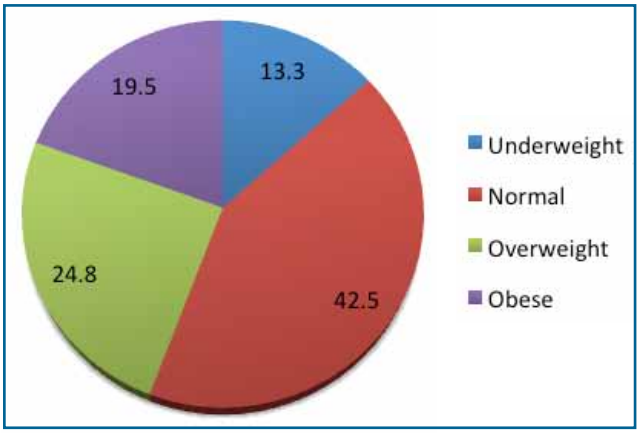

Figure 1: Weight distribution of patients referred for spirometry based on body mass index (BMI).

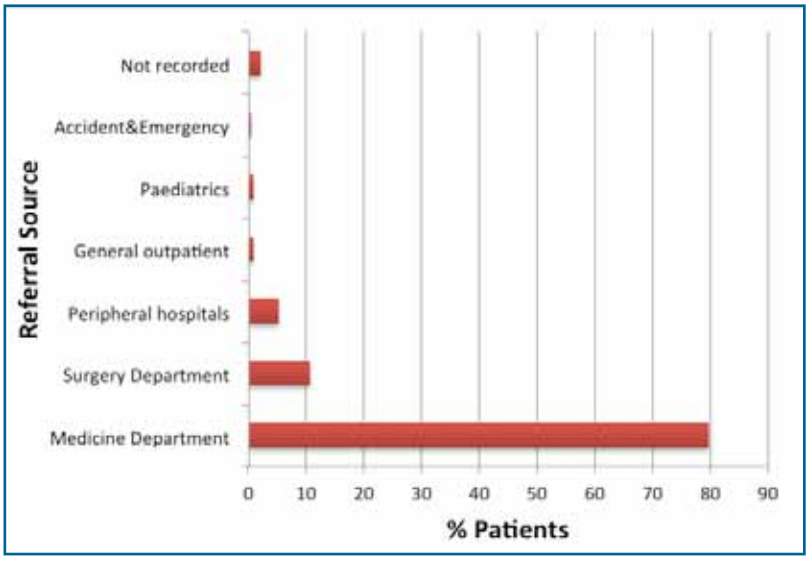

Figure 2: Distribution of referral sources for spirometry at UNTH, Enugu, Nigeria.

physicians and trained residents attached to the respiratory unit. Spirometry was carried out according to the Global Initiative on Chronic Lung Disease (GOLD) and American Thoracic Society and European Respiratory Society (ATS/ERS) guidelines.[20,21]

Ventilatory function was classified as follows. Normal function: FEV_1/FVC (forced expiratory volume in one second/forced vital capacity) equal to or above 70% with FEV_1 and FVC each equal to or above 80% predicted; obstructive: FEV_1/FVC below 70%; restrictive: FEV_1/FVC equal to or above 70% with FEV_1 and FVC below 80% of predicted; mixed: FEV_1/FVC less than 70% and FVC below 80% of predicted. European Respiratory Society and Knudson reference values were used for adults and paediatrics respectively, with a correction factor of 10%. Patients with unacceptable spirometry were excluded from the final analysis.

Data analysis was done using the Statistical Package for the Social Sciences, version 20 (SPSS Inc., Chicago, IL, USA). Descriptives (frequency and percentages) were used to analyse the age, sex and body mass index (BMI). Chi squared was used as a test of association. The level of significance was set at $p<0.05$.

Results

The records of 243 patients were initially obtained, with 17 excluded due to unacceptable spirometry; 226 subjects had acceptable spirometry and were enrolled into the study. There were 120 (53.1%) males with a male to female ratio of 1.13:1. The age range was from 15 to 87 years with a mean age of 48.51±18.13 (Table 1). BMI was normal (18.5–24.9 kg/m^2) in 96 (42.5%) of the study participants while 56 (24.8%), 44 (19.5%), and 30 (13.3%) subjects were overweight (25.0–29.9 kg/m^2), obese (≥30.0 kg/m2), and underweight (<18.5 kg/m^2) respectively (Figure 1).

One hundred and eighty (79.6%) patients were referred from the Department of Medicine in our hospital, 24 (10.6%) from the Department of Surgery, and 12 (5.3%) from peripheral hospitals (Figure 2). In 2013 and 2015, spirometry referral showed a rising trend compared with out-patients visits to MOP, SOP, CHOP and GOPD clinics (Figure 3(a)) and the same trend was seen when the different clinics were viewed together as hospital out-patients (Figure 3(b)).The most common indication for spirometry referral was for patients with bronchial asthma diagnosis (89 (39.4%) of participants), followed by COPD in 35 (15.5%) and pre-operative spirometry assessment in 33 (14.6%) patients (Table 2).

Assessment of ventilatory function showed that 85 (37.6%) patients had a normal pattern, 62 (27.4%) had a restrictive pattern, 57 (25.2%) had an obstructive pattern, and 22 (9.7%) a mixed ventilatory pattern (Table 3); 44.9% of asthma referrals showed either obstructive (34.8%) or mixed patterns (10.1%). Reversibility testing was documented in only 28 of these patients and was positive in 53% of cases. Only 28.6% and 11.4%. of suspected COPD cases (40%) showed obstructive and mixed ventilatory patterns respectively, while 33.3% of interstitial lung disease referrals revealed restrictive ventilatory function.

Discussion

A total of 226 patients performed acceptable spirometry over the study period of 2.5 years. This was a four-fold rise in spirometry

Indications	n (%)
Asthma	89 (39.4)
COPD	35 (15.5)
Pre-operative assessment	33 (14.6)
Unexplained dyspnoea/chest tightness	13 (5.8)
Chronic cough	12 (5.3)
Interstitial lung disease	9 (4.0)
Connective tissue disease	5 (2.2)
Thoracic cage deformity	3 (1.3)
Lung collapse	2 (0.9)
Hypertensive heart disease	1 (0.4)
Neuromuscular disease	1 (0.4)
Miscellaneous (other lung diseases)	11 (4.8)
Not recorded	12 (5.3)

Table 2: Indications for Spirometry at UNTH, Enugu, Nigeria.

Ventilatory pattern	n (%)
Normal	85 (37.6)
Restrictive	62 (27.4)
Obstructive	57 (25.2)
Mixed	22 (9.7)

Table 3: Ventilatory function patterns of patients at UNTH, Enugu, Nigeria.

referral when compared to an earlier study in the same centre10 where only 52 referrals were received over a three-year period. Overall, our study showed a rise in spirometry referral over the study period, with a peak in the second or third quarter of each year, with the exception of 2014 when the spirometer was unusable in the first three months and industrial action by hospital workers in July and August precluded spirometry services. Even so, the greatest number of referrals in a month occurred more recently in 2015. In addition, while the monthly percentage number of patients visiting the hospital out-patient departments remained relatively stable at between 4 and 6%, the monthly percentage referral for spirometry showed a progressive rise, punctuated by two periods of industrial action (July, August and December in 2014 and January in 2015). This rising trend may be related to sensitisation of the hospital community regarding the availability of spirometry at the beginning of 2013.

The majority of referrals for spirometry in our study were from the Department of Medicine. This may be because the commonest indications for spirometry in this study were asthma and COPD, and these were managed by physicians who then referred them. Another plausible explanation may be the fact that the spirometer was domiciled with the Adult Department and was more readily accessible to that department compared with the Paediatrics Department, hence explaining the low number of pediatric patients referred. Kaminsky et al[22] suggested that spirometry is much more relevant to the diagnosis of respiratory disease in medicine compared with the pre-operative evaluation of patients in surgery. Referral from the Surgery Department was mainly from the Cardiothoracic Unit (CTU). As part of hospital protocol, spirometry is recommended as a pre-operative assessment for patients undergoing cardiac, thoracic, and upper abdominal surgeries.[23,24]

In the previous study carried out at our centre, Onyedum and Chukwuka[10] only reported referrals from the Department of Medicine and three surgery sub-units: CTU, Orthopaedic, and Maxillofacial. The current study in contrast showed more sources of referral from General out-patient, Paediatrics, and Accident and Emergency Departments as well as peripheral hospitals. This may be related to more awareness of the availability and utility of spirometry among doctors that has been obtained from self-education, discussions with colleagues, and scientific conferences conducted within this period.

While the previous studies in the tertiary hospital in Enugu, south-east Nigeria[10] and at a tertiary hospital in Lagos, south-west Nigeria[9] had no referrals from peripheral hospitals, another study carried out at a tertiary hospital in Ilorin, south-west Nigeria[8] reported up to 21% of referrals from peripheral hospitals. Referral from the peripheral hospitals may have occurred in our current study due to sensitisation workshops involving doctors from these hospitals. Workshops and seminars have earlier been shown to improve knowledge and use of spirometers.[22] However an Ontario study reported that if policies regarding evaluation of respiratory symptoms are encouraged and enforced, it will increase the utilisation of spirometry as a procedure.[25]

Most respiratory illnesses requiring spirometry evaluation, including asthma and COPD, are known to be managed in the peripheral hospitals by primary care physicians,[10,26] and most of these health facilities in Nigeria do not have spirometers available in their centres,[22] thus primary care physicians would of necessity need to refer patients needing spirometry. The low level of referral from the peripheral hospitals in this study may therefore indicate lack of spirometry utilisation by these primary care physicians. This may be due to lack of awareness of spirometer availability in bigger tertiary centres or lack of knowledge of the utility of spirometers in clinical practice as previously reported.[22] In addition, Enright et al[27] reported that underutilisation of spirometry by primary care physicians may be related to perceptions that spirometers were expensive, that the test process was disturbing to patients, took too much time to complete, and that the reports were too difficult to interpret. Surprising to note also is that in parts of the world where access to a spirometer was very high, spirometry utilisation in the diagnosis of respiratory diseases such as COPD was still low.[28,29]

The most common indication for spirometry in our study was bronchial asthma. This finding was consistent with that of other workers in Africa and Europe,[9,10,30] with the most common indications for spirometry being asthma and COPD. Contrary to our study, the work by Desalu et al[8] showed occupational diseases screening to be the second most-common indication for spirometry following bronchial asthma. They reported that part of their sample included bankers who were involved in a screening exercise during an organised event. This was to help assess for occupation-related lung diseases due to handling dirty and dusty currency notes (pre/intra employment screening). This may have introduced sample bias and thus influenced the outcome of their study.

Our study found that the majority of patients had either normal or restrictive ventilatory patterns. Asthma and COPD were the predominant indications for spirometry in our study, and normal or obstructive patterns would be expected as documented by two Nigerian studies done in Ilorin and Lagos.[8,9] However,

both groups of patients can develop air trapping and therefore can present with pseudorestriction, which would partly account for the high frequency of restrictive ventilatory pattern seen in our study.[31,32] Secondly, a reasonable percentage of our population sample were referred for pre-operative assessment. All the patients for pre-operative assessment from CTU in our study were cardiac patients for open heart surgery. The majority of them had restrictive ventilatory patterns due to varying degrees of cardiomegaly and heart failure, in agreement with findings in previous studies.[33,34] Another reason for the difference in ventilatory patterns may be the impact of body mass index (BMI) on ventilatory pattern. A BMI well above normal is known to cause a restrictive ventilatory pattern[35,36] and our study found 19.5% of the subjects to be obese and 24.8% overweight. We used the GOLD criteria which defined air flow obstruction by a fixed ratio of FEV_1 to FVC of less than 70%; this is in contrast to the definition of obstruction as an FEV_1/FVC less than the lower limit of normal (LLN), as derived from the Global Lung Function Initiative (GLI) equation.[37] This may result in reduced frequency of obstructive ventilatory patterns as shown in a 2015 prevalence study of COPD in a rural district in Uganda.[38] That study found a lower estimate of obstruction when the GOLD criteria was used (12.4%) compared with the GLI equation (16.2%).

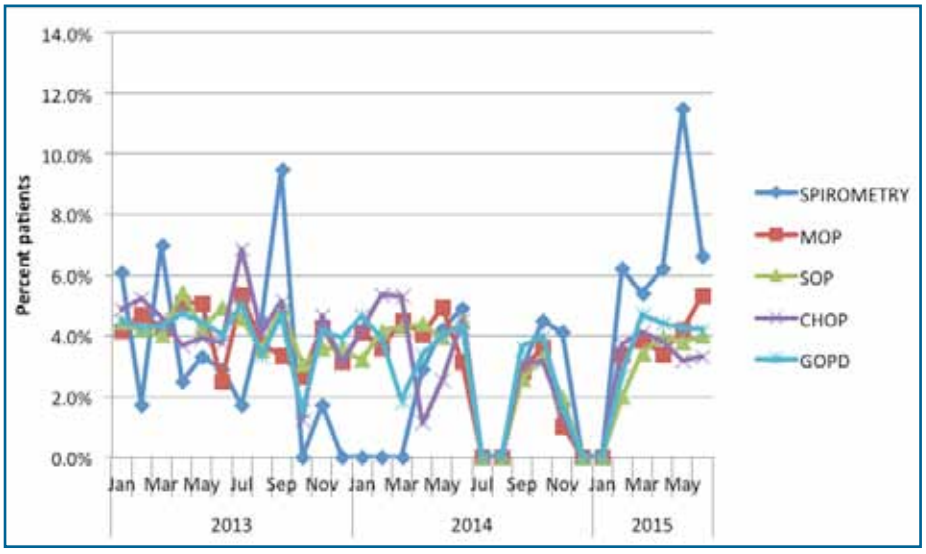

Figure 3(a): Successive percentage number of spirometry tests carried out per month compared with the percentage number of out-patients seen per month at the medical out-patient (MOP), surgical out-patient (SOP), childrens' out-patient (CHOP), and general out-patient departments (GOPD), respectively, at the UNTH. Total number of patients who had spirometry during the study period is 243. Total number of patients over the study at the MOP is 34,226; SOP 33,179; CHOP 20,723; and GOPD 82,613. Percentage is calculated as fraction of the total number in the respective departments over the study period.

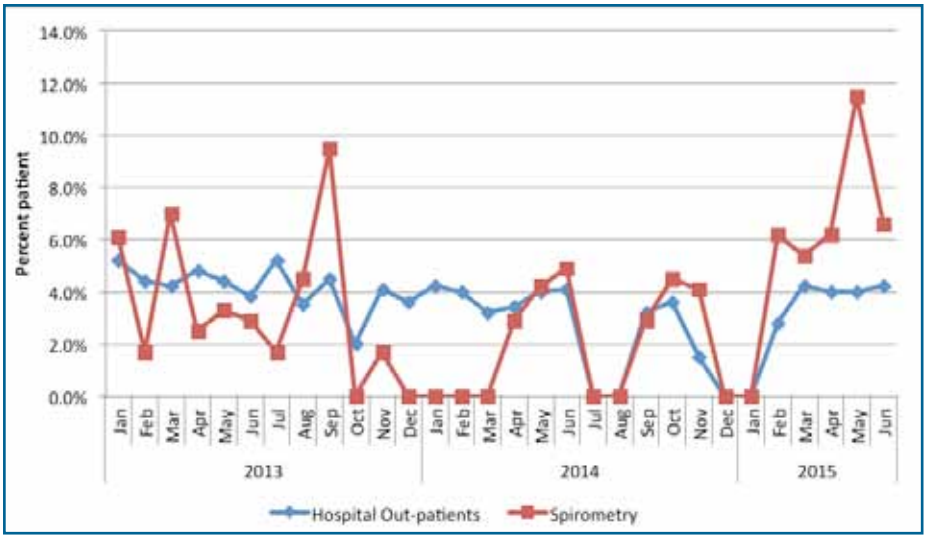

Figure 3(b): Successive percentage number of spirometry tests carried out per month compared with the percentage number of hospital out-patients seen per month at UNTH (hospital out-patients here comprise MOP, SOP, CHOP, and GOPD combined together). The total number of patients undergoing spirometry during the study period is 243. The total number of hospital out-patients during the study period is 170,741. Percentage is calculated as fraction of the total number undergoing spirometry and the total of hospital out-patients respectively, over the study period. Sensitisation of the hospital community to the use of spirometry occurred in January 2013; a doctors' forum emphasising spirometry occurred in May 2015.

Our study showed that 40% of those referred on account of COPD had an irreversible obstructive airway, proving the diagnosis of COPD. The rest had normal or restrictive ventilatory patterns. Without spirometry, all the COPD referrals would have continued to receive treatment for COPD, exposing those in whom COPD was ruled out by spirometry to unnecessary medical costs, unsuitable drugs and their side effects, and delaying the time to reach a definitive diagnosis. Over half of those referred with a presumed diagnosis of asthma in our study had either normal or restrictive ventilatory patterns. Walker et al[39] reported that of 63 patients documented in hospital case notes as having COPD, and of 65 documented as having asthma, who were then referred for primary-care spirometry, only 76% and 52% were diagnosed to have COPD and asthma, respectively, enabling changes in diagnosis and treatment accordingly. It is established that suspected asthma patients with normal spirometry can have positive results on methacholine or exercise challenge tests indicating airway hyper- responsiveness (AHR) which is a hallmark of bronchial asthma.[40] Conducting methacholine tests would probably have increased the number of asthma referrals to our respiratory

laboratory who could then have been definitively diagnosed to have bronchial asthma. However, as our centre does not have this facility, these types of patients are followed up to monitor future symptoms and seek alternative diagnoses, while some are given empirical treatment with bronchodilators if bronchial asthma is still strongly suspected.

The use of spirometers in our centre is limited by the fact that spirometry services are offered only on a Monday each week; this is due to the lack of adequate numbers of well-trained staff to conduct spirometry. Patients with pulmonary tuberculosis are excluded from spirometry in our centre, because although we use separate disposable mouth pieces for successive patients, they are fitted to a reusable turbine which increases the potential for cross-infection. Employment of a different disposable turbine for each patient would increase the charge for spirometry (US$11) by 25%. Another limitation is the inability of some patients to perform acceptable spirometry manuoevres in spite of painstaking coaching.

Our study does have some limitations. Non-African spirometry reference values (ERS for adults and Knudson for paediatrics) were used in the absence of true African reference values and a correction factor of 10% was applied. This may have affected the frequency of normal versus abnormal ventilatory patterns. The presence of a functional cardiothoracic centre within our facility may have also influenced the overall ventilatory pattern seen in our study population.

Conclusion

Spirometry utilisation is on the increase in our centre with wider spread of referrals. Referral from primary care physicians is still poor. Bronchial asthma, COPD, and pre-operative assessment constitute the predominant indications for spirometry in our centre. A restrictive ventilatory pattern was prominent in our study and this needs further evaluation. Seminars and workshops to educate primary care physicians and other doctors on the usefulness of spirometry are recommended.

Author Declaration

Competing interests: none.

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