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Pulmonary Function Test Outcomes in Adult Omani Patients

Preliminary findings of single-centre study

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Abstract

Objectives: There is limited information regarding distribution of Pulmonary Diseases (PD) in Oman. Pulmonary Function Tests (PFT) outcome patterns could be a pointer to an indirect indication of the distribution of PD. This study aimed to document distribution of PFT outcomes among Omani adult patients. ***Methods:*** This retrospective cross-sectional study was conducted from January to December 2015 at a tertiary hospital in Oman. A total of 1,118 adults referred for PFTs during this period were included. ***Results:*** There were 605 (54.1%) female and 513 (45.9%) male patients. The mean age was 47.11±18.1 years. Most underwent spirometry with reversibility (36.8%) or full lung function testing with reversibility (29.7%). Of the 1,064 patients with conclusive PFT outcomes, 39.9% had normal findings, followed by 26.1% with obstructive defects, 19.6% restrictive defects and 10.6% had mixed obstructive/restrictive defects. ***Conclusion:*** This study generated important preliminary data regarding PFT outcomes (defects) in Omani patients.

Keywords: Pulmonary Function Tests; Spirometry; Pulmonary Diseases; Asthma; Chronic Obstructive Pulmonary Disease; Oman.

Introduction

According to the World Health Organization, chronic obstructive pulmonary disease (COPD) will become the third leading cause of death by 2030.[1] Each country will therefore need to conduct evidence-based policy and resource planning to provide for the increased burden of non-communicable diseases such as bronchial asthma and COPD. Although the prevalence of chronic pulmonary diseases in the Eastern Mediterranean (EMRO) region is rising, research output is low in these fields.[2–4] Another recent systematic review similarly noted an under-representation of data from the EMRO, South East Asian and African regions.[5]

Pulmonary diseases (PDs) can be monitored and distinguished using pulmonary function tests (PFTs).[6,7] Generally, PDs can be classified into obstructive or restrictive diseases. Obstructive diseases—such as asthma, chronic bronchitis and emphysema—are characterised by airflow limitations due to narrowing of the anatomic airway or loss of elastic recoil, thereby leading to partial or complete obstruction and increased resistance to air movement.[8] Restrictive diseases—like sarcoidosis, pneumoconiosis, acute respiratory distress syndrome and interstitial fibrosis of unknown aetiology—are denoted by reduced total lung capacity due to factors restricting expansion of the lung parenchyma, such as pleural diseases, obesity, interstitial lung disease (ILD) or chest wall disorders. In certain cases, obstructive and restrictive lung diseases can overlap.[6]

Specifically in Oman, there is limited information concerning the burden of common respiratory diseases; in particular, COPD remains underdiagnosed and undertreated and limited data are available regarding rates of restrictive diseases or asthma in adults.[9,10] PFT outcomes are corroborated by referring clinicians to confirm presence of PD. This study aimed to document the distribution of PFT outcomes as obstructive, restrictive and mixed obstructive/restrictive defects in Omani adult patients referred for PFTs to a tertiary hospital in Muscat, Oman. These findings will generate important baseline evidence for researchers.

Methods

This retrospective study of PFTs was conducted at a tertiary care hospital in Muscat from January to December 2015. All adult patients referred by clinicians for PFTs to assess lung function were included in the study

Patients underwent spirometry (Platinum Elite™ Body Plethysmograph, MGC Diagnostics Corp., Saint Paul, Minnesota, USA; and PowerCube® System, Ganshorn Medizin Electronic, Niederlauer, Germany) or full lung function testing (FLF) (PowerCube® System, Ganshorn Medizin Electronic). In this pulmonary laboratory of the study centre (a) spirometry includes estimation of FVC and FEV1 (b) FLF includes spirometry and estimations of lung volumes and diffusion functions. Asian standard reference equations were used to estimate predicted values.[6] All patients are instructed not to use bronchodilators the morning prior to the test to avoid altering baseline spirometry indices.

All PFT results were interpreted by a specialist according to the criteria of the American Thoracic Society (ATS)/European Respiratory Society (ERS).[6] Information regarding the patients' sociodemographic characteristics, referring physician and hospital, reason for referral and PFT outcomes was collected. The PFT outcomes were categorised as normal findings; obstructive defects; restrictive defects; mixed obstructive/restrictive defects or isolated diffusion impairment. Patients with inconclusive findings were excluded from the analysis of PFT outcomes.

Data were entered into the Statistical Package for the Social Sciences (SPSS), Version 22.0 (IBM Corp., Armonk, New York, USA). Results were presented using descriptive statistics, including frequencies and percentages. Associations between gender and type of test done, referring hospital and specialty and PFT outcomes were assessed using a Chi-squared test. Gender differences in age and body mass index (BMI) were calculated using a student's t-test.

Ethical approval for this study was obtained from the Medical Research & Ethics Committee of the College of Medicine & Health Sciences, Sultan Qaboos University.

Results

A total of 1,118 adult patients underwent PFTs during the study period. Of these, 513 (45.9%) were male and 605 (54.1%) were female. Compared to female patients, male patients were significantly younger (P = 0.007) and had lower BMI values (P <0.001). Most patients underwent spirometry with reversibility (36.8%), followed by full lung function testing with reversibility (29.7%). The majority were referred from a national tertiary hospital (76.4%). Over half (52.4%) were referred from pulmonary medicine, while the remaining patients were referred from other specialties [Table 1].

A total of 890 patients (79.6%) were referred for PFTs due to respiratory symptoms or conditions, including asthma (41.2%), shortness of breath (17.6%), cough (15.5%), ILD (8.9%), COPD (8.2%), bronchiectasis (7.8%), wheeze (4.1%), obstructive sleep apnoea (2.5%), sarcoidosis (1.9%), systemic lupus erythematosus (1.3%), cystic fibrosis (0.4%) and lung carcinoma (0.3%). The other 228 patients (20.4%) were referred for other reasons, including presurgical assessment (11.8%), pre/post-bone marrow transplant assessment (5.5%), genetic or immunological diseases (3%), pre/post-chemotherapy assessment (2.1%) and pre-hyperbaric oxygen therapy assessment (0.2%). A total of 271 patients (24.2%) had two or more reasons for PFT referral.

Overall, the PFT findings for 54 patients (4.8%) were inconclusive. Of the remaining 1,064 patients (95.2%) with conclusive results, 425 (39.9%) had normal PFT findings. But 311/425 had respiratory symptoms or conditions. A total of 278 patients (26.1%) had obstructive defects, 209 (19.6%) had restrictive defects, 113 (10.6%) had mixed obstructive/restrictive defects and 39 (3.7%) had isolated diffusion impairment. Total of 136/278 (48.9%) of obstructive defects were evident from spirometry with reversibility. About 60.8% (127/209) of restrictive defects were identified by FLF testing, although restrictive signs were earlier evident by spirometry in 82 cases (39.2%) [Table 2]. The frequency of isolated diffusion impairment was significantly higher in females compared to males ($\chi^2 = 23.21$; $P < 0.001$) [Table 3].

Discussion

The current study aimed to consolidate relevant information regarding the obstructive and restrictive defects as outcomes of PFTs in Omani adults. The distribution of PFT defect patterns could be a pointer to an indirect indication of the distribution of PD patterns. We reiterate that although most of PFTs were for respiratory symptoms or conditions, however, one fifth of PFTs were for preoperative assessment, obesity, pre-drug and pre-bone marrow studies in which the presence of any defect may not indicate a respiratory disease.

Researchers have proposed that spirometry be incorporated into assessments of airflow obstruction; however, estimates of spirometry-assessed COPD burden from epidemiological studies are often inconsistent due to variations in methods, including spirometry cut-off values.[11] In our study, we have considered spirometry to document obstructive defects using standard guidelines[6]. Alzaabi *et al*. conducted a review of studies from the EMRO and Middle

Eastern and North African regions, excluding Oman; the researchers noted that the prevalence of COPD in these regions was likely underestimated due to an overreliance on clinical diagnosis rather than spirometry findings or international diagnostic guidelines.[12] In our study centre, patients are usually referred for PFTs by a clinician based on suspicion of obstructive disease. Spirometry indices allow for the objective assessment of obstructive impairment compared to physician-diagnosed disease. In the Gulf region, lung function testing is generally underutilised, with 66% of patients reportedly never having undergone a PFT; moreover, peak expiratory flow is rarely used as an indicator of breathing difficulty.[3,13] Classifying PDs into restrictive, obstructive or other categories is only possible with full lung function testing. The current study utilised data based on both spirometry and full lung function testing, including assessment of lung volume and diffusion capacity.

The present study showed that obstructive defects was most prevalent, followed by restrictive defects in this limited sample. In 2012, the World Health Survey reported that the prevalence of physician-diagnosed asthma in the EMRO region was considerably lower at 2.95%; however, data for this region were limited to a few countries, including Pakistan (3.12%), the United Arab Emirates (5.3%), Morocco (2.76%) and Tunisia (2.74%).[14] A recent meta-analysis found that the pooled crude prevalence of spirometry-defined COPD in the EMRO region was 13.2%.[5] Masjedi *et al.* reported the pooled prevalence of asthma and COPD in the EMRO region to be 9.38% and 5.39%, respectively.[4]

In the present study, 29.2% of patients with conclusive PFT results demonstrated normal findings, despite been referred for respiratory symptoms or conditions. This could be because the respiratory symptoms of such patients were being controlled with various pharmaceutical treatments, or because the PFTs were performed to assess the presenting symptoms. Further research to explore reasons for this finding is recommended as this was beyond the scope of the current study. In addition, a significant association was noted between pulmonary defect patterns and gender. In particular, the frequency of obstructive and mixed obstructive/restrictive pulmonary defects were significantly higher in males compared to females, whereas the reverse was true for isolated diffusion impairment. Reasons for this are unclear. Isolated diffusion impairment could be an indicator of restrictive pulmonary disease suggestive of an early lung disease or an infiltrative process. However our study shows restrictive defects and low diffusion similar to other studies in the region.[15,16]

A major limitation of the current study was that pulmonary defect patterns cannot be meaningfully considered as PD patterns. Besides, isolated diffusion impairment can be documented in non-pulmonary diseases like cardiac failure but this issue was not considered in our research. Our findings in no way can be generalized to the country as they are from a single study center.

Conclusion

Among adult Omanis referred to a tertiary hospital for PFTs, obstructive defects were found to be present in 1/4th; restrictive defects in 1/5th; mixed obstructive restrictive defects in 1/10th and about 4% had isolated diffusion impairment among the referred patients. These preliminary findings of distribution of defects could be a pointer to an indirect indication of the distribution of PDs in this set-up. These statistics also provide baseline estimates for sample size calculations in future research.

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Table 1: Baseline characteristics of adult Omani patients referred for pulmonary function tests to a tertiary hospital (N = 1,118)

Characteristic	**n (%)**			***P* value**
	Total	**Male (n = 513)**	**Female (n = 605)**	
Mean age in years ± SD	47.11 ± 18.1	46.57 ± 18.8	47.57 ± 17.5	0.007
Mean BMI in kg/m^2 ± SD	-	26.95 ± 7.2	30.64 ± 8.80	<0.001
Type of PFT performed				0.061
Baseline spirometry	107 (9.6)	39 (36.4)	68 (63.6)	
Spirometry with reversibility	411 (36.8)	179 (43.6)	232 (56.4)	
Baseline full lung function testing	268 (24)	131 (48.9)	137 (51.1)	
Full lung function testing with reversibility	332 (29.7)	164 (49.4)	168 (50.6)	
Referring hospital				0.001
National tertiary hospital	854 (76.4)	356 (41.7)	498 (58.3)	
Other hospitals or health centres	264 (23.6)	157 (59.5)	107 (40.5)	
Referring specialty				0.002
Pulmonary medicine	586 (52.4)	243 (41.5)	343 (58.5)	
Other*	532 (47.6)	270 (50.8)	262 (49.2)	

*SD = standard deviation; BMI = body mass index; PFT = pulmonary function test.*Including cardiology, internal medicine, haematology, oncology, rheumatology, immunology, surgery and family medicine specialties.*

Table 2: Outcomes of various types of pulmonary function tests among adult Omani patients referred to a tertiary hospital (N = 1,064)*

Outcome	**Type of PFT performed, n (%)**				
	Baseline spirometry	**Spirometry with reversibility**	**Baseline full lung function testing**	**Full lung function testing with reversibility**	**Total**
Normal findings	66 (15.5)	136 (32)	140 (32.9)	83 (19.5)	425 (39.9)
Obstructive PD	2 (0.7)	136 (48.9)	15 (5.4)	125 (45)	278 (26.1)
Restrictive PD	31 (14.8)	51 (24.4)	67 (32.1)	60 (28.7)	209 (19.6)
Combined obstructive/ restrictive PD	3 (2.7)	61 (54)	7 (6.2)	42 (37.2)	113 (10.6)
Diffusion impairment	N/A	N/A	25 (64.1)	14 (35.9)	39 (3.9)

PFT = pulmonary function test; *PD = pulmonary disease; N/A = not applicable. *Excluding patients with inconclusive findings.*

Table 3: Gender differences according to pulmonary function test outcomes among adult Omani patients referred to a tertiary hospital (N = 1,064)*

Outcome of PFT	**n (%)**			χ^2	***P* value**
	Total	**Male**	**Female**		
Normal findings	425	184 (43.3)	241 (56.7)	23.21	<0.001
Obstructive PD	113	142 (51.1)	136 (48.9)		
Restrictive PD	278	102 (48.8)	107 (51.2)		
Combined obstructive/restrictive PD	209	59 (52.2)	54 (47.8)		
Diffusion impairment	39	8 (17.9)	32 (82.1)		

PFT = pulmonary function test; *PD = pulmonary disease*. **Excluding patients with inconclusive findings.*