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Correlation of BMI, Oxygen Saturation and CRP Levels in COPD Patients

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Abstract: Chronic Obstructive Pulmonary Disease (COPD), the fourth leading cause of death in the world, is a common preventable and treatable disease. Weight loss being the most common extra pulmonary manifestation in COPD, with increased inflammatory markers like CRP with disease progression. We aimed at correlating these with severity of COPD. To study the BMI (Body mass index), Oxygen Saturation and CRP(C reactive protein) levels in COPD (Chronic obstructive pulmonary disease) patients and correlate these with regards to severity of COPD. This will be useful in the prognosis and the management of COPD. A total of 339 adult patients of COPD diagnosed on the basis of history, clinical examination and investigations attending pulmonary medicine department at GGCH/GMC, Hyderabad went through investigations like CBP, CXR PA, sputum for AFB, ECG, CRP, O_2 saturation and spirometry. In these patients TB, HIV, MALIGNANCY was excluded. These patients were graded according to GOLD 2016 guidelines into mild, moderate, severe and very severe and were correlated with their BMI, O_2 saturation and CRP levels respectively. Of these 339 patients 12.09% were mild, 32.74% moderate, 43.36% severe and 11.79% very severe COPD. In the present study, the overall prevalence of under nutrition among COPD patients was around 55%. And, with increasing COPD grade, the BMI and mean SpO_2 values decreased in progressive manner. Also the increase in CRP value correlates with the increase in severity of the COPD, suggesting the fact that COPD is a systemic inflammatory disease which primarily affects the lungs.
Keywords: BMI, OXYGEN SATURATION, CRP, CBP, CXR PA, sputum for AFB, ECG, spirometry and COPD grading

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD), a common preventable and treatable disease is a leading cause of morbidity and mortality worldwide and results in an economic and social burden that is both substantial and increasing[1,2]. It is characterized by airflow limitation that is not fully reversible. The airflow limitation is usually progressive and is associated with an abnormal inflammatory response of the lungs to noxious particles or gases, primarily caused by cigarette smoking. Chronic obstructive pulmonary disease (COPD) has been redefined to indicate that apart from the deleterious effects on the lungs, it is associated with clinically relevant extra Pulmonary manifestations [3].

COPD is characterized by slowly progressive airflow obstruction, resulting in dyspnea and exercise limitation. Although COPD affects the lungs, it also produces significant systemic consequences like nutritional abnormality, weight loss, and peripheral muscle dysfunction [3]. Systemic consequences now recognized as important features of the disease contribute to exercise intolerance, decreased health status and increased mortality. Nutritional depletion and weight loss are features of COPD. Using the criteria of weight <90% of ideal body weight or weight loss of 5 to 10% of initial body weight, the incidence of malnutrition is 24 to 35% in patients with moderate-to-severe COPD [4].

C-reactive protein (CRP) is an acute-phase protein synthesized predominantly by the hepatocytes in response to tissue damage or inflammation. It reflects the total systemic burden of inflammation and has been shown to be increased in COPD [5] patients. The chronic inflammation in COPD, orchestrated by multiple inflammatory cells and mediators in the airways and the lung tissues, is induced by inhalation of noxious gases and particulate matter [6]. In COPD

patient's increased CRP levels are associated with poor lung function, reduced exercise capacity and worse quality of life as well as being a significant predictor of all-cause mortality. Smoking, which is the most commonly encountered risk factor for COPD is also responsible for rise in serum CRP levels in stable condition and during exacerbations [5].

Nutritional status, weight loss and cachexia have important prognostic implications in patients with chronic disease. In contrast to common public beliefs and guidelines for primary preventive medicine, high body mass index (BMI) confers protective effects for patients with established chronic diseases such as chronic obstructive pulmonary disease (COPD), heart failure (HF) and chronic kidney disease [7]. Along the natural course of COPD, poor nutritional status, weight loss and development of cachexia frequently occur and contribute to excessive morbidity and mortality burden [7].

The present study was carried out to assess the nutritional status – BMI, oxygen saturation and the systemic inflammation – CRP in COPD patients and correlating these with regards to the severity of COPD.

Aim of the study

- To study the BMI (Body mass index), oxygen saturation (SPO2) and CRP (C reactive protein) levels in COPD (Chronic obstructive pulmonary disease) patients.
- To correlate these values with regards to the severity of the disease.

MATERIALS AND METHODS

This was a observational study conducted on 339 patients who were recruited from outpatient & inpatient department of pulmonary medicine, Gandhi Medical College, Government General and Chest Hospital, Hyderabad with a duration 18 months i.e. between Dec 2014 to May 2016.

Inclusion Criteria

All adult stable COPD patients diagnosed on the basis of history, clinical examination and investigations (Spirometry) attending the Department of Pulmonary Medicine, Gandhi medical college, Government General and Chest Hospital, Hyderabad.

Exclusion Criteria

- Patients with associated recent myocardial infarction.
- Patients with Tuberculosis infection.
- Patients with any malignancy.
- Patients with HIV – status known under voluntary basis.

Routine investigations like Chest X-ray Postero Anterior view, Sputum for Acid fast bacilli, Complete blood count, Electrocardiogram, Liver function test, Blood urea and Serum Creatinine, Random blood sugar, Fasting lipid profile and specific investigations like Pulmonary function testing – Spirometry, Serum C-reactive protein levels ,Oxygen saturation using pulse oximetry Will be done.

BMI (Body Mass Index)

Body Mass Index (BMI) is a simple index of weight-for-height that is commonly used to classify underweight, overweight and obesity in adults. BMI is defined as the weight in kilograms divided by the square of the height in metres (kg/m^2).

BMI values are age-independent and the same for both sexes. However, BMI may not correspond to the same degree of fatness in different populations due, in part, to different body proportions. The health risks associated with increasing BMI are continuous and the interpretation of BMI grading in relation to risk may differ for different populations.

Table-1: Classification of adult underweight, overweight and obesity according to BMI

CLASSIFICATION	BMI (Kg/m^2)
UNDER WEIGHT	<18.5
Severe thinness	<16.00
Moderate thinness	16.00 - 16.99
Mild thinness	17.00 - 18.49
NORMAL RANGE	18.5 – 24.99
OVER WEIGHT	≥25.00
Pre obese	25 – 29.99
OBESE	≥30.00
Obese class I	30.00 - 34.99
Obese class II	35.00 - 39.99
Obese class III	≥40.00

The International Classification of adult underweight, overweight and obesity according to BMI (Source: Adapted from WHO, 1995, WHO, 2000 and WHO 2004)

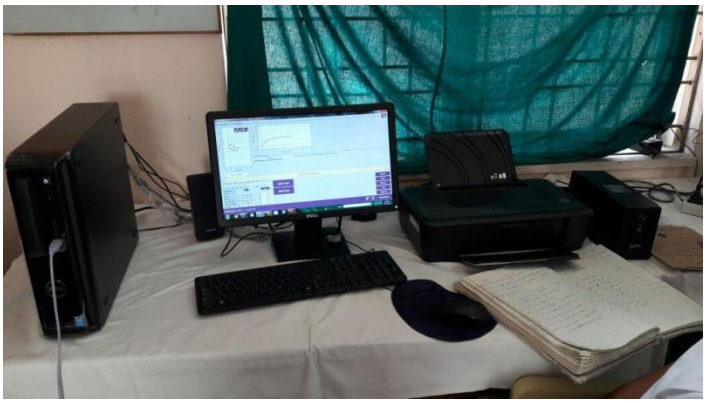

Fig-1: SPIROMETRY

Spirometry meeting ATS criteria used – Spirometry will be done in sitiing position by the patient. best of the 3 manoeuvres will be defined as the highest FEV1 and highest PEF regardless from which manoeuvres they come from same or different effort. if medication gas been taken within 6 hours PFT was not performed and the visit will be rescheduled.

Reversibility testing –at th screening visit after completion of three acceptable pre-bronchodilator forced expiratory manoeuvres, all patients will be asked to inhale salbutemol(100ug) so as to document the degree of reversibility.within 10 minutes of the pre-bronchodilator forced expiratory manoeuvres, two separate doses approximately 30 seconds apart of 100ug of salbutamal will be administered.

Criteria for acceptability of the test ,Maximal effort should be entertained, with no cough during the first second or leaks/obstruction of the mouthpiece, Tracing of a minimum of six seconds of exhalation or an obvious plateau, no early termination/cut off or the subject should not continue to exhale, Three acceptable spirograms should be obtained; two largest FVC values within 150 ml and two largest FEV1 values within 150 ml or less than 5% variability between readings and The spirogram with the highest FVC and FEV1 should be reported and the FEV1/FVC should be calculated from this set of values Total dose 200ug of salbutamol will be delivered. The patient will be encouraged to hold his breath for 10 seconds after each inhalation. Three additional acceptable post-bronchodilator forced expiratory manoeuvre tests will be recorded within 10-30 mins after the last dose of salbutamol is inhaled. The severity of COPD as assessed by FEV1, FEV1/FVC and grouped into mild, moderate, severe, very severe group based on FEV1 Classification-Adapted from GOLD-2016 Guidelines for the diagnosis and treatment of COPD.

Classification of severity of airflow limitation in COPD

(Based on Post Bronchodilator FEV1) - In patients with FEV1/FVC <70%

Table-2: Classification of severity of COPD

STAGES	SEVERITY	VALUES	
GOLD 1	Mild	FEV1	>80% PREDICTED
GOLD 2	Moderate	FEV1	50% - 80% PREDICTED
GOLD 3	Severe	FEV1	30% - 50% PREDICTED
GOLD 4	Very severe	FEV1	< 30% PREDICTED

Estimation of C - reactive protein using the latex agglutination test

The latex reagent contains uniform latex particles which are coated with anti-human CRP. The specimen containing CRP agglutinates upon mixing with the latex reagent, showing a positive test result. If CRP is absent, there is no agglutination, indicating a negative test result. Kit contains Latex reagent (50T)Positive control (0.25ml)Reagent, Negative control (0.25 ml)and Other accessories required are a glass slide with 4 circles, glass dropper for latex reagent, capillary droppers and mixing sticks. Fresh serum is collected and tested immediately. In case of a delay in testing, the serum should be stored at 2 - 8˚C (up to one week). Hemolysed, lipaemic or icteric serum samples should not be used.

Procedure

Qualitative test

Place one drop of the specimen along with positive and negative control in separate circles of the slide using the capillary dropper provided. One drop of latex

reagent is added in each of the circles. The content of the circles are mixed separately, spreading it within the circles. The slide is mixed for a maximum of two minutes, and agglutination is looked for.

Semi quantitative test

The specimen is diluted serially (1:2, 1:4, 1:8, 1:16, etc.) using normal saline. One drop each of the serially diluted serum sample is placed using capillary droppers in each circle of the slide. Thereafter, further testing is proceeded as in the qualitative test.

Interpretation of results

Qualitative test

Agglutination/no agglutination is checked with the positive/ negative control respectively. The agglutination should be checked within two minutes. Absence of agglutination within two minutes indicates a negative result and the results should not be observed beyond two minutes.

Semi quantitative test

The highest dilution which shows a visible agglutination within two minutes indicates the CRP titre. The approximate can be obtained by multiplying titre by sensitivity of the test.

CRP in mg/L = D x S,
Where D: Highest dilution showing clear-cut agglutination. S: Sensitivity of the test is 0.6 mg/L.

Oxygen saturation using pulse oximeter

Oxygen saturation is a percentage of oxyhaemoglobin (HbO_2) capacity, compounded with oxygen, by all combinative haemoglobin (Hb) capacity in blood. In other words, it is consistency of oxyhaemoglobin in blood. Many respiratory diseases can result in low oxygen saturation in human blood.

Measuring Principle- An experience formula of data process is established taking use of Lambert Beer Law according to Spectrum Absorption Characteristics of Reductive haemoglobin (HbR) and Oxyhaemoglobin (HbO_2) in red light and near-infrared light zones. The photoelectric oxyhaemoglobin inspection technology is adopted in accordance with capacity pulse scanning and recording technology, so that two beams of different wavelength of lights (660nm red light and 940nm near infrared light) can be focused onto human nail tip through perspective clamp finger-type sensor. Then measured signal can be obtained by a photosensitive element, information acquired through which will be shown on the display through process in electronic circuits and microprocessor.

Statistical analysis and descriptive values

In the present study a total of 339 patients were included.

Table-3: Grade wise distribution of severity of COPD patients according to gold guidelines

GRADES	Number of COPD patients	
	Frequency (n)	Percent
G1	41	12.1%
G2	111	32.7%
G3	147	43.4%
G4	40	11.8%
	TOTAL - 339 patients	

In the present study a total of 339 patients were included and of them most of them were belonging to grade 3 severity according to GOLD guidelines.

Table-4: Gender wise distribution of COPD patients

Sex	Grade 1		Grade 2		Grade 3		Grade 4	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Female	4	9.8%	14	12.6%	26	17.7%	10	25.0%
Male	37	90.2%	97	87.4%	121	82.3%	30	75.0%

In the present study, of 339 patients – 54 pateints were females and 285 were males

Table-5: Various parameters in grade 1 COPD patients

Grade I	Minimum	Maximum	Mean	SD
Age	40.00	79.00	54.12	9.62
Height	148.00	187.00	162.85	8.79
Weight	38.00	89.00	55.00	11.10
BMI	15.00	35.60	20.75	3.98
SPO_2	71.00	96.00	87.29	5.85
CRP	6.00	24.00	8.49	5.02
FEV1(L)	1.13	3.19	1.88	0.52
PRED FEVI	80.00	95.00	84.37	3.62
FVC (L)	1.62	4.62	2.84	0.77
FEV1/FVC	53.40	69.93	66.27	3.78

Table-6: Various parameters in grade 2 COPD patients

Grade II	Minimum	Maximum	Mean	SD
Age	40.00	78.00	55.01	9.78
Height	144.00	184.00	161.57	8.53
Weight	34.00	93.00	54.04	12.57
BMI	13.73	35.70	20.71	4.68
SPO_2	65.00	96.00	85.69	6.73
CRP	6.00	24.00	10.05	5.95
FEV1(L)	0.55	2.33	1.48	0.37
PRED FEVI	50.00	79.00	60.58	6.87
FVC (L)	1.08	85.00	3.19	7.85
FEV1/FVC	34.00	69.70	60.02	7.32

Table-7: Various parameters in grade 3 COPD patients

Grade III	Minimum	Maximum	Mean	SD
Age	36.00	81.00	55.12	9.41
Height	140.00	187.00	161.29	8.36
Weight	32.00	86.00	49.74	9.85
BMI	13.30	36.70	19.28	4.11
SPO_2	60.00	96.00	81.68	7.49
CRP	6.00	24.00	12.98	6.36
FEV1(L)	0.36	1.69	0.96	0.24
PRED FEVI	30.00	49.00	39.67	5.64
FVC (L)	0.54	3.06	1.78	0.46
FEV1/FVC	35.10	77.50	54.46	8.71

Table-8: Various parameters in grade 4 COPD patients

Grade IV	Minimum	Maximum	Mean	SD
Age	40.00	75.00	56.58	8.91
Height	142.00	184.00	161.73	8.21
Weight	32.00	73.00	48.55	8.98
BMI	14.60	27.50	18.67	3.08
SPO_2	66.00	96.00	80.63	7.21
CRP	6.00	24.00	16.65	6.99
FEV1(L)	0.39	1.46	0.88	0.26
PRED FEVI	20.00	29.00	25.80	1.68
FVC (L)	0.65	2.72	1.60	0.45
FEV1/FVC	40.70	68.90	54.61	7.04

Table-9: BMI in various grades of COPD patients

Parameters	COPD Grades	Mean	SD	P-value	Inference
BMI	Grade I	20.75	3.98	<0.01	HS
	Grade II	20.71	4.68		
	Grade III	19.28	4.11		
	Grade IV	18.67	3.08		

In the present study the BMI values decreased progressively from grade 1 to grade 4 with statistical significance by anova test.

Table-10: Oxygen saturation in various grades of COPD patients

Parameters	COPD Grades	Mean	SD	P-value	Inference
SPO_2	Grade I	87.29	5.85	<0.01	HS
	Grade II	85.69	6.73		
	Grade III	81.68	7.49		
	Grade IV	80.63	7.21		

In the present study the mean oxygen saturation decreased from 87.29 to 80.63 from grade 1 to 4 with statistical significance p value <0.01.

Table-11: CRP levels in various grades of cop patients

Parameters	COPD Grades	Mean	SD	P-value	Inference
CRP	Grade I	8.49	5.02	<0.01	HS
	Grade II	10.05	5.95		
	Grade III	12.98	6.36		
	Grade IV	16.65	6.99		

In the present study the CRP levels increased progressively from grade 1 to 4 from mean value of 8.49 to 16.65 with statistical significance.

Table-12: BMI, SPO_2 and CRP levels in males

GRADES	NO.OFPATIENTS	BMI	SPO_2	CRP
1	37	21.17	86.89	8.1
2	97	20.52	85.77	11.93
3	121	19.26	81.97	13.38
4	30	18.83	77.66	17.40

In the present study the total numbers of males were 285 and the mean BMI and mean SPO_2 values decreased gradually from grade 1 to 4.

Table-13: BMI, SPO_2 and CRP levels in FEMALES

GRADES	NO.OFPATIENTS	BMI	SPO_2	CRP
1	4	17.7	91	12
2	14	21.5	85.14	10.8
3	26	19.39	80.30	15.3
4	10	18.26	79.3	14.4

The total numbers of females were 54 and there was no gradual change with increased severity of the disease.

Table-14: BMI SPO_2 and CRP in smokers

GRADES	NO.OFPATIENTS	BMI	SPO_2	CRP
1	23	20.41	86.26	8.34
2	82	19.98	85.23	12.58
3	100	19.07	81.36	13.5
4	30	18.39	77.86	18

In the present study the total numbers of smokers were 235 and the mean BMI and mean SPO_2 values decreased gradually from grade 1 to 4.

Table-15: BMI, SPO_2 and CRP in non-smokers

GRADES	NO.OFPATIENTS	BMI	SPO_2	CRP
1	18	21.37	88.61	8.66
2	29	22.55	87	9.31
3	47	19.73	82.36	14.17
4	10	19.59	78.7	12.6

The total numbers of nonsmokers were 104 and there was no gradual change with increased severity of the disease.

Table-16: Comparison of BMI and spo2

GRADES	BMI	SPO_2
1	20.75	87.29
2	20.71	85.69
3	19.28	81.68
4	8.67	80.63

In the present study the mean BMI and mean SPO_2 values decreased progressively with the increased severity of the disease.

DISCUSSION

In the present study total of 339 stable COPD patients were included who attended the Department of Pulmonary Medicine, Gandhi Medical College, Government General and Chest hospital.

In the present study most of the patients were belonging to grades 2 and 3. Number of patients in each grade were 41(12.1%), 111(32.7%), 147(43.4%) and 40(11.8%) in grades 1,2,3,4 respectively.

In the present study of total 339 patients, 285 were males with 84.05% and 54 were females with 15.95%. Among 285 males – 37 (12.98%), 97 (34.03%), 121 (42.45%) and 30 (10.52%) were present in grades 1,2,3 and 4 respectively similarly in females of 54 – 4 (7.4%), 14(25.92%), 26 (48.14%) and 10 (18.5%) were present in grades1,2,3,4 respectively.

In the present study the mean age of presentation in grade 1,2,3,4 was 54.12, 55.14, 54.95, and 56.97 respectively. In a similar study by Gupta [3] *et al*. the mean age of presentation was 58, 55.59, 55.95, and 54.05 in grades 1,2,3,4 respectively as in our study stating that the COPD is the disease of elderly with a mean age of presentation around 55.

In grade 1, the age wise distribution was 9(22%), 17(41.5%), 11.4(26.8%),4(9.8%) in 36-45, 46-55, 56-65, >65 years respectively. Similarly in grade 2 the distribution was 24 (21.6%), 36 (32.4%), 31(27.9%) and 20(18.0%) in 36-45, 46-55,56-65 >65 years respectively. In grade 3 the distribution was 26 (17.7%), 56 (38.1%),50 (34.0%) and 15(10.2%) in 36-45, 46 -55, 56-65, >65 years respectively.

In grade 4 the distribution was 6 (15.0%), 13(32.5%), 15(37.5%) and 6(15.0%) in 36-45, 46-55, 56-65, >65 years respectively.

In the present study the overall prevalence of low BMI (under nutrition) was 55.16. The mean BMI in grades 1,2,3,4 was 20.75, 20.71, 19.28, and 18.67 respectively. The association between COPD stage and

BMI category revealed that with increasing COPD stage the proportion of subjects with undernourished BMI status increased significantly. With increasing COPD grades the mean BMI values decreased progressively and were statistically significant with p value less than <0.01.

In the present study the prevalence (69.14 %) of low BMI in higher grades (3 and4) was higher than lower grades. The possible explanation for the higher prevalence of under nutrition in the present study could be due to lower socioeconomic strata, poor health care facility, late diagnosis and intervention. We would like to emphasize here for an urgent need to provide proper proper nutritional counselling to patients with severe COPD as it has been proved that low BMI is an independent risk factor for mortality in subjects with severe COPD.

The possible explanation of nutritional abnormality and weight loss is due to decreased caloric intake and increased basal metabolic rate. Loss of muscle mass is main cause of weight loss in COPD patients, where loss of fat free mass contributes to lesser extent. It has been seen that at a microscopic level, muscle fibre atrophy and alteration of fibre type can occur. Plasma levels of certain pro-inflammatory cytokines like TNF-α are increased in COPD that can provoke muscle cell apoptosis and protein degradation via the ubiquitin/proteasome system leading to loss of muscle mass.

In most patients with COPD there is an imbalance between metabolic requirement and calorie intake leading to weight loss. Increased BMR may be due to use of β2 agonist. Systemic inflammation could also play a significant role as shown by relationship between metabolic derangement and increased level of inflammatory mediators in COPD and tissue hypoxia may also make a contribution. One reason for this association could be attributed to loss of metabolic functions owing to lack of SPO_2.

Oxygen saturation levels in COPD patients

In the present study, an inverse association between disease severity and SPO_2 was seen and was observed that with increasing COPD stage the median SPO_2 value decreased in a progressive manner. The mean SPO_2 values in grade 1 was 87.29 and 85.69, 81.68, 80.63 in grades 2,3 and 4 respectively and the association was statistically significant using anova test with p value <0.01.The association observed in the present study supports the need for more extensive exploration of the relationship between oxygenation, inflammatory markers and outcomes.

CRP levels in COPD patients

The presence of ‘‘extra-pulmonary or systemic’’ consequences of COPD can be detected clinically and can be measured by the determination and level of increased systemic inflammatory markers. CRP is one of these markers. It is an acute phase protein synthesized predominantly by the hepatocytes in response to tissue damage or inflammation reflecting the total systemic burden of inflammation of individuals. In the present study the CRP levels were increased with the increased severity of the disease. The mean CRP values were 8.49, 10.05, 12.98 and 16.65 in grades 1, 2, 3 and 4 respectively.

The present study showed statistically significant correlation between the level of CRP and severity of COPD using anova test. The present study showed the CRP value to correlate with the severity of the COPD clinical presentation. These results are in favor of the proven fact that COPD is a systemic inflammatory disease which primarily affects the lungs. Similar results were obtained in the studies which suggest that the reduced lung function in COPD is associated with increased levels of systemic inflammatory markers.

Inflammatory response at the lung level to noxious agents causes systemic inflammatory changes and results in significant extra pulmonary effects that contribute to the increase of CRP and leukocyte count. In support of this interpretation, some research results indicate a higher rate of association of COPD with nutritional abnormalities, skeletal muscle dysfunction and an increased risk of diseases such as cardiovascular, metabolic, neurological and other diseases. In the present study’s population of stable COPD patients, CRP levels correlated mainly with physiological parameters, such as FEV1, FVC, IC/TLC, 6MWD, PaO_2 and BMI, or others that include them as BODE index or GOLD stages.

Although leukocyte count is considered as a marker of systemic inflammation in COPD, in our study the main limitation was leukocyte count was not considered and in previous studies the leukocyte counts did not show any significant correlation with the severity of COPD. Several studies showed that leukocyte count was sometimes poor predictor of mortality in COPD patients.

Comparison of BMI, SPO_2 and CRP levels among males and females

In the present study out of 339 patients involved 285 patients were males and 54 patients were females. As the grades of COPD increased the mean BMI values in males decreased progressively from grade 1 to 4, whereas in females the mean BMI values in grade 1 was 17.7 lower than the other grades i.e 17.7, 21.5, 19.39

and 18.26 in grades 1, 2, 3 and 4 respectively. The probable explanation for low BMI in females in grade 1 when compared to other grades was less number of patients in grade 1.

The mean SPO2 values decreased progressively in both males and females from grade 1 to 4.Whereas the mean CRP levels in males increased progressively with increased severity of the disease but in females the mean CRP levels in grade 1 was high when compared to grade 2 the possible explanation for this variability may be because of the less number of patients in grade 1.

Comparison of BMI, SPO2 and CRP levels among smokers and non-smokers

Of all 339 patients included in the study the total number of smokers was 235 and non-smokers were 104 patients. In the present study as the grades of COPD increased the mean BMI values in smokers decreased progressively with increased severity of the disease, whereas in non-smokers the mean BMI values in grade 1, 2, 3 and 4 were 21.37, 22.55, 19.73and 19.59 respectively**.**

The mean SPO2 levels decreased progressively from 86.26 to 77.86 with increased severity among smokers and in non-smokers also the mean SPO2 values decreased progressively from 88.61 to 78.1. The mean CRP levels in smokers increased progressively but in non-smokers the mean values of CRP were 8.66, 9.31, 14.17 and 12.6 in grades 1, 2, 3 and 4 respectively.

CONCLUSION

- The overall prevalence of under nutrition in stable COPD patients was 60.77%.
- With increasing COPD stage the mean SPO2 and BMI were decreased in a progressive manner.
- The higher was the disease severity the higher the CRP concentrations.
- Low BMI and increased CRP levels in COPD patients may predict a poor prognosis and increased mortality
- Hence serum CRP levels and BMI can be used as tools in assessing the severity and prognosis of COPD patients.
- The association between COPD stage and BMI in the present study helps to know the importance of pulmonary rehabilitation, mainly in increasing the nutritional status of the patients to prevent the disease severity.
- The study also found a significant association between SPO2 and COPD stage which could be explored further in order to suggest an additional marker of COPD severity that would add a new dimension to the traditional clinical tool in assessment and management of COPD

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