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A Cross-Sectional Study On Prevalence And Predictors Of Metabolic Syndrome Among Patients With Bronchial Asthma In A Tertiary Care Teaching Hospital

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Abstract:
Background*: Bronchial Asthma is most common, chronic, non-communicable, heterogenous, inflammatory disease of respiratory passages affecting over 399 million individuals worldwide. Asthma and metabolic syndrome are major health problems that have increased rapidly worldwide and there are close links between asthma and metabolic syndrome which is characterised by central obesity impaired glucose tolerance or insulin resistance, hypertension and dyslipidemia.*
Materials and Methods: *The study was designed to evaluate the prevalence and predictors of metabolic syndrome (MS) in patients with bronchial asthma. A prospective cross-sectional observational study was conducted over a period of 6 months in a tertiary care teaching hospital with 107 asthmatic patients in which 90 of them were confirmed to have MS.*
Results*: The study revealed that 84% of the subjects were diagnosed with metabolic syndrome with higher prevalence in males. Individuals with unhealthy habits like smoking and alcohol consumption are prone to have greater risk. The study also revealed that the severity of asthma is positively correlated with central obesity, elevated triglycerides, low HDL, and fasting glucose levels. The Extent of correlation of study subjects with metabolic components can be identified using Karl Pearson's coefficient of correlation.*
Conclusion: *The study shows individuals with Bronchial Asthma often exhibit a higher prevalence of metabolic syndrome and hence a comprehensive management strategy has to be implemented to prevent complications and improve the quality of life in patients with bronchial asthma and associated risk factors*
Key Words: *Bronchial Asthma, Metabolic Syndrome, Obesity, Insulin Resistance, Hypertension, Dyslipidemia, Dyspnea, Obstructive sleep Apnea.*

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I. Introduction

Bronchial Asthma is a prevalent, chronic, non-communicable, and inflammatory disease of the respiratory passages characterized by airway hyper-responsiveness [1,2,3&4]. This hyper-responsiveness leads to airway swelling and narrowing, resulting in airflow obstruction [4]. The condition is marked by the involvement of mast cells, eosinophils, and T-lymphocytes, which release inflammatory mediators [2]. This inflammatory process causes recurrent respiratory symptoms, including wheezing, shortness of breath, chest tightness, and cough, which often worsen at night or in the early morning [3&5]. Asthma manifests in acute attacks of deterioration, termed exacerbations, against a backdrop of chronic inflammation that may include structural changes and persistent symptoms, potentially leading to reduced lung function and the need for emergency care [6&7]. Asthma is recognized by the World Health Organization (WHO) as a significant health issue, affecting over 399 million people globally and projected to increase to 500 million by 2025 [2,3&8]. The prevalence is notably higher in developed countries, with around 90% of the burden falling on individuals in low- and middle-income countries [1&2]. While asthma can occur at any age, children and young adults are particularly affected, contributing to increased morbidity and mortality rates [2&3]. The incidence rates are 3.8% per 1000 for adults and 12.5% per 1000 for children, with the highest incidence (23.4% per 1000) in children aged 0-4 years [2].

Metabolic Syndrome is an asymptomatic, pathophysiological complex disorder associated with several chronic diseases in adults characterised by central obesity impaired glucose tolerance or insulin resistance, hypertension and dyslipidaemia [9,10,11&12]. It is a disorder of energy storage and utilization which is an important

problem in internal medicine with a cluster of interconnected factors that is directly associated with increased risk of coronary heart disease (CHD), other forms of cardiovascular atherosclerotic diseases (CVD), and diabetes mellitus [6,10&13].

Evolution Of Metabolic Syndrome:

- World Health Organization criteria **(1998)**
- European Group for the Study of Insulin Resistance criteria **(1999)**
- National Cholesterol Education Program Adult Treatment Panel III (NCEP: ATPIII) criteria **(2001)**
- American Association of Clinical Endocrinology criteria **(2003)**
- International Diabetes Federation (IDF) criteria **(2005)**
- American Heart Association/National Heart, Lung, and Blood Institute (AHA/NHLBI) criteria **(2004)**

Incorporating **IDF and AHA/NHLBI definitions**, MS was diagnosed when at least three of the following criteria were present.

❖Elevated waist circumference waist circumference ≥ 94 cm or ≥ 80 cm
❖Systolic blood pressure ≥ 130 mmHg and
❖Diastolic blood pressure ≥ 85 mmHg or ongoing therapy for hypertension
❖Fasting glucose 100 mg/dl or greater.
❖Triglycerides 150 mg/dl or greater.
❖HDL-cholesterol < 40 mg/dl in men and < 50 mg/ dl in women [10,14,15].

Link Between Asthma and Other Conditions:

Bronchial asthma and metabolic syndrome are major health problems that have increased rapidly worldwide and there are close links between asthma and metabolic syndrome [11,15]. Metabolic syndrome is a cluster of disorders including central obesity, insulin resistance, hypertension, and dyslipidemia, which correlates strongly with asthma exacerbation risk [16].

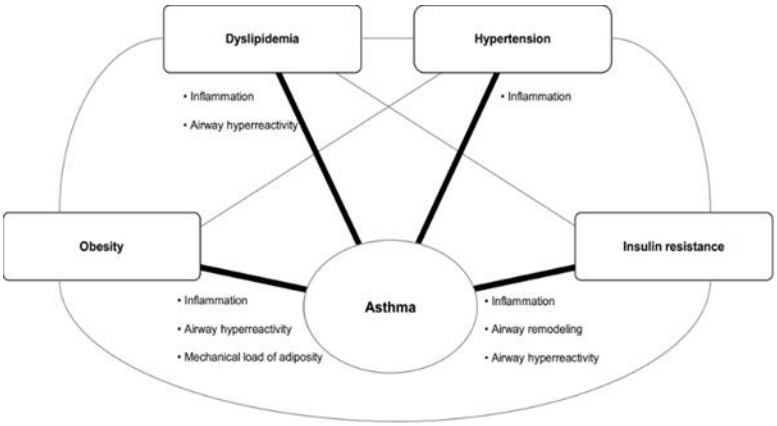

Figure 1.2: Shows link between Asthma and Metabolic syndrome parameters

Obesity and Asthma: Obesity leads to chronic low-grade inflammation and is associated with a specific asthma phenotype characterized by altered lung function and medication response [17,18]. Key inflammatory markers from adipose tissue, such as leptin and TNF-α, may contribute to asthma pathogenesis [19]. Obesity also exacerbates gastroesophageal reflux disease, complicating asthma management [20].

Hypertension and Asthma: The inflammatory environment in asthma can lead to hypertension [21]. Certain anti-asthmatic medications may worsen hypertension, while some antihypertensives are contraindicated in asthma management [22].

Type 2 Diabetes Mellitus and Asthma: Type 2 diabetes mellitus (T2DM) is linked to asthma, as hyperglycemia can lead to diabetic pneumopathy, affecting lung function [23,24]. The presence of advanced glycation end-products (AGEs) and RAGE signalling in the lungs may contribute to chronic airway inflammation [24]. Some diabetes medications, like metformin and GLP-1 receptor agonists, have been associated with reduced asthma exacerbation risk [24].

II. Material And Methods

A Prospective Observational Cross-Sectional Study Was Conducted over a period of 6 months (i.e. from August 2023 to February 2024) in Department of Respiratory medicine at Sri Balaji Medical College Hospital and Research Institution Renigunta, Tirupati.

Study Design: Prospective Observational Cross-Sectional Study

Study Location: This was a tertiary care teaching hospital-based study done in Department of Respiratory Medicine, at Sri Balaji Medical College Hospital and Research Institution Renigunta, Tirupati.

Study Duration: November 2014 to November 2015.

Sample size: 107 patients.

Inclusion criteria:
1. The Patients between 30-70 years of age.
2. Both Genders are included (Male and Female).
3. Hemodynamically stable patient
4. As per GINA guidelines, subjects diagnosed with Bronchial Asthma. They should have a confirmed diagnosis of bronchial asthma, usually based on clinical symptoms, pulmonary function tests, and/or response to bronchodilator therapy. Diabetic patients (fasting blood glucose ≥ 126 mg/dL [7.0mmol/L])

Exclusion criteria:
1. Patients whose age group 70 years are excluded.
2. Individuals with pre-existing diagnosis of metabolic syndrome.
3. The patients with a history of non-adherence to treatment of bronchial asthma.
4. Individuals with chronic respiratory conditions other than bronchial asthma, such as chronic obstructive pulmonary disease (COPD), Lung cancers, Tuberculosis, Interstitial lung disease, may be excluded to maintain homogeneity in the study population.
5. Participants with severe comorbidities that could interfere with the study or pose a significant risk to their health may be excluded.
6. Pregnant individuals or those with conditions affecting metabolic measurements during pregnancy.
7. Patient who are not willing to participate in the study.
8. Participant with a history of medication influencing parameters of metabolic syndrome not related to asthma.

Procedure methodology

We recruited the patients who were came to department of respiratory medicine on daily basis with the respiratory complaints were screened as per the study eligibility criteria and eligible patients were recruited after getting the consent through written, signed ICF from the subjects/care takers. After identifying subjects the eligible subjects, were asked for detailed history and clinical examination was performed according to the well-designed proforma. A Data collection regarding any venous blood was drawn for CBC, lipid profile (Triglycerides, HDL-cholesterol, LDL- cholesterol), Thyroid Profile (T3, T4 and TSH levels) and Fasting blood glucose levels. The disease was determined using the criteria available in the Guidelines for the Diagnosis and Management of Asthma by GINA Guidelines (based on the forced expiratory volume in 1 second [FEV1], forced vital capacity [FVC], and FEV1/FVC). Based on the patient history and physical examination mMRC Dyspnea score is evaluated for the Assessment of severity of breathlessness in patients with respiratory conditions. STOP BANG sleep Questionnaire is evaluated to detect the risk of sleep related breathing disorders. The laboratory parameters were evaluated and metabolic syndrome was interpreted.

Statistical analysis:

Data of Percentage, Average mean and Standard Deviation was analyzed by using Microsoft Excel 2019 and extent of correlation between variables was analyzed by using Karl Pearson's coefficient of correlation. The level $P < 0.05$ was considered as the significance.

III. Results

A Prospective Observational Cross-Sectional Study Was Conducted for 6 months (i.e. from August 2023 to February 2024) in Department of Respiratory medicine at Sri Balaji Medical College Hospital and Research Institution Renigunta, Tirupati. A total of 107 Bronchial Asthma patients were recruited in our study out of 107 subjects 90 subjects were diagnosed with presence of metabolic syndrome through analyzing the parameters of metabolic syndrome. Out of 107 subjects 65(61%) were Males and 42(39%) were Females. We categorized the patient to their age groups. The average age of the total study population is 51.4 Years. The average age of total male population is 53 Years and the average age of total female population is 48 Years. Out of 107 Subjects 42(39%) of them were from age group 51-60 Years, followed by 23(21%) from 61-70 Years, 21(20%) from 41-50 Years, 20(19%) from 31-40 Years, 1(1%) from less than or equal to 30 Years of age. Out of 107 subjects

61(57%) of subjects belongs to urban area and 46(43%) of subjects belongs to rural area. We have assessed the Occupational status of study subjects. Out of 107 subjects 29(27%) of subjects are Daily labours, followed by 28(26%) of subjects are home makers, followed by 21(20%) of subjects are Employees, followed by 14(13%) of subjects are Business people, followed by 8(7%) of subjects are drivers and 7(7%) of subjects are belongs to Agriculture. ***Figure 3.1 explains the distribution of subjects based on their respective Occupational status.*** Out of 107 subjects 28(26%) of them not having any kind of habits, followed by 24(22%) of subjects having a habit of both Alcohol & Smoking, 21(20%) of subjects have habit of smoking, followed by 20(19%) of subjects have habit of taking Alcohol and 14(13%) of subjects have habit of chewing tobacco. ***Figure 3.2 explains the detailed distribution of personal habits of the total study subjects.*** Out of 107 Subjects 70(65%) of subjects have 5-8 Years of Duration of Asthma, followed by 18(17%) of subjects have 9-10 Years of Duration of Asthma, followed by 16(15%) of subjects have 1-4 Years of Duration of Asthma, followed by 3(3%) of subjects having >10 Years of Duration of Asthma and 0(0%) of subjects have < 1year of Duration of Asthma. ***Figure 3.3 explains the distribution of subjects based on their Duration of Asthma.*** Out of 107 Subjects 50(47%) of subjects have Dyspnea of Grade III and 50(47%) of subjects have Dyspnea of Grade II and 7(6%) of subjects have Dyspnea of Grade. Out of 107 subjects 48 (45%) of subjects are belongs to Obese T1, followed by 39 (36%) of subjects are belongs to Over Weight and 20 (19%) of subjects are belongs to Normal category. ***Figure 3.4 explains the detailed distribution of study subjects based on their BMI range.*** Out of 107 subjects 76(71%) of subjects are in the high risk of development of OSA, followed by 31(29%) of subjects are at intermediate risk and 0(0%) of subjects are at low risk of development of OSA. ***Figure 3.5 explains the distribution of study subjects based on the probability of development of OSA (Obstructive Sleep Apnea).*** Out of 107 subjects 48(45%) of subjects have ratio between 81-90, followed by 36(34%) of subjects have ratio between 71-80, followed by 16(15%) of subjects have ratio of 91-100, followed by 7(6%) of subjects have ratio between 61-70 and 0(0%) subjects are in the ratio of <60. ***Figure 3.6, explains the distribution of study subjects based on the Ratio of FEV1 & FVC.*** The average value of TG was 171.12, average value of HDL was 34.36 and the average value of LDL was152.37. All the subjects are categorized based on the metabolic syndrome components. ***Table No. 1, describes the average lipid profile values of total study subjects.*** Out of 107 subjects 86(80%) of subjects have elevated Triglycerides (TG), followed by 81(76%) of subjects have FBS >100mg/dL, followed by 71(66%) of subjects have SBP ≥130 mm of Hg or DBP ≥85 mm of Hg, followed by 65 (61%) of subjects have HDL (Only applicable for Male) <40 mg/dL, followed by 61(57%) of subjects have Waist circumference ≥ 94 cm (Only applicable for Male), 42(39%) of subjects have Waist circumference ≥ 80 cm(Only applicable for Female) and followed by 42(39%) of subjects have HDL <50mg/dL (Only applicable for Female). ***Figure 3.7 explains the distribution of study subjects based on their presence of type of metabolic syndrome components. Table No. 2, explains the distribution of clinical parameters of total study population. Table No. 3 explains the correlation between study subjects and Duration of Asthma.*** Out of 107 subjects 90(84%) of subjects have presence of 3 or more number of metabolic syndrome components, followed by 13(12%) of subjects have 2 components of metabolic syndrome, followed by 3(3%) of subjects have no components of metabolic syndrome and 1(1%) of subjects have one component of metabolic syndrome. ***Figure 3.8 explains the distribution of study subjects based on no. of metabolic components.***

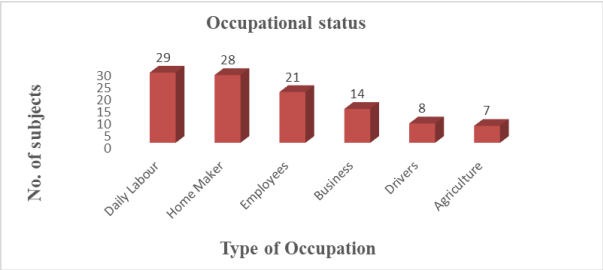

Figure 3.1: Distribution of subjects based on Occupational status

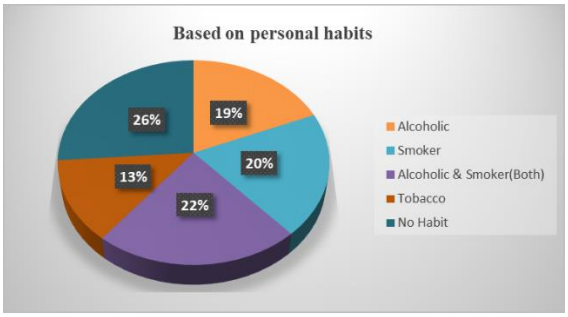

Figure 3.2: Distribution of subjects based on their Personal habits

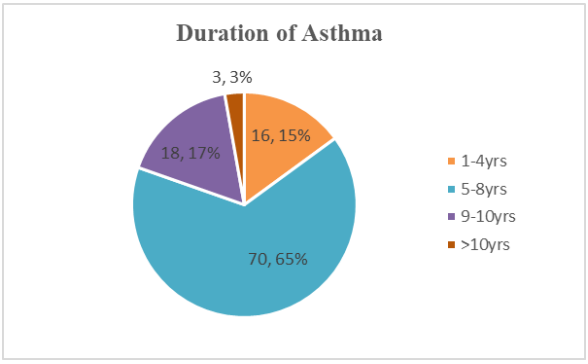

Figure 3.3: Distribution of subjects based on Duration of Asthma

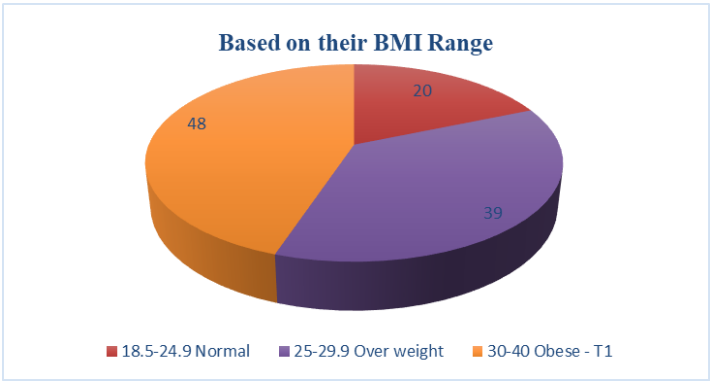

Figure 3.4: Distribution of subjects based on Obesity

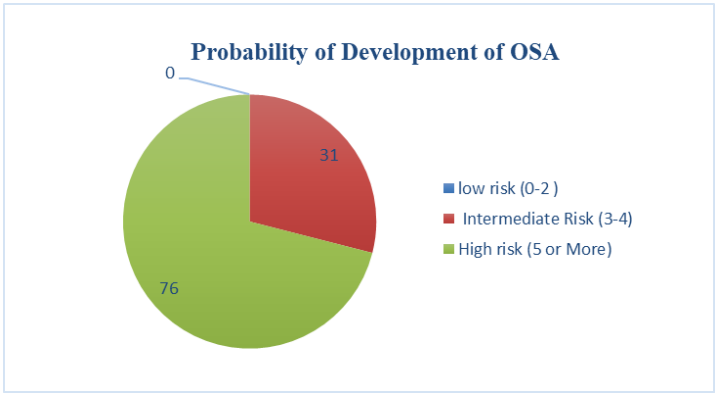

Figure 3.5: Distribution of subjects based on probability of development of OSA (Obstructive Sleep Apnea)

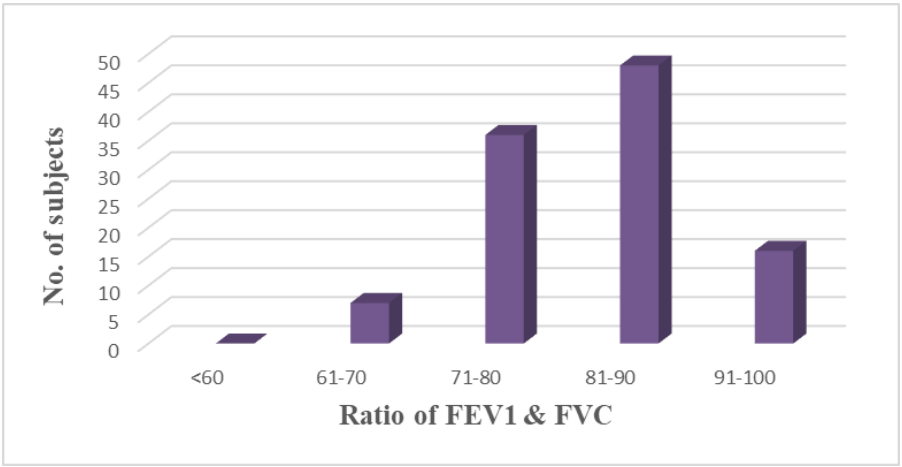

Figure 3.6: Distribution of subjects based on FEV_1&FVC Ratio

Table no 1: Average Lipid profile values of total study subjects

PARAMETER	TG (mg/dL)	HDL (mg/dL)	LDL (mg/dL)
Average	171.121	34.3645	152.374
SD ±	16.274	2.78944	17.6108

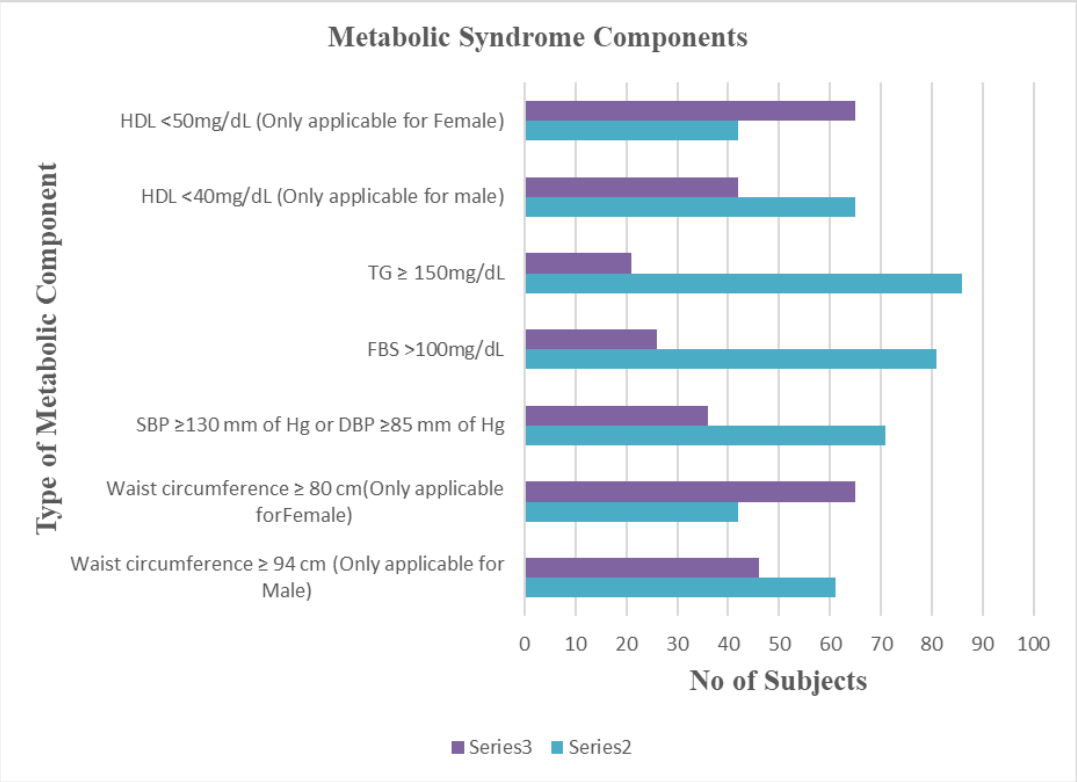

Figure 3.7: Distribution of subjects based on the metabolic syndrome components

Table no 2: Distribution of clinical parameters of total study population

S No	Clinical Parameters	Asthma (n=107)
1	Age	51.45±10.52
2	Gender	-
3	Males	65(61%)
4	Females	42(39%)
5	BMI Kg/m2	28.93±2.89
6	Waist Circumference (cm)	102.46±6.93
7	SBP (mm of Hg)	131.74±12.01
8	DBP (mm of Hg)	83.89±7.79
9	FBS (mg/dL)	113.78±16.19
10	Triglycerides (mg/dL)	171.12±16.27
11	HDL (mg/dL)	34.36±2.78
12	FEV1	66.42±6.33
13	FVC	81.15±5.80
14	FEV1/FVC	82.02±7.43
15	Met Syndrome	90(84%)

Table no 3: Correlation between study subjects & Duration of Asthma

S.N o	TEST PARAMETER	*r* -value
1	Waist circumference (male)	0.036
2	Waist circumference (female)	0.052
3	SBP	0.047
4	DBP	0.023
5	FBS	0.021
6	TG	0.122
7	HDL (male)	-0.17
8	HDL (female)	-0.432
9	FEV1	-0.185
10	FVC	0.188
11	FEVL/FVC	-0.411

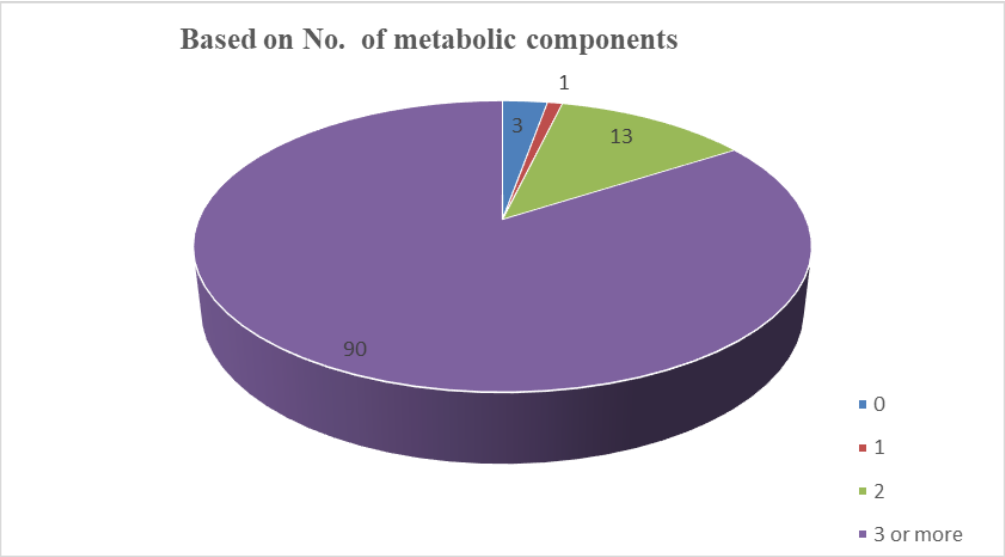

Figure 3.8: Distribution of subjects based on No. of metabolic components

IV. Discussion

Most of the studies have suggested that prevalence of metabolic syndrome is high in patients with Bronchial Asthma. In our study84% of subjects have diagnosed with the presence of metabolic syndrome same was reported in ***Abdellah H.K. Ali,Mohammad Emami-Ardestani et al &Olufunke O Adeyeye et al.*** In our study males (66%) were more prevalent to Metabolic syndrome than females (34%) same was reported in ***Khaleel Ahmed Manik et al.*** We categorised the patient to their age groups. The average age of the total study population is 51.4±10.52 Years with age ranging between 30-70 years. The average age of total male population is 53±10.54 Years and the average age of total female population is 48±10.57 Years. We found there is no significant sex differences in the study population with p value=0.020793, same was reported by ***Shelly Dutta et al, Therese S. Ghatas.*** We have made an attempt to know the impact of locality on the disease and observed Urban population (57%) have been developing MS significantly higher than Rural population (43%). Another important parameter of Asthma is occupation. We have assessed occupational status and found Daily labours are significantly high i.e. 27% followed by Homemakers 26%, Employees 20%, Business people 13%, Drivers & Agriculture 7%. Occupation can influence asthma through specific environmental exposure, same was reported in ***Louis-Philippe Boulet et al.*** Personal habits play a key role in the development of Asthma and MS. We have assessed personal habits and found Alcoholics and smokers are significantly higher i.e. 22%, followed by smokers 20%, Alcoholics 19% and habit of chewing tobacco 13% same was reported in ***Khaleel Ahmed Manik et al.*** Duration of Asthma plays a major role in developing Asthma associated issues. We have assessed the duration of asthma and found subjects with 5-8 years of Duration are significantly high i.e. 65%, followed by 9-10 Years of duration of asthma 17%, 1-4 years of duration 15%, >10 years of duration 3%. The important clinical feature of Asthma is Dyspnea. We have assessed mMRC Dyspnea grade to evaluate the extent of breathlessness and found Grade II & III are significantly high i.e. 47%, followed by Grade I 6%. The Asthmatics have more probability of risk of development of OSA. The STOP-BANG sleep questionnaire a highly sensitive & screening tool for patients to assess OSA and found high risk of development of OSA i.e. 71% and Intermediate risk is 29% same was reported in ***Bianca Pivetta et al. Hiroki Tashiro et al & Megat Razeem Abdul Razak et al.*** Pulmonary function test was performed in individual patients and found an Average mean and Standard deviation of FEV_1 is 66.42±6.33, Average mean and Standard deviation of FVC is 81.15±5.80, Average mean and Standard deviation of ratio FEV_1/FVC is 82.02±7.43. Lipid profile is an important source to assess the patient with Dyslipidemia. The lipid profile was performed for individual study subjects and the results are; Average mean and Standard deviation of Triglycerides (TG) is 171.12±16.27, Average mean and Standard deviation of HDL (High density lipoprotein) is 34.36±2.78, Average mean and Standard deviation of LDL (Low density lipoprotein) is 152.37±17.61. We have made an attempt to find the link between Asthma and MS. The Average mean and Standard deviation of MS components in Asthmatics subjects are found to be Average mean of waist circumference is 102.46±6.93, Average mean of Systolic Blood pressure (SBP) is 131.74±12.01, Average meanof Diastolic Blood pressure (DBP) is 83.89±7.79, Average meanof Fasting blood sugar (FBS) is 113.78±16.19, Average mean of Triglycerides is 171.12±16.27, Average mean of High-density lipoprotein (HDL) is 34.36±2.78. The Extent of correlation of study subjects with metabolic components can be identified using Karl Pearson's coefficient of correlation. The Results were found to be Waist circumference in males (r=0.36) & in females (r=0.52), SBP(r=0.04), DBP (r=0.02), FBS (r=0.21), TG (r=0.12), HDL in males (r= - 0.17) & in females (r= -0.43), FEV_1 (r= -0.18), FVC (r=0.18), FEV_1/FVC (r= -

0.41) with level of significance p <0.05%. In our study Waist circumference, SBP, DBP, FBS, FVC has positive correlation with asthma i.e. these parameters increase with increase in the duration of asthma whereas HDL, FEV_1, FEV_1/FVC have negative correlation with asthma i.e. the parameters decrease with increase in the duration of asthma. Increased levels of central adiposity, raised TG's, low levels of HDL-cholesterol, impaired fasting glucose, and hypertension. These are the clustering factors leads to development of metabolic syndrome in the patients with Bronchial Asthma same was reported in ***Khaleel Ahmed Manik et al.***

V. Conclusion

In our study, 84% of subjects were diagnosed with metabolic syndrome, with central obesity, dyslipidemia, and elevated glucose levels being the most common conditions. We concluded that individuals with bronchial asthma have a higher prevalence of metabolic syndrome. This highlights the need for comprehensive strategies to prevent and treat co-morbidities, as addressing metabolic syndrome risk factors may improve asthma patient outcomes and quality of life.

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