How to Cite:
Wanadiatri, H., Irawan, R., Ruqayyah, S., & Pratiwi, L. P. I. S. S. (2023). Correlation between FEV1/FVC ratio with Body Mass Index (BMI) and absolute eosinophils in patients with acute exacerbation of asthma at Mataram City Hospital, West Nusa Tenggara in 2019–2020. *International Journal of Health Sciences*, *6*(S9), 4538–4547. https://doi.org/10.53730/ijhs.v6nS9.13824

Correlation between FEV1/FVC ratio with Body Mass Index (BMI) and absolute eosinophils in patients with acute exacerbation of asthma at Mataram City Hospital, West Nusa Tenggara in 2019–2020

Halia Wanadiatri
Faculty of Medicine, Universitas Islam Al-Azhar, Mataram, Indonesia

Risky Irawan
Faculty of Medicine, Universitas Islam Al-Azhar, Mataram, Indonesia

Siti Ruqayyah
Faculty of Medicine, Universitas Islam Al-Azhar, Mataram, Indonesia

Luh Putu Indira Satya Sungu Pratiwi
Faculty of Medicine, Universitas Islam Al-Azhar, Mataram, Indonesia

***Abstract*---**This study aimed to analyze Correlation between FEV1/FVC ratio with body mass index (BMI) and absolute eosinophils in patients with acute exacerbation of asthma. A cross sectional study based on the medical records of asthma patients from June 2019 to June 2020, with a total population of 180 cases conducted at Mataram City Regional General Hospital, West Nusa Tenggara. The data were analyzed using multiple linier regression using SPSS. The data collected showed that getting older reduces the value of FEV1/FVC, but it is not statistically significant (b= -0.03; 95% CI= -0.18 to 0.13; p= 0.746). Male gender has a lower probability of having a FEV1/FVC value than female sex, but it is not statistically significant (b= -2.78; 95% CI= -6.38 to 0.83; p= 0.130). An increase in the eosinophil score reduced the FEV1/FVC value by 6.03 units and was statistically significant (b= -6.03; 95% CI= -7.80 to -4.26; p< 0.001). An increase in body mass index decreased the FEV1/FVC value by 1.22 units and was statistically significant (b= -1.22; 95% CI= -1.71 to -0.75; p< 0.001).

***Keywords*---**BMI, absolute eosinophils, asthma, FEV1/FVC.

Introduction

Asthma is a significant noncommunicable disease that can affect both children and adults. According to the Global Initiative for Asthma (GINA), it is reversible, meaning it can be calm without symptoms and does not interfere with daily activities, but it can also experience exacerbations with mild to severe symptoms and even cause death (GINA, 2021; PDP, 2019).

The World Health Organization (WHO) stated that the total prevalence in 2019 in the world is estimated at 262 million people, with 20% of cases experiencing exacerbations resulting in hospitalization and causing 461 thousand cases of death. The prevalence of asthma in Indonesia, according to basic health research, in 2018 was 2.3-2.4%, or 1,017,290 people. For West Nusa Tenggara province in the same year, it was as much as 59.2%, reaching 19,247 people (Ministry of Health of Republic Indonesia, 2019; WHO, 2021). According to data obtained by researchers from the Regional General Hospital of Mataram City, the total number of asthma patients who were hospitalized due to asthma exacerbations during the period 2020–2021 was 95 people. In addition, there will be one death from an inpatient asthma exacerbation in 2021.

Asthma is divided into groups based on demographic, clinical, and/or patho-physiological characteristics, which are often referred to as 'asthma phenotypes'. One clinical phenotype of asthma that has been identified and mentioned in the Global Initiative for Asthma is asthma with obesity. Some obese patients with asthma have prominent respiratory symptoms and mild eosinophilic inflammation of the airways. Based on these characteristics, it appears that there is a relationship between obesity and asthma (Haitamy, 2017; Liu et al., 2015). According to Liu Yong et al. (2015), the relationship between body mass index (BMI) and respiratory symptoms such as asthma and chronic obstructive pulmonary disease (COPD) is stronger in individuals who are in the extreme BMI category, namely underweight, overweight, or obese, than in individuals with normal BMI.

This is also reinforced by the results of research conducted by Liu Yong et al. (2015) concerning the relationship between Body Mass Index (BMI) and respiratory symptoms, asthma, and chronic obstructive pulmonary disease (COPD), which shows that individuals in the extreme BMI category are underweight, overweight or obese are more likely to suffer from asthma and/or COPD than individuals with a normal BMI.

The gold standard in the examination of asthma is spirometry. The parameters assessed in the spirometry examination are the First Second Forced Expiratory Volume (FEV1), the Forced Vital Capacity (FVC), or the Forced Expiratory Volume in the First Second Per Forced Vital Capacity (FEV1/FVC). Factors that influence spirometry values for FEV1, and FEV1/FVC include age, sex, active and passive smoking, genetics, and BMI, several studies have shown that asthmatic patients with obese BMI groups have a relationship with spirometry values in the FEV1 parameter (Otrowski et al., 2006; Andayani, 2017; Rahmawati, 2014; Liu et al., 2015).

Someone who is overweight (obese) and underweight (thin) has a high risk of developing asthma, which affects lung function. The mechanism that explains, among other things, why a person with an obese body weight shows changes in the mechanical process of breathing and the inflammatory response in the respiratory tract. Changes in the mechanical respiratory system are caused by the presence of adipose tissue around the ribs, which fills the chest wall, resulting in compression and infiltration of fatty tissue in the chest wall, which causes a decrease in the function of the respiratory muscles and bones so that chest wall compliance decreases. This will increase the work of breathing due to a decrease in residual volume, vital capacity, and total lung capacity, which will later affect the values of FEV1, FVC, and FEV1/FVC. Another theory about pro-inflammatory cytokines is that adipose tissue secretes cytokines like leptin, tumor necrosis factor- (TNF-), and interleukin (IL)-6, which have a pro-inflammatory effect on the respiratory tract and can cause hyperresponsiveness, resulting in obstruction and lower FEV1 values (Nair et al., 2008; Sutherland et al., 2008; Amanda, 2015; Haitamy, 2017).

Based on this background, about the relationship between BMI and asthma and the absence of studies that have analyzed the BMI variable with the FEV1/FVC ratio in asthma patients, researchers were interested in examining the relationship between the FEV1/FVC ratio with BMI and absolute eosinophils in patients with acute exacerbations of asthma at Mataram City Hospital, West Nusa Tenggara in 2019 to 2020.

Method

Study Design

This research is an observational study with a cross sectional design based on the medical records of asthma patients from June 2019 to June 2020, with a total population of 180 cases. This research was conducted at the Mataram City Regional General Hospital. Determination of the sample used by purposive sampling with inclusion and exclusion criteria.

Inclusion and Exclusion Criteria

The inclusion criteria in this study were patients with acute exacerbations of asthma who were hospitalized at the Mataram City Hospital for the period June 2019 - June 2020, and aged 18–60 years.

While the exclusion criteria in this study were patients with incomplete medical record data (weight, height, absolute eosinophils, and FEV1/FVC values), patients with acute exacerbation of asthma with metabolic diseases (DM, hyperthyroidism), patients with lung disease other than asthma (COPD, pulmonary TB, bronchiectasis, emphysema, etc.), asthma patients with immunocompromised diseases (HIV, SLE), asthma patients with malignancy (lung cancer and extrapulmonary cancer), and exacerbated asthma patients with infectious diseases (parasites, viruses, and bacteria).

Data Analysis

Data analysis was carried out in this study with univariate analysis and bivariate analysis. Univariate analysis shows the characteristics of continuous and categorical data samples. Data were tabulated and univariately analyzed to determine the frequency and distribution of COVID-19 patients using a mean and standard deviation. Bivariate analysis using the Pearson correlation test. Multivariate analysis using multiple linear regression. The collected data is processed and analyzed using computer software, namely the Statistical Product and Service Solution (SPSS).

Results

Univariate Analysis

Table 1 shows the average age of the research subjects was 38 years (Mean= 38.64; SD= 11.77) with the youngest being 20 years and the oldest being 60 years. The mean FEV1/FVC score was 67.62 (Mean= 67.62; SD= 14.87). The mean eosinophil score was 0.86 (Mean= 0.86; SD= 1.07). The study subjects had an average height of 161 cm (Mean= 161.11; SD= 6.99), body weight of 62 kg (Mean= 62.11; SD= 10.07), and a body mass index of 23 kgBW/m^2 (Mean= 23.87; SD= 3.83).

Table 1
Sample Characteristic of Continuous Data

Variables	n	Mean	SD	Minimum	Maximum
Age (year)	180	38.64	11.77	20	60
FEV1/FVC Score	180	67.62	14.87	32	93.2
Eosinophil Score	180	0.86	1.07	0.01	7.2
Height (cm)	180	161.43	6.99	146	178
Weight (kg)	180	62.11	10.07	38	80
BMI (kgBW/m^2)	180	23.87	3.83	15.06	35.56

Table 2
Sample Characteristic of Categorical Data

Variables	Categories	N= 180	Percentage
Gender	Female	80	44.44
	Male	100	55.56
Body Mass Index	Underweight	17	9.44
	Normal	82	45.56
	Overweight	77	42.78
	Obese	4	2.22

Table 2 shows the results of the categorical data sample characteristics, it can be seen that half of the research subjects are male (55.56%). The majority of research subjects had a normal body mass index (45.56%) and were overweight (42.78%).

Bivariate Analysis

Table 3
Bivariate analysis of the determinants of FEV1/FVC values using Pearson correlation

Independent Variables	r	p
Age (Year)	-0.15	0.038
Gender (Male)	-0.07	0.329
Eosinophil Score	-0.49	<0.001
BMI (kgBW/m^2)	-0.41	<0.001

Table 3 shows the results of the analysis using the Pearson correlation on the determinants of FEV1/FVC values. Table 3 shows that the increase in age (r= -0.15; p= 0.038), male sex (r= -0.07; p= 0.329), eosinophil value (r= -0.49; p< 0.001), and body mass index (r= -0.41; p< 0.001) reduced the FEV1/FVC score.

Multivariate Analysis

Table 4
The results of multivariate analysis with multiple linear regression determines the value of FEV1/FVC

Independent Variables	b (Coefficient regression)	95% CI		p
		Lower Limit	Upper Limit	
Age (Year)	-0.03	-0.18	0.13	0.746
Gender (Male)	-2.78	-6.38	0.83	0.130
Eosinophil Score	-6.03	-7.80	-4.26	<0.001
BMI (kgBW/m^2)	-1.22	-1.71	-0.75	<0.001
N observation= 180				
Adj R^2= 33.72%				

The results of a multiple linear regression analysis on the determinants of FEV1/FVC values are shown in Table 4. Table 4 shows that getting older reduces the value of FEV1/FVC, but it is not statistically significant (b= -0.03; 95% CI= -0.18 to 0.13; p= 0.746). Male sex has a lower probability of having a FEV1/FVC value than female sex, but it is not statistically significant (b= -2.78; 95% CI= -6.38 to 0.83; p= 0.130). An increase in the eosinophil score reduced the FEV1/FVC value by 6.03 units and was statistically significant (b= -6.03; 95% CI= -7.80 to -4.26; p< 0.001). An increase in body mass index decreased the FEV1/FVC value by 1.22 units and was statistically significant (b= -1.22; 95% CI= -1.71 to -0.75; p< 0.001).

Discussion

Age and FEV1/FVC

The average age of the subjects in this study was 38 years (Mean= 38.64; SD= 11.77), the youngest was 20 years, and the oldest was 60 years. The older a person is, the more prone to aging they are. A decrease in lung elasticity occurs in the lungs, which affects the results of lung function tests. Age affects lung physiology and body mass index. With age, susceptibility to disease, especially respiratory disease, increases. The age factor affects the elasticity of the lungs and other body tissues. Although the relationship between age and lung volume cannot be observed, averages show large changes in lung volume. This is in accordance with the concept of lung elasticity (Mengkidi, 2006).

The results of the multivariate analysis found that older age decreased the value of FEV1/FVC, but it was not statistically significant (b= -0.03; 95% CI= -0.18 to 0.13; p= 0.746). The increasing age of a person affects the body's tissues. The elastic function of the lung tissue is reduced, so that the power of breathing becomes weaker, as a result, the air volume during breathing will become smaller. The elastic properties of the lungs do not change at the age of 7–39 years, but there is a tendency to decrease after the age of 25 years, and this decline is evident after the age of 30 years.

The theory states that physiologically, with increasing age, the ability of the body's organs will naturally decrease, including, in this case, impaired lung function. During the aging process, there is a decrease in the elasticity of the alveoli, thickening of the bronchial glands, and a decrease in lung capacity. If someone who is getting older is accompanied by unfavourable environmental conditions or is exposed to a disease, the possibility of decreasing lung function will also be greater (Guyton and Hall, 2010).

The results of this study found 15 elderly patients (53.6%) with abnormal FVC values because in this age category there has been a decrease in respiratory function and physical activity has begun to decrease. Increasing age and unfavourable environmental conditions can allow for lung disease, which will increase the decline in lung function. The most affected variables are forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV1) (Vaz et al., 2016).

Gender and FEV1/FVC

In the univariate table, it can be seen that half of the study subjects were male (55.56%), with the results of the multivariate analysis of sex showing that men have a lower probability of having a FEV1/FVC value than women, but it is not statistically significant (b= -2.78; CI 95%= -6.38 to 0.83; p= 0.130). In theory, the total lung volume and lung capacity of women are about 20–25 percent less than those of men, and larger in tall, athletic people than in short, asthenic people. With a volume of 4.8 liters, men have a larger lung capacity than women, with a volume of 3.1 liters (Tambayong, 2001).

Eosinophil Score and FEV1/FVC

Eosinophils are thought to alter lung function in asthmatic patients, exacerbated by chronic inflammation, through their ability to secrete cytoplasmic proteins and their cytokines. Eosinophil granular proteins include major basic protein (MBP), eosinophil cationic protein (ECP), eosinophil peroxidase (EPX), and eosinophil-derived neurotoxin (EDN), which can damage the structure of lung epithelial tissue. The overall action of the granular eosinophil protein is to stimulate nerve-mediated bronchoconstriction and activate epithelial cells. Drugs that inhibit airway eosinophils, including corticosteroids, anti-IgE, and anti-IL-5, are usually effective in reducing asthma exacerbations (Kerkhof et al., 2018; Yudhawati & Krisdanti, 2017).

Body Mass Index (BMI) and FEV1/FVC

The results of the univariate analysis showed that the majority of research subjects had a normal body mass index (45.56%) and were overweight (42.78%). Meanwhile, the results of the multivariate analysis showed that an increase in body mass index decreased the FEV1/FVC value by 1.22 units and was statistically significant (b= -1.22; 95% CI= -1.71 to -0.75; p< 0.001). An increase in a person's body mass index affects the body's tissues. The function of the elasticity of the lung tissue is weakened, and as a result, the power of breathing is weakened, and as a result, the amount of air in the breath is reduced. Obesity reduces the amount of adiponectin, which increases the effect of inflammation.

One of the mechanisms by which adiponectin acts is on the smooth muscle of the airways. Another mediator that increases is leptin. The cause of airway obstruction in asthma is airway hyperactivity, possibly due to increased leptin. Airway obstruction itself causes air resistance during exhalation, increases expiration time, and decreases FEV1 and FVC values (Shore, 2008; Nair et al., 2008; Sutherland et al., 2008; Sabirina, 2011).

The relationship between underweight and pulmonary congestion is reflected in the negative effects of malnutrition on airway structures. Malnutrition impairs lung structure, flexibility, and function, respiratory muscle strength and endurance, lung immune defense mechanisms, and respiratory regulation, which in turn increases respiratory problems in asthmatics, including airway obstruction (Fasitasari, 2013; Fujianti et al., 2015).

Limitation

Data collection was carried out during the COVID-19 situation, so that instead of data collection through medical records, it is better to collect data directly from patients, so the results are more accurate.

Conclusion

This study discusses the correlation between FEV1/FVC Ratio with Body Mass Index (BMI) and Absolute Eosinophils in Patients with Acute Exacerbation of Asthma at Mataram City Hospital, West Nusa Tenggara in 2019–2020, and the

results showed the average FEV1/FVC value in patients with acute exacerbations of asthma at Mataram City Hospital in 2019–2020 was 67.62 (Mean= 67.62; SD= 14.87). An increase in age (r= -0.15; p = 0.038), male sex (r= -0.07; p= 0.329), eosinophil score (r= -0.49; p= 0.001), and body mass index (r= -0.41; p= 0.001) reduced the FEV1/FVC score in patients with acute exacerbations of asthma at Mataram City Hospital in 2019-2020. An increase in the eosinophil value reduced the FEV1/FVC value by 6.03 units and was statistically significant. Likewise, an increase in the value of body mass index decreased the value of FEV1/FVC by 1.22 units and was statistically significant.

Conflict of Interest
There is no conflict of interest.

Funding and sponsorship
This study is self-funded.

Research ethic
There was no ethical agreement.

Author contribution
All authors contributed equally in the in-data collection, data analysis, and manuscript writing.

References

Amanda, G. (2015). Obesitas dan Asma (Obesity and Asthma). RS PMC Pekanbaru, Riau, Indonesia.

Andayani, N. (2017). Hubungan Obesitas Terhadap Asma (The Correlation between Obesity and Asthma). Jurnal Kedokteran Syiah Kuala, 17(1), 54-59.

Data Rekam Medik RSUD Kota Mataram. (2021). RSUD Kota Mataram. Accessed at June, 2019.

Fasitasari, M. (2013). Terapi Gizi pada Lanjut Usia dengan Penyakit Paru Obstruktif Kronik (PPOK) (Nutrition therapy in Elderly with Chronic Obstructive Pulmonary Disease (COPD) Januari - Juni 2013. Sains Medika. 5(1), 50-61.

Fujianti, P., Hasyim, H., & Sunarsih, E. (2015). Faktor-Faktor yang Mempengaruhi Timbulnya Keluhan Gangguan Pernapasan pada Pekerja Mebel Jati Berkah Kota Jambi (Factors Associated with the Occurrence of Complaints of Respiratory Disorders in Teak Furniture Workers in the City of Jambi). Jurnal Ilmu Kesehatan Masyarakat, 6(3).

Global Initiative for Asthma (GINA). (2019). Pocket Guide for Asthma Management and Prevention. Cape Town: Global Initiative for Asthma

Haitamy, N., & Kadarullah, O. (2017). Pengaruh Obesitas Terhadap Terjadinya Penyakit Asma Di RS Islam Fatimah Cilacap. Sainteks, 12(2).

Hall, J. E. (2016). Guyton and Hall Textbook of Medical Physiology (13th ed.). Elsevier, Inc.

Hancox, R. J., Pavord, I. D., & Sears, M. R. (2018). Associations Between Blood Eosinophils and Decline in Lung Function Among Adults With and Without Asthma. European Respiratory Journal, 51(4). Doi: 10.1183/13993003.02536-2017

James H Hull. (2020). Lung Function Testing in the COVID-19 Endemic. Lung Function Department, Royal Brompton Hospital, London SW3 6HP, UK (JHH); and Lung Function & Sleep, University Hospitals Birmingham NHSF Trust, Birmingham.

Kemenkes RI. (2019). Laporan Nasional RISKESDAS 2018. Kemenkes RI. http://labdata.¬lit¬bang.¬kemkes.go.id/. Accessed at October 2020.

Kerkhof, M., Tran, T. N., van den Berge, M., Brusselle, G. G., Gopalan, G., Jones, R. C. M., Kocks., et al. (2018). Association between blood eosinophil count and risk of readmission for patients with asthma: Historical cohort study. PloS one, 13(7), e0201143. Doi: 10.1371/journal.pone.0201143

Liu, Y., Pleasants, R. A., Croft, J. B., Lugogo, N., Ohar, J., Heidari, K., Strange, C., et al. (2015). Body mass index, respiratory conditions, asthma, and chronic obstructive pulmonary disease. Respiratory medicine, 109(7), 851–859. Doi: 10.1016/j.rmed.¬2015.05.006

Nair, P., Pizzichini, M. M., Kjarsgaard, M., Inman, M. D., Efthimiadis, A., Pizzichini, E., Hargreave, F. E., & O'Byrne, P. M. (2009). Mepolizumab for prednisone-dependent asthma with sputum eosinophilia. The New England journal of medicine, 360(10), 985–993. Doi: 10.1056/NEJMoa0805435

Nasiri, K, R., Hamedi, R., Nasirian, R., Farsani, M., Kashefi, H., Khalafi, B., & Kooti, W. (2016). Association of body mass index with asthma severity and pulmonary function among asthmatic children. International Journal of Pediatrics, 4(9), 3551-3559. Doi: 10.¬22038/ijp.2016.7316

Nisa, A., Afghani, A., Dharmmika, S., & Muhammad. (2019). Hubungan Kejadian Asma Bron¬kial dengan Jumlah Eosinofil Total Darah Tepi. Prosiding Pendidikan Dokter, 045(22), 318–325. Doi: 10.29313/kedokteran.v0i0.14915.

Ortega, H., Yancey, S. W., Keene, O. N., & Gunsoy, N. B. (2018). Asthma Exacerbations Associated with Lung Function Decline in Patients with Severe Eosinophilic Asthma Study Population. The Journal of Allergy and Clinical Immunology in Practice, 6(3), 980-986.e1. Doi: 10.1016/j.jaip.2017.12.019

Ostrowski, S., & Barud, W. (2006). Factors influencing lung function: are the predicted values for spirometry reliable enough?. Journal of physiology and pharmacology: an official journal of the Polish Physiological Society, 57 Suppl 4, 263–271.

PDPI. (2020). SPO Spirometri pada Masa Pandemi COVID-19. www.klikpdpi.com

Rahmawati, Galih Lidya, and Muhammad Fachri. (2014). Comparison of Various Degree of Stable Asthmatic Patients With Obesity and Normoweight at Jakarta Islamic Hospital Sukapura. Journal Of The Indonesian Medical Association Majalah Kedokteran Indo¬nesia 64(2).

Sabirina. N. A. (2011). Perbedaan Fungsi Paru antara Penderita Asma Obesitas dan Normoweight rentan Usia 30-40 tahun di Poli Asma RSUP Persahabatan periode Agustus 2008-Agustus 2010. Skripsi Fakultas Kedokteran UPN Veteran Jakarta, 1-47.

Shore S. A. (2008). Obesity and asthma: possible mechanisms. The Journal of allergy and clinical immunology, 121(5), 1087–1095. Doi: 10.1016/j.jaci.2008.03.004

Sutherland, T. J., Cowan, J. O., Young, S., Goulding, A., Grant, A. M., Williamson, A., Brassett, K., et al. (2008). The association between obesity and asthma: interactions between systemic and airway inflammation. American journal of respiratory and critical care medicine, 178(5), 469–475. Doi: 10.1164/rccm.200802-301OC

Vedel-Krogh, S., Nielsen, S. F., Lange, P., Vestbo, J., & Nordestgaard, B. G. (2017). Association of Blood Eosinophil and Blood Neutrophil Counts with Asthma Exacerbations in the Copenhagen General Population Study. Clinical Chemistry, 63(4), 823–832. Doi: 10.1373/clinchem.2016.267450