



ORIGINAL RESEARCH

RELATIONSHIP BETWEEN BODY MASS INDEX AND GENDER WITH ASTHMA

Hubungan Indeks Massa Tubuh dan Jenis Kelamin dengan Asma

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ABSTRACT

Background: Asthma is ranked 16th among the leading causes of years lived with disability (YLD) and ranks 28th among the causes of global burden of disease (GBD). Various potential factors can cause asthma, which include body mass index (BMI) and gender. **Purpose:** This research aimed to determine the relationship between BMI and gender in people living with asthma in Indonesia. **Methods:** This research employed secondary data obtained from the Indonesian family life support (IFLS) 5th edition. This research used an observational analysis technique with a cross-sectional approach. The number of respondents in this research were 30,713. In this study, the BMI category was based on WHO's classification for Asians. Data was analyzed using logistic regression tests and chi square. Statistical significance was set at a value of $p < 0.05$. **Results:** As many as 17,175 respondents had a normal BMI range (56.92%), out of which the majority were women—16,001 respondents (52.10%). After controlling the other variables, statistical test results with logistic regression indicated that male respondents had 1.23 times the odds of experiencing asthma compared to females (adjusted odds ratio (AOR)=1.23; 95% confidence interval (CI), 1.04–1.44; $p=0.02$). Again, after controlling the other variables, underweight respondents had 1.31 times the odds of experiencing asthma compared to respondents who had a normal BMI (AOR=1.31; 95% CI=1.07–1.59; $p=0.01$). **Conclusion:** A relationship between gender and the category of people who were underweight after determining their BMI could be established. Health counseling can be provided to help improve the respiratory conditions of these individuals.

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ABSTRAK

Latar Belakang: Asma berada pada posisi peringkat 16 sebagai penyakit penyebab Years of Life lived with Disability (YLD) dan peringkat 28 sebagai penyebab dari Global Burden of Disease (GBD). Berbagai faktor potensial dapat menyebabkan asma termasuk yaitu Indeks Massa Tubuh (IMT) dan jenis kelamin. **Tujuan:** Penelitian ini bertujuan untuk mengetahui hubungan IMT dan jenis kelamin dengan asma di Indonesia. **Metode:** Penelitian ini menggunakan data sekunder yang berasal dari data Indonesian Family Life Support (IFLS) 5. Penelitian ini menggunakan teknik observasional analitik dengan pendekatan cross sectional. Jumlah responden yang terdapat dalam penelitian ini adalah 30.713 responden. Kategori BMI dalam penelitian ini, menggunakan klasifikasi WHO untuk orang Asia. Data dianalisis dengan menggunakan uji regresi logistic dan chi square. Signifikansi statistik ditetapkan pada nilai $p < 0,05$. **Hasil:** Karakteristik responden sebagian besar memiliki BMI category normal sebanyak 17.175 responden (56,92%) dengan mayoritas jenis kelamin perempuan sebanyak 16.001 responden (52,10%). Hasil uji statistik dengan regresi logistik menunjukkan responden laki-laki mempunyai odds 1,23 kali untuk mengalami asthma dibandingkan dengan perempuan (AOR=1,23;95%CI=1,04–1,44;p=0,02) setelah dikontrol variable lain. Responden yang underweight mempunyai odds 1,31 kali untuk mengalami asthma dibandingkan dengan responden yang bmi normal (AOR=1,31;95%CI=1,07–1,59;p=0,01) setelah dikontrol variable lain. **Kesimpulan:** Jenis kelamin dan kategori IMT berat badan kurang memiliki hubungan dengan asma. Pemberian konseling kesehatan diharapkan dapat membantu memperbaiki kondisi pernapasan.

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INTRODUCTION

Asthma as a heterogeneous disease is characterized by inflammation of the chronic airways (Bush, 2019). This condition is more specific than chronic inflammation in the lower airway but still represents a set of clinical conditions that vary in severity, onset, risk factors, triggers, response to treatment, genetics, and natural history (Mims, 2015). Asthma sufferers can experience symptoms such as wheezing, shortness of breath, chest pain, and coughing that vary from time to time and also in intensity due to the narrowing of the airways (Bush, 2019).

Asthma is a chronic disease that attacks all ages in all regions of the world. It is a cause of substantial burden of disease, including both premature death and reduced quality of life, in people who suffer (Global Asthma Network, 2018). Asthma can cause negative impacts on people's lives who suffer this disease, such as

restrictions on the activities of individuals, not going to school or work, emotional health problems, and the ability to perform routine activities (Harris et al., 2018). In 2016, asthma was globally ranked 16th among the causes of YLD and was also ranked 28th among the causes of GBD (Global Asthma Network, 2018).

A world health survey conducted by the World Health Organization (WHO) with 177,496 young adults aged between 18 and 45 years in 70 countries stated that the prevalence of asthma in the survey group could be classified into three segments: the percentage of the population who reported a doctor's diagnosis of asthma was 4.30%; the percentage of the population who reported either a doctor's diagnosis or that they were undergoing treatment for asthma was 4.50%; and 8.60% of the population reported that they experienced wheezing or a whistling breath. In 2018, the WHO stated that approximately 235

billion people from all over the world were suffering from asthma. 80% of the deaths caused by asthma occur in countries with low to medium income (WHO, 2020). In Indonesia, the data retrieved from Indonesia Basic Health Research (or RISKESDAS) in 2018 mentioned that the prevalence of asthma diagnosed by doctors at all ages was 2.40% (Ministry of Health RI, 2018).

Based on the report by the International Study of Asthma and Allergies in Childhood (ISAAC), there are various potential factors that can cause asthma, which include air pollution, cigarette smoke, passive and active smoking, house dust mites, pets, types of food, household furniture, weather changes, family history of disease (genetic), stress, exercise, gender, and obesity (Bhattacharjee et al., 2018). Obesity can lead to other health problems (Heymsfield & Wadden, 2017). The research conducted by Rasyida and Loriza (2019) revealed that excessive weight gain could cause decreased lung function and increased morbidity in asthma sufferers. Other studies, however, have indicated different results by indicating that Body Mass Index (BMI) is not linked to the onset of asthma (Wahyudi, Yani, & Erkadius, 2016).

Another risk factor of asthma is gender. The prevalence of asthma in a certain demographic depends upon gender (Koper, Hufnagl, & Ehmann, 2017). The reason for this could be different hormones and differences in lung capacity between men and women (Fuseini & Newcomb, 2017). Based on age standards, with asthma, there is a difference in mortality rates that affect women more than men (Koper, Hufnagl, & Ehmann, 2017). According to research conducted by Greenblatt, Mansour, Zhao, Ross, & Himes (2017), there is a relationship between gender and the incidence of asthma. Other studies have produced contrasting results and have indicated that gender is not linked to the incidence of asthma (Wahyudi, Yani, & Erkadius, 2016).

Previous studies have discovered a link between BMI and gender with asthma, however, several studies have not found any relationship between BMI and gender. Thus, the aim of this study was to examine the relationship between BMI and gender in people who suffered from asthma by considering a large sample size of the Indonesian population.

METHODS

This study adopted a cross-sectional research approach and used secondary data, which was

obtained from the Indonesian Family Life Support (IFLS) 5th edition. The IFLS was a longitudinal survey that was conducted in Indonesia. About 83% of the samples used in the IFLS survey represented the population of Indonesia. This sample contained over 30,000 people, living in 13 out of the 27 provinces in Indonesia. The number of respondents for this research was 30,713. The respondents were divided into 14,666 males and 16,047 females. IFLS-5 was a survey conducted in 2014–2015. The IFLS survey and its procedures were properly reviewed and approved by institutional review boards (IRB) in the US at the Research and Development (RAND) Corporation with number s0064-06-01-CR01 and in Indonesia at the Gadjah Mada University (UGM) for IFLS-5 (Strauss, Witoelar, & Sikoki, 2015).

The asthma status of individuals living in households was obtained by answering cd-type questions: cd05 and cd07. The asthma status was estimated through doctors' diagnoses. BMI can be defined as the value obtained by dividing the weight (in kg) by the height of the quadratic body (in meters). Respondents up to the age of 80 were able to take part in this study. Respondents' characteristic information was obtained from book 3A, book 3B, and a questionnaire book designed by the US, which included age groups <20, 20–35, 36–45, 46–55, 56–75, and >75 years; gender (male or female); marital status (yes or no); education (grouped as low or high); domicile (urban or rural); BMI category (underweight as <18.50, normal as 18.50–22.90, overweight as 23.00–24.00, and obese as >25.00); and smoking (yes or no) (Strauss, Witoelar, & Sikoki, 2015). The inclusion criteria for all respondents was that they were required to take part in the IFLS survey and possess information with regard to their weight, height, and gender.

Data analysis was carried out by checking the completeness of the data, grouping the data, and then analyzing the data. Data was presented in a tabular form using a computer program. Table 1 indicates the general characteristics of the participants. Categorical variables expressed as numbers and percentages can be seen. A chi-square and multiple logistic regression analysis was performed to evaluate the association between BMI and gender to detect the prevalence of asthma. Statistical significance was set at a value of $p < 0.05$. Confounding variables in this study were simultaneously tested using multiple logistic regression analysis.

RESULTS

Characteristics of Respondent

Based on Table 1, it can be observed that as many as 12,537 (40.82%) respondents were aged between 20 and 35 years. Asthma was mostly prevalent in the age group above 75 years (5.74%). The majority of respondents were women (52.10%). The largest percentage of people suffering from asthma was seen in the women's group (3.15%). The majority of respondents were married (72.23%). The largest percentage of people experiencing asthma could be found in the not married group (3.12%). As many as 15,808 (51.47%) respondents (the majority of the respondents) had a low level of education. The largest percentage of people with asthma was seen in a group of individuals who obtained a high level of education (3.37%). As many as 18,359 (59.78%) respondents (a majority) were living in urban areas. The largest percentage of people with asthma was observed in people living in urban areas (3.13%). This could be due to the fact that in urban areas, pollutants from factories, and emissions from motor vehicles cause air pollution. Air pollution is one of the risk factors leading to asthma. The majority of respondents had a normal BMI of 17.175 (56.92%); the number of overweight individuals were 7,173 (23.36%); the number of underweight individuals were 3,741 (12.180%); and the number of obese individuals were 2,481 (8.075%). The largest percentage of people with asthma was observed in the underweight BMI category (3.58%). The majority of respondents did not smoke were 20,920 (68.11%). The largest percentage of people suffering from asthma was observed in the non-smoking habit group (3.37%). Based on Table 1, the statistical test results with chi-square indicated a relationship between age, gender, education, domicile, BMI, and smoking with asthma.

Relationship between BMI Category and Asthma

Based on table 2, from the results obtained through the analysis, a relationship between the underweight BMI category and asthma was noticed (as evident from the p values being less than 0.05). This meant that individuals falling under all the ranges of BMI experienced asthma, however, a relationship between the overweight and obese BMI categories and asthma was not evident. Underweight respondents had 1.31 times the odds of experiencing asthma compared to respondents who had a normal BMI (AOR=1.31;

95%CI=1.07–1.59;p-value=0.01). The results were obtained after controlling other variables.

Relationship between Gender and Asthma

Based on Table 2, from the results obtained through the analysis, a relationship between gender and asthma can be noticed (as observed from the p values being less than 0.05). This means that gender and asthma were linked. Statistical test results with logistic regression revealed that male respondents had 1.23 times the odds of experiencing asthma compared to women (AOR=1.23; 95%CI=1.04–1.44; p=0.02). The results were obtained after controlling other variables.

DISCUSSION

Asthma is a chronic inflammation in the respiratory tract and is characterized by bronchial hyperactivity and airway obstruction. The risk factor identified for developing asthma is an interaction between host factors and environmental factors. Host factors include genetic asthma, allergic (atopy), bronchial hyper-reactivity, sex, race, and the BMI category. Environmental factors affect individuals with a tendency to develop asthma. Also included in environmental factors are allergens, work environment sensitization, cigarette smoke, air pollution, respiratory infections (viruses), socio-economic status, and diet (Berawi & Ningrum, 2017).

Characteristics of Respondents

In this study, asthma was mostly prevalent in the age group above 75 years. This is in accordance with previous research, which suggests that early elderly groups suffer more from asthma. This could be because elderly individuals have lower levels of lung function (Liu et al., 2015). The largest percentage of individuals with asthma was noticed in the non-smoking group. This is in accordance with previous research, which suggests that a greater number of asthma attacks occur when individuals smoke (Park, Jung, & Kwon, 2019). This occurs because smoking can cause inflammation of the respiratory tract (Nusa & Widyastiti, 2016).

Relationship between BMI and Asthma

The largest percentage of people suffering from asthma was noticed in the overweight BMI category. This is in line with expert opinion, which suggests that individuals having additional weight

have reduced levels of physical activity (Mohamed, El-Askary, & Abd-Eltawab, 2018).

In Indonesia, based on the statistical test carried out, there was a relationship observed between individuals who were underweight (on the basis of their BMI) and asthma. This is in line with a research conducted in Columbia, which demonstrated that a link exists between being underweight and the incidence of asthma (Pate, Zahran, & Bailey, 2019). Individuals who were classified below the underweight BMI category had low muscle mass. Other studies have revealed that low levels of lung function are associated with reduced skeletal muscle mass, especially the diaphragm muscle mass. Theoretically, the abdominal muscle mass can affect the strength of the breathing muscles. Forced Vital Capacity (FVC) and Forced Expiratory Volume in One

Second (FEV1) are associated with muscle mass (Do, Park, Lee, & Yoon, 2019).

The statistical test results indicated that no relationship exists between being overweight and having asthma in Indonesia. This is not in line with previous studies, which suggest that there is a relationship between being overweight and having asthma (de Castro Mendes et al., 2019). Other research studies have revealed a relationship between being overweight and experiencing asthma only in males (Park, Jung, & Kwon, 2019). The statistical test results revealed no relationship between obesity and asthma in Indonesia. This result is in line with the research conducted in Padang, where the absence of a relationship between being obese and having asthma was observed (Wahyudi, Yani, & Erkadius, 2016).

Table 1

Distribution of Respondents' Characteristics, BMI Category, and Gender by Asthma

Variable	Asthma				Total		<i>p-value</i>
	Yes		No		n	%	
	n	%	n	%			
Age (years)							
<20	134	3.73	3,457	96.27	3,591	11.69	
20-35	355	2.83	12,182	97.17	12,537	40.82	
36-45	158	2.42	6,364	97.58	6,522	21.24	0.01
46-55	104	2.49	4,078	97.54	4,181	13.61	
56-75	128	3.63	3,400	96.37	3,528	11.47	
>75	12	5.74	198	94.74	209	0.68	
Gender							
Women	504	3.15	15,497	96.85	16,001	52.10	0.01
Men	387	2.66	14,182	97.34	14,569	47.44	
Married Status							
No	262	3.12	8,125	96.88	8,387	27.31	0.18
Yes	629	2.84	21,554	97.16	22,183	72.23	
Education							
High	479	3.37	14,283	96.76	14,762	48.06	0.01
Low	412	2.61	15,396	97.39	15,808	51.47	
Domicile							
Urban	574	3.13	17,785	96.87	18,359	59.78	0.01
Rural	317	2.60	11,894	97.40	12,211	39.76	
BMI Category							
Underweight	134	3.58	3,607	96.42	3,741	12.18	
Normal	474	2.76	16,701	97.24	17,175	56.92	0.01
Overweight	195	2.72	6,978	97.28	7,173	23.36	
Obesity	88	3.55	2,393	96.48	2,481	8.08	
Smoke							
No	704	3.36	20,216	96.64	20,920	68.11	0.01
Yes	187	1.94	9,463	98.06	9,650	31.42	
Total	673	2.19	30,040	97.81	30,713	100.00	

Source: Strauss, Witoelar, & Sikoki (2015)

Table 2
Multiple Logistic Regression Between BMI, Gender, and Asthma

Variable	Univariable				Multivariable			
	OR	95% CI		<i>p</i> -value	AOR	95% CI		<i>p</i> -value
		Lower	Upper			Lower	Upper	
Age (years)								
<20	(Ref)							
20-35	0.75	0.61	0.92	0.01				
36-45	0.64	0.51	0.81	0.01				
46-55	0.66	0.51	0.85	0.01				
56-75	0.97	0.76	1.24	0.83				
>75	1.56	0.85	2.87	0.15				
Gender								
Women	(Ref)				(Ref)			
Men	0.849	0.73	0.96	0.01	1.23	1.04	1.44	0.02
Married Status								
No	(Ref)							
Yes	0.90	0.78	1.05	0.18				
Education								
High	(Ref)							
Low	0.80	0.03	0.04	0.01				
Domicile								
Urban	(Ref)							
Rural	0.83	0.72	0.95	0.01				
BMI Category								
Normal	(Ref)				(Ref)			
Underweight	1.31	1.08	1.59	0.01	1.31	1.07	1.59	0.01
Overweight	0.98	0.83	1.17	0.86	0.92	0.78	1.09	0.35
Obesity	1.30	1.03	1.63	0.03	1.19	0.94	1.50	0.14
Smoke								
No	(Ref)				(Ref)			
Yes	0.57	0.48	0.67	0.01	0.49	0.40	0.60	0.01

Source: Strauss, Witoelar, & Sikoki (2015)

These results are in contrast to the research conducted by Somashekar & Sowmya (2016), who revealed that there is a relationship between BMI and asthma. The results of this study indicate that both overweight and obese BMI category individuals need not necessarily experience asthma due to a single factor; rather, these individuals may suffer from asthma because of various factors that can increase their risk and exposure to asthma. These factors include poverty and lack of health insurance, which can also contribute to an individual developing asthmatic symptoms.

Relationship between Gender and Asthma

This study revealed a relationship between gender and asthma. The results obtained were in line with research conducted by Greenblatt, Mansour, Zhao, Ross, & Himes (2017), who indicated a relationship between gender and the incidence of asthma. Men are at more risk of developing asthma compared to women. This

result is not in accordance with previous studies, which suggest that women have a higher chance of developing asthma compared to men (Tana, 2018). The results of this study are also not in line with the theory, which suggests that women have a higher chance of developing asthma because of differences in airway diameter and women's lung capacity being lower than men's. These results are also not in line with previous studies, which suggest that asthma can be caused by smoking. The majority of smokers in Indonesia are male. This could be one of the factors that causes men to be more at risk of developing asthma when compared to women (Do, Park, Lee, & Yoon, 2019).

CONCLUSION

The majority of respondents in this study who had asthma were women and were in the underweight BMI category. The majority of

respondents who did not have asthma were men and were in the overweight BMI category. There is a relationship between gender and the underweight BMI category experiencing asthma. In the overweight BMI category, being obese has no relationship with developing asthma in Indonesia. Health institutions are expected to provide nutrition-related counseling that can help improve respiratory symptoms and conditions.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS

All authors have actively participated actively in this article and have been responsible for writing the content, including preparing and writing the draft, research design selection, analysis, and revision of the article. DPA: preparation, writing the original draft, research design selection, editing, and revision of the article. RNF: software, analysis, editing, and revision of the article. RN: editing and revision of the article. EA: software, analysis, editing, and revision of the article

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REFERENCES

- Berawi, K. N., & Ningrum, A. F. (2017). Faktor risiko obesitas dan kejadian asma. *Majority*, 6(2), 6–11.
- Bhattacharjee, S., Haldar, P., Gopal Maity, S., Debnath, S., Moitra, S., Saha, S., ... Moitra, S. (2018). Prevalence and risk factors of asthma and allergy-related diseases among adolescents (Performance) study: rationale and methods. *ERJ Open Research*, 4(2), 1–8. <https://doi.org/10.1183/23120541.00034-2018>
- Bush, A. (2019). Pathophysiological mechanisms of asthma. *Frontiers in Pediatrics*, 7, 1–17. <https://doi.org/10.3389/fped.2019.00068>
- de Castro Mendes, F., Paciência, I., Rufo, J. C., Silva, D., Cunha, P., Farraia, M., ... Moreira, A. (2019). Asthma and body mass definitions affect estimates of association: evidence from a community-based cross-sectional survey. *ERJ Open Research*, 5(4), 00076–02019. <https://doi.org/10.1183/23120541.00076-2019>
- Do, J. G., Park, C. H., Lee, Y. T., & Yoon, K. J. (2019). Association between underweight and pulmonary function in 282,135 healthy adults: a cross-sectional study in Korean population. *Scientific Reports*, 9(1), 1–10. <https://doi.org/10.1038/s41598-019-50488-3>
- Fuseini, H., & Newcomb, D. C. (2017). Mechanisms driving gender differences in asthma. *Current Allergy and Asthma Reports*, 17(3), 1–9. <https://doi.org/10.1007/s11882-017-0686-1>
- Global Asthma Network. (2018). *The global asthma report 2018*. Retrieved April 26, 2020, from www.globalasthmanetwork.org
- Greenblatt, R., Mansour, O., Zhao, E., Ross, M., & Himes, B. E. (2017). Gender-specific determinants of asthma among U.S. adults. *Asthma Research and Practice*, 3(1), 1–11. <https://doi.org/10.1186/s40733-017-0030-5>
- Harris, D. A., Mainardi, A., Iyamu, O., Rosenthal, M. S., Bruce, R. D., Pisani, M. A., & Redlich, C. A. (2018). Improving the asthma disparity gap with legal advocacy? a qualitative study of patient-identified challenges to improve social and environmental factors that contribute to poorly controlled asthma. *Journal of Asthma*, 55(8), 924–932. <https://doi.org/10.1080/02770903.2017.1373393>
- Koper, I., Hufnagl, K., & Ehmann, R. (2017). Gender aspects and influence of hormones on bronchial asthma - secondary publication and update. *World Allergy Organization Journal*, 10(1), 1–7. <https://doi.org/10.1186/s40413-017-0177-9>
- Liu, Y., Pleasants, R. A., Croft, J. B., Lugogo, N., Ohar, J., Heidari, K., ... Kraft, M. (2015). Body mass index, respiratory conditions, asthma, and chronic obstructive pulmonary disease. *Respiratory Medicine*, 109(7), 851–859. <https://doi.org/10.1016/j.rmed.2015.05.006>
- Mims, J. W. (2015). Asthma: definitions and pathophysiology. *International Forum of Allergy & Rhinology*, 5(S1), S2–S6. <https://doi.org/10.1002/alr.21609>
- Ministry of Health RI. (2018). *Indonesia basic health research (Riskesmas) at 2018*. Jakarta: Ministry of Health RI. Retrieved March 26, 2020, from <https://labmandat.litbang.kemkes.go.id/riset-badan-litbangkes/menu-riskesmas/menu-riskesmas/426-rkd-2018>

- Mohamed, S., El-Askary, A., & Abd-Eltawab, A. (2018). Environmental tobacco smoke exposure and relation to asthma exacerbations and severity among primary school children. *Acta Scientific Paediatrics*, *1*(4), 20–26.
- Nusa, G. B., & Widyastiti, N. S. (2016). Perbedaan neutrophil-lymphocyte ratio pada subyek bukan perokok, perokok ringan dan perokok sedang-berat. *Jurnal Kedokteran Diponegoro*, *5*(4), 903–910.
- Park, S., Jung, S. Y., & Kwon, J. W. (2019). Sex differences in the association between asthma incidence and modifiable risk factors in Korean middle-aged and older adults: NHIS-HEALS 10-year cohort. *BMC Pulmonary Medicine*, *19*(1), 1–10. <https://doi.org/10.1186/s12890-019-1023-3>
- Pate, C. A., Zahran, H. S., & Bailey, C. M. (2019). Impaired health-related quality of life and related risk factors among US adults with asthma. *Journal of Asthma*, *56*(4), 431–439. <https://doi.org/10.1080/02770903.2018.1466314>
- Rasyida, A., & Loriza, S. Y. (2019). Indeks massa tubuh (IMT) dengan kualitas hidup penderita asma usia dewasa dan usia lanjut. *Jurnal Vokasi Kesehatan*, *5*(2), 89–94.
- Somashekar, A., & Sowmya, A. (2016). Correlation of body mass index with the prevalence and severity of asthma in urban children aged 7-12 years. *Journal of Pediatric Care*, *2*(2), 1–4. <https://doi.org/10.21767/2471-805x.100012>
- Strauss, J., Witoelar, F., & Sikoki, B. (2015). *The fifth wave of the Indonesia family life survey (IFLS5): overview and field report*. Retrieved February 14, 2020, from <https://www.rand.org/labor/FLS/IFLS.html>
- Tana, L. (2018). Determinan penyakit asma pada pekerja usia produktif di Indonesia, riset kesehatan dasar 2013. *Buletin Penelitian Kesehatan*, *46*(1), 11–22. <https://doi.org/10.22435/bpk.v46i1.43>
- Wahyudi, A., Yani, F. F., & Erkadius, E. (2016). Hubungan faktor risiko terhadap kejadian asma pada anak di RSUP Dr. M. Djamil Padang. *Jurnal Kesehatan Andalas*, *5*(2), 312–318. <https://doi.org/10.25077/jka.v5i2.514>
- WHO. (2020). *Asthma*. Geneva: World Health Organization Retrieved August 18, 2020, from <https://www.who.int/news-room/fact-sheets/detail/asthma>