Advanced Journal of Science, Technology and Engineering
ISSN: 2997-5972
Volume 4, Issue 4, 2024 (pp. 10-22)
www.abjournals.org

STATISTICAL ANALYSIS OF THE PREVALENCE AND PREDICTORS OF ASTHMA AND ALLERGIC RHINITIS IN NIGERIA

Oderinde E. O.[1] and Adeoti O. A.[2]

[1]Department of Statistics, School of Physical Science, Federal University of Technology, Akure, Nigeria.
Email: oderindesta174941@futa.edu.ng

[2]Department of Statistics, School of Physical Science, Federal University of Technology, Akure, Nigeria.
Email: oaadeoti@futa.edu.ng

Cite this article:

Oderinde, E. O., Adeoti, O. A. (2024), Statistical Analysis of the Prevalence and Predictors of Asthma and Allergic Rhinitis in Nigeria. Advanced Journal of Science, Technology and Engineering 4(4), 10-22. DOI: 10.52589/AJSTE-GA5AXYDB

Manuscript History

Received: 15 Jul 2024

Accepted: 18 Sep 2024

Published: 24 Sep 2024

ABSTRACT: *The incidence and prevalence of asthma and allergic rhinitis have increased worldwide over the past ten years and it places a burden on already poorly financed healthcare systems. This article explores the prevalence of asthma and allergic rhinitis in Nigeria, utilizing statistical analyses to investigate the prevalence, demographic predictors, and familial associations. Objectives include determining average ages of diagnosis, identifying significant predictors, examining the relationship between asthma and allergic rhinitis, and investigating familial associations. The study employed the use of statistical tools like logistics regression, chi-square test of independence, cross-tabulation, and descriptive statistics. The analysis reveals an average age of 22 for asthma and 28 for allergic rhinitis. Significant predictors influencing asthma include age, body mass index, years of smoking, level of education, and the number of cigarettes smoked per day. The study establishes a positive correlation between asthma and allergic rhinitis, emphasizing their interconnected nature. Importantly, a highly significant relationship is identified between a family history of asthma and individual diagnoses. The prevalence of asthma and allergic rhinitis in Nigeria is influenced by various demographic factors that should be looked into, emphasizing the importance of considering demographic factors and age in developing effective approaches to address and manage asthma in the Nigerian population.*

KEYWORDS: Asthma, Allergic Rhinitis, Diagnosis, Asthma Predictors, Demographic Factors.

Article DOI: 10.52589/AJSTE-GA5AXYDB
DOI URL: https://doi.org/10.52589/AJSTE-GA5AXYDB

Advanced Journal of Science, Technology and Engineering
ISSN: 2997-5972
Volume 4, Issue 4, 2024 (pp. 10-22)

www.abjournals.org

INTRODUCTION

A respiratory condition, asthma, characterized by persistent airway inflammation, has seen a marked rise globally over the last twenty years. This increase is attributed to shifting environmental influences, improved awareness, and changes in diagnostic methodologies. According to the 2014 Global Asthma Report, approximately 334 million individuals worldwide are affected by this condition (Desalu et al., (2019)). The prevalence of asthma globally varies between 1% to 18%. According to statistics, approximately 1 in every 250 deaths worldwide is attributable to asthma (Desalu et al., (2019).)

Asthma is a long-term chronic condition that affects the airways in the lungs. When an individual has asthma, the airways can sometimes become inflamed and narrowed. This makes it harder for air to flow out of the airways when he or she breathes out. But, with proper care and management, individuals can lead fulfilling lives

Asthma has increasingly become a health challenge in Nigeria. Studies have shown that the prevalence of asthma in Nigeria can be associated with factors such as environmental changes, urbanization, and pollution (Awopeju et al., (2015)). However, asthma documentation in Nigeria is relatively low compared to regions with more advanced healthcare systems and historical medical records.

On the contrary, allergic rhinitis is a prognosis associated with symptoms affecting the nose (A.D.A.M. Medical Encyclopedia, (2022)). These symptoms manifest when one inhales allergens that trigger the allergies, like dust, animal dander, or pollen. They may also arise after consuming food to which an individual has an allergy.

The prevalence of asthma and allergies is increasingly becoming high across all age groups including both children and adults. Therefore, this study seeks to investigate and understand the prevalence, demographic factors, and predictors of asthma and allergic rhinitis in Nigeria through a comprehensive statistical analysis while studying the association between a patient diagnosed with asthma and a family member having asthma and also examining the effect of allergies on asthma.

The objectives of this study include the following: (i) determining the average age of individuals diagnosed with asthma and allergic rhinitis in Nigeria (ii) identifying significant predictors of asthma in Nigeria (iii) exploring the relationship between asthma and allergic rhinitis and analyze the effect of allergic rhinitis on asthma (iv) investigating the association between a family history of asthma and asthma and individual diagnoses.

By achieving these objectives, the study aims to investigate the epidemiology of asthma and allergic rhinitis in Nigeria, while exploring their prevalence, interrelationships, demographic predictors, and familial associations through various statistical techniques.

Article DOI: 10.52589/AJSTE-GA5AXYDB
DOI URL: https://doi.org/10.52589/AJSTE-GA5AXYDB

Advanced Journal of Science, Technology and Engineering
ISSN: 2997-5972
Volume 4, Issue 4, 2024 (pp. 10-22)

www.abjournals.org

LITERATURE REVIEW

Asthma is an important cause of morbidity and mortality worldwide. The estimated prevalence of asthma has increased globally by 12% according to The Global Burden of Disease (GBD) project between 2005 to 2015 (Soriano et al., 2015; Asher et al., 2006). The national prevalence of diagnosed asthma and wheezing in the year 2019 across all age groups was 2.5%, 6.4%, and 9% respectively (Ozoh et al., 2019). Asthma and other allergic diseases are increasing worldwide at a rapid rate, mostly in low and middle-income countries, and it requires an efficient intervention plan (Björkstén et al., 2008).

Asthma has various risk factors. Despite the considerable number of studies on risk factors from asthma, very little is still known about their relative importance (Mengfan et al., 2015. The environmental factors that cause asthma are those that induce airway inflammation with eosinophils or neutrophils along with airway hyperresponsiveness (AHR) (Cockcroft, 2018). Environmental factors including smoking, diet, and viral respiratory infections, have contributed to the cause of asthma (Wiesch et al., 1999). Associations have been reported between a wide range of risk factors and childhood asthma, substantiation of causality is inherently difficult from observational studies, and few risk factors have been assessed in primary prevention studies (Beasleyet al., 2015).

Various primary prevention strategies have been developed to improve lung health and in turn reduce the risk of having asthma. As outlined by Toskala and Kennedy (2015), the measures include: reducing tobacco smoking and environmental tobacco smoke exposure; reducing indoor and outdoor air pollution and occupational exposures; reducing childhood obesity and encouraging a diet high in vegetables and fruit; improving feto-maternal health; encouraging breastfeeding; promoting childhood vaccinations; and reducing social inequalities.

Allergic diseases cause significant morbidity and considerable problems in the health systems of all economies both developed and emerging (Krishna et al., 2020). An early study conducted by Ayuk et al. (2018) showed that allergic diseases such as allergic rhinitis, conjunctivitis, and dermatitis were highly prevalent among children with asthma. These findings suggest that allergies may play a role in the development and progression of asthma. The study also found that children from higher socioeconomic classes and smaller families were more likely to have allergies.

Rhinitis and asthma are often associated and the two disorders interact at various levels. Most time rhinitis precedes asthma and the type of asthma is often influenced by the severity of allergic rhinitis (Compalati et al., 2010). Most patients with asthma have rhinitis present in them and similarities between the two occur like the inflammation present in the target tissue (Bousquet et al., 2003). Studies conducted by Linneberg et al. (2002) further supported that allergic rhinitis and allergic asthma are manifestations of the same disease entity.

In light of the gaps in existing studies, this study investigated the demographic factors that influence asthma and allergic rhinitis in Nigeria. The study also identified the association between a family member having asthma and a patient diagnosed with asthma. The relationship between

Article DOI: 10.52589/AJSTE-GA5AXYDB
DOI URL: https://doi.org/10.52589/AJSTE-GA5AXYDB

allergic rhinitis and asthma and the effect allergic rhinitis has on asthma was investigated. The study was conducted using the R software package.

METHODOLOGY

The data of the study is Asthma Insight and Reality (AIR) survey data, which is secondary data originally collected by Ozoh et al. (2019). The study was a cross-sectional study carried out between June 2017 and March 2018 across five cities in Nigeria (Lagos, Kano, Ilorin, Enugu, and Benin-city). Study participants were children and adolescents 6 years to 17 years of age and adults ≥18 years who resided in selected households. The procedure for the data collection is detailed in the work of Ozoh et al. (2019).

The data analysis was conducted using R programming language. Multiple logistic regression was used to identify the significant demographic factors that influenced asthma. The chi-square test of independence was used to investigate the association between a family history of asthma and asthma individual diagnoses. Also, a correlation test was used to identify the relationship between asthma and allergic rhinitis and logistic regression was employed in investigating the effect of allergic rhinitis on asthma.

RESULTS

Table 1 shows the mean age and standard deviation of individuals with asthma and allergies.

Table 1: Average Age of Individuals with Asthma and Allergic

	Mean age	**Standard deviation**
Asthma	22	16
Allergic	28	16

Article DOI: 10.52589/AJSTE-GA5AXYDB
DOI URL: https://doi.org/10.52589/AJSTE-GA5AXYDB

Figure 1 displays the age groups of individuals diagnosed with asthma and allergic rhinitis in Nigeria.

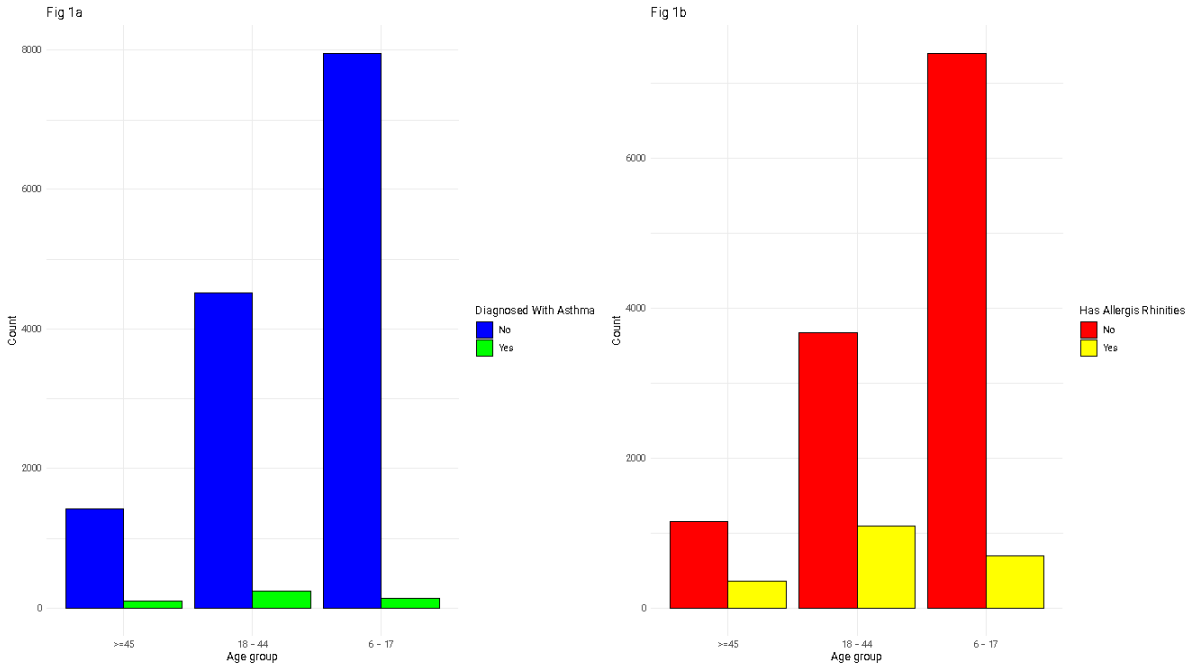

Figure 1: Bar plot of the age groups of individuals diagnosed with asthma and allergic rhinitis

Table 2 shows the demographic analysis of the predictors of asthma in Nigeria.

Table 2: Demographic Analysis of Asthma

Variable		**Frequency**	**Percentage (%)**
Gender	Male	9545	47.5751
	Female	10518	52.4249
Age group	6-17	10948	54.5681
	18-44	6722	33.5045
	>=45	2393	11.9274
Highest Level of Education	none	1306	6.512416
	Primary	5783	28.83714

Article DOI: 10.52589/AJSTE-GA5AXYDB
DOI URL: https://doi.org/10.52589/AJSTE-GA5AXYDB

	Faith-based school	1334	6.652039
	Some secondary	4350	21.69143
	Completed Secondary	4783	23.8506
	Technical post-secondary	707	3.540441
	Some university	717	3.575347
	University graduate	974	4.856886
	Postgraduate	97	0.483694
Employment status	Self-employed	6780	33.7936
	Unemployed	468	2.3327
	Retired/not working	212	1.0567
	Students	11731	58.4708
	Stay-at-home parents	841	4.1918
	Disabled/too ill to work	31	0.1545
Household income	< ₦18450	8909	44.4051
	₦18450 - ₦36561	2600	12.9592
	₦36900 - ₦54981	4817	24.0094
	₦55350 - ₦73431	2039	10.1639
	₦73800 - ₦91881	1033	5.1488
	>₦92250	665	3.3146
BMI	Normal	9879	49.2399
	Obese	1846	9.2010
	Overweight	3045	15.1772
	Underweight	5293	26.3819

Article DOI: 10.52589/AJSTE-GA5AXYDB
DOI URL: https://doi.org/10.52589/AJSTE-GA5AXYDB

Table 3 gives the result for the logistic regression of asthma.

Table 3: Logistic Regression of Asthma

	Estimate	**Std. Error**	**z value**	**Pr(>|z|)**
(Intercept)	-7.3E+14	23428865	-3.1E+07	0
Age	7.45E+12	53523.64	1.39E+08	0
BMI	7.12E+10	598.0945	1.19E+08	0
Never smoker				
Former smoker	7.25E+14	6258272	1.16E+08	0
Current smoker	9.17E+14	6663755	1.38E+08	0
Agricultural waste				
Wood	-3.6E+13	6204101	-5812043	0
Charcoal	-3.1E+14	6576438	-4.7E+07	0
Coal	2.37E+12	6680342	354354.8	0
Kerosene	-1.1E+15	6165618	-1.8E+08	0
Liquified Petroleum Gas (LPG)	-7.8E+14	6194689	-1.3E+08	0
Electricity	-7.5E+14	7956571	-9.5E+07	0
Current tobacco smoker	-2.5E+15	9496105	-2.6E+08	0
Postgraduate				
None	-2.3E+15	22479102	-1E+08	0
Primary	-2.4E+15	22395747	-1.1E+08	0
Faith-based school	-1.3E+15	22490692	-5.7E+07	0
Some secondary	-2.7E+15	22397846	-1.2E+08	0
Completed secondary	-2.2E+15	22416705	-9.8E+07	0
Technical post-secondary	-1.1E+15	22549251	-4.9E+07	0
Some universities	-1.2E+15	22531657	-5.4E+07	0
University graduate	-1.4E+15	22519111	-6.2E+07	0
Others	-7.9E+14	23438320	-3.4E+07	0

Article DOI: 10.52589/AJSTE-GA5AXYDB
DOI URL: https://doi.org/10.52589/AJSTE-GA5AXYDB

Self employed				
Unemployed	7.4E+13	3232419	22892109	0
Retired or not working	9.22E+12	4952537	1861306	0
Students	1.85E+14	1761405	1.05E+08	0
Stay at home parents	-3.2E+14	2680167	-1.2E+08	0
Disabled/Too Ill to Work	1.11E+15	12143382	91533334	0
Years of smoking	-1.4E+13	354557.9	-3.9E+07	0
Cigarettes per day	-8.7E+12	428468.7	-2E+07	0
Waist circumference	1.5E+13	34817.36	4.31E+08	0

Table 4 shows the observed correlation between asthma and allergic rhinitis in Nigeria

Table 4: Relationship between Asthma and Allergic Rhinitis

Variables	**Correlation**	**p-value**
Asthma-allergic rhinitis	0.25	2.2e-16

Table 5 displays the logistic regression of asthma on allergic rhinitis.

Table 5: Effect of Allergic Rhinitis on Asthma

Variables	**Estimates**	**Std.error**	**p-value**
Intercept	-4.4337	0.0697	<2e-16
Allergic	2.5879	0.0922	<2e-16

Article DOI: 10.52589/AJSTE-GA5AXYDB
DOI URL: https://doi.org/10.52589/AJSTE-GA5AXYDB

Table 6 displays the results of the chi-square test of independence conducted to examine the relationship between a family history of asthma and the presence of asthma.

Table 6: Association between Family History of Asthma and Having Asthma

Family suffers from asthma				**Chi square test (p-value)**
		No	Yes	
	No	18743	255	
	Yes	794	271	
Total		19537	526	2.2e-16

DISCUSSION

Research Question One: What is the average age of individuals diagnosed with asthma and allergic rhinitis in Nigeria

In Figure 1a, the proportion of respondents diagnosed with asthma is less compared to those that do not have asthma. Respondents within the age range 18-44 years have the highest prevalence of asthma, followed by those between the ages 6-17 years, while those with the least prevalence of asthma are from the age group more than 45 years.

Figure 1b shows the proportion of respondents with allergic rhinitis is less compared to those who do not have allergic rhinitis. Respondents aged 18-44 years have the highest prevalence of allergic rhinitis, followed by those between the ages 6-17 years, while those with the least prevalence of allergic rhinitis are from the age group more than 45 years.

The analysis of asthma prevalence across different age groups provides insightful trends regarding the average age of individuals diagnosed with asthma in Nigeria. The findings in Figure 1 show that asthma and allergic rhinitis are dominant among individuals aged 18 – 44 years and are less dominant among people aged 45 years and above. The average age of individuals with asthma and allergic rhinitis was observed to be 22 and 28 years respectively.

Research Question Two: What are the significant predictors of asthma in Nigeria?

The results in table 2 show the survey has almost an equal frequency of male (47.58%) and female (52.42%) respondents. Most respondents fall into the 6-17 age group (54.57%), and the 18-44 age group constitutes 33.50% of the respondents. A significant portion of respondents has completed some secondary education, with 21.69% having some secondary education and 23.85% having completed secondary education. Primary education is also typical, with 28.84% having completed it. Higher education levels (university graduate and postgraduate) comprise around 9.34% of the

Article DOI: 10.52589/AJSTE-GA5AXYDB
DOI URL: https://doi.org/10.52589/AJSTE-GA5AXYDB

respondents. The remaining 11.93% are aged 45 and above. Many respondents are students (58.47%), indicating a younger demographic or a focus on student respondents. Self-employed individuals make up 33.79% of the respondents. The unemployed, retired/not working, stay-at-home parents, and those disabled/too ill to work collectively comprise a smaller percentage of the surveyed population. The largest income bracket is less than ₦92,250, with 5.1% falling into this category. The frequency across other income brackets shows a gradual decrease as income increases. Most respondents have a normal BMI (49.24%). 26.38% of respondents are underweight, 15.18% are overweight, and 9.20% are classified as obese.

The results in table 3 show the intercept represents the log odds of asthma when all predictor variables are zero. The very large negative estimate and the extremely low p-value (0) suggest a significant intercept, but this might indicate numerical instability or other issues. For every one-unit increase in Age, the log odds of the event increase by 7.45E+12. The p-value (0) indicates that the effect is highly significant. For every one-unit increase in BMI, the log odds of the event increase by 7.12E+10. The p-value (0) indicates that the effect is highly significant. Never smoking is used as the reference category for the smoking status variable. The estimates represent the log odds of the event for former and current smokers compared to never smokers. All estimates are significant (p-values = 0), indicating that being a former or current smoker significantly influences the log odds of the event. The estimates represent the log odds of the event for different cooking fuels compared to the reference category (not provided). All estimates are significant (p-values = 0), suggesting that the choice of cooking fuel significantly influences the log odds of the event. The estimates represent the log odds of the event for different education levels compared to the reference category (not provided). All estimates are significant (p-values = 0), indicating that the level of education significantly influences the log odds of the event.

The estimates represent the log odds of the event for different employment statuses compared to the reference category (not provided). All estimates are significant (p-values = 0), suggesting that employment status significantly influences the log odds of the event. For every one-unit increase in Years of Smoking, the log odds of the event decrease by -1.4E+13. The p-value (0) indicates that the effect is highly significant. For every one-unit increase in Cigarettes Per Day, the log odds of the event decrease by -8.7E+12. The p-value (0) indicates that the effect is highly significant. For every one-unit increase in Waist Circumference, the log odds of the event increase by 1.5E+13. The p-value (0) indicates that the effect is highly significant.

The logistics regression analysis conducted to identify the significant predictors of asthma yielded a lot of positive insights. The significant predictors can be identified from Table 3 as those factors with extremely low p-values (< 0.001). From the analysis, the factors of age, BMI, smoking status, cooking fuels, educational level, and educational history are possible predictors of asthma. These findings align with existing research that suggested that current tobacco smoking and being underweight (BMI) were independent determinants of clinical asthma (Ozoh et al., 2019).

Article DOI: 10.52589/AJSTE-GA5AXYDB
DOI URL: https://doi.org/10.52589/AJSTE-GA5AXYDB

Research Question Three: What is the relationship between asthma and allergic rhinitis?

The results in Table 4 show the correlation coefficient between asthma and allergic rhinitis. The correlation coefficient of 0.25 suggests a positive correlation between asthma and allergic rhinitis. The extremely low p-value (2.2e-16) indicates that the observed correlation is highly unlikely to be due to random chance alone.

The results in Table 5 show the logistic regression analysis on the effect of allergic rhinitis. In this case, the intercept is -4.4337, and the p-value is less than 2e-16, indicating that the intercept significantly differs from zero. A one-unit increase in the "Allergic" variable is associated with an estimated increase in the log odds of asthma by 2.5879.

In line with existing research that suggests most patients with asthma have rhinitis present in them and similarities between the two occur (Bousquet et al., 2003). The findings from Table 4 and Table 5 suggest a positive correlation between asthma and allergic rhinitis among Nigerians which means the two conditions co-occur.

Research Question Four: What is the association between a family history of asthma and asthma and individual diagnoses?

The results in Table 6 show the result of the association between a family having asthma and being diagnosed with asthma. The p-value is extremely low, indicating strong evidence against the null hypothesis that no association exists between "Family suffers from asthma" and "Yes/No".

A family history of asthma is an important risk factor for asthma and familial risk assessments can help identify people at the highest risk for developing asthma in the USA (Bjerg et al., 2007). The finding of this study aligns with that of previous research by Bjerg et al., (2007). Which suggests an association between a family history of asthma and asthma. The very low p-value in Table 6 suggests a highly significant relationship between the two.

CONCLUSION

In conclusion, this study determined that asthma and allergic rhinitis tended to co-exist with the average age of individuals with asthma being 22 years and that of allergic rhinitis being 28 years, respectively. Furthermore, the analysis conducted also suggested possible predictors of asthma to be age, BMI, years of smoking, liquid petroleum gas, cigarettes per day, years of smoking, tobacco smoke, and level of education. Additionally, a significant relationship was observed between families experiencing asthma and individuals diagnosed with asthma.

Article DOI: 10.52589/AJSTE-GA5AXYDB
DOI URL: https://doi.org/10.52589/AJSTE-GA5AXYDB

REFERENCES

A.D.A.M. Medical Encyclopedia [Internet]. Johns Creek (GA): Ebix, Inc., A.D.A.M.; c1997-2020. Nail abnormalities; [updated 2019 July 31; reviewed 2019 Apr 16; cited 2020 Aug 30]; [about 4 p.]. Available from: https://medlineplus.gov/ency/article/000813.htm

Asher, M. I., Montefort, S., Björkstén, B., Lai, C., Strachan, D. P., Weiland, S. K., … & Williams, H. C. (2006). Worldwide time trends in the prevalence of symptoms of asthma, allergic rhinoconjunctivitis, and eczema in childhood: isaac phases one and three repeat multicountry cross-sectional surveys. The Lancet, 368(9537), 733-743. https://doi.org/10.1016/s0140-6736(06)69283-0

Awopeju, O. F., Erhabor GE, Agbroko SO, and Bamigboye P. (2015). Prevalence of Asthma Symptoms among University Students Aged 18-30 years in Southwest Nigeria. *Journal of Asthma*.

Ayuk, A. C., Eze, J. N., Edelu, B. O., and Oguonu, T. (2018). The Prevalence of Allergic Diseases among Children with Asthma: What is the Impact on Asthma Control in South East Nigeria. *Nigerian Journal of Clinical Practice, 21(5)*. DOI: 10.4103/njcp.njcp_343_17

Beasley, R., Semprini, A., & Mitchell, E. A. (2015). Risk factors for asthma: is prevention possible?. The Lancet, 386(9998), 1075-1085. https://doi.org/10.1016/s0140-6736(15)00156-7

Bjerg, A., Hedman, L., Perzanowski, M. S., Platts-Mills, T. A., Lundbäck, B., & Rönmark, E. (2007). Family history of asthma and atopy: in-depth analyses of the impact on asthma and wheeze in 7- to 8-year-old children. Pediatrics, 120(4), 741-748. https://doi.org/10.1542/peds.2006-3742

Björkstén B, Clayton T, Ellwood P, et al. (2008). ISAAC Phase III Study Group. Worldwide time trends for symptoms of rhinitis and conjunctivitis: phase III of the international study of asthma and allergies in childhood. *Pediatr Allergy Immunol*, 19(2):110–124. doi:10.1111/j.1399-3038.2007.00601.x

Bousquet, J., Vignola, A. M., & Demoly, P. (2003). Links between rhinitis and asthma. Allergy, 58(8), 691-706. https://doi.org/10.1034/j.1398-9995.2003.00105.x

Cockcroft, D. W. (2018). Environmental causes of asthma. Seminars in Respiratory and Critical Care Medicine, 39(01), 012-018. https://doi.org/10.1055/s-0037-1606219

Compalati, E., Ridolo, E., Passalacqua, G., Braido, F., Villa, E., & Canonica, G. W. (2010). The link between allergic rhinitis and asthma: the united airways disease. *Expert Review of Clinical Immunology*, *6*(3), 413–423. https://doi.org/10.1586/eci.10.15

Desalu, O.O., Onyedum, C.C., Makusidi, M.A., Adeoti, A.O., Sanya, E.O., Fadare, J.O., Isah, M.D., Aladesanmi, A., Ojuawo, O.B., and Opeyemi, C.M. (2019). Physical and Socioeconomic Impact of Asthma in Nigeria: Experience of Patients Attending Three Tertiary Hospitals. *Nigerian Journal of Clinical Practice, 22*(6), 855-861. DOI: 10.4103/njcp.njcp_294_18.

Krishna, M. T., Mahesh, P. A., Vedanthan, P., Moitra, S., Mehta, V., & Christopher, D. J. (2020). An appraisal of allergic disorders in India and an urgent call for action. World Allergy Organization Journal, 13(7), 100446. https://doi.org/10.1016/j.waojou.2020.100446

Linneberg, A., Nielsen, N., Frølund, L., Madsen, F., Dirksen, A., & Jørgensen, T. (2002). The link between allergic rhinitis and allergic asthma: a prospective population-based study. The

Article DOI: 10.52589/AJSTE-GA5AXYDB
DOI URL: https://doi.org/10.52589/AJSTE-GA5AXYDB

Copenhagen allergy study. Allergy, 57(11), 1048-1052. https://doi.org/10.1034/j.1398-9995.2002.23664.x

Pawankar R, Holgate ST, Canonical GW, et al., editors. *The WAO White Book on Allergy (Update 2013)*. Milwaukee (WI): White Book on Allergy; 2013. Available from: https://www.worldallergy.org/wao-white-book-on-allergy. Accessed October 6, 2021.

Soriano, J. B., Abajobir, A. A., Abate, K. H., Abera, S. F., Agrawal, A., Ahmed, M. B., … & Vos, T. (2017). Global, regional, and national deaths, prevalence, disability-adjusted life years, and years lived with disability for chronic obstructive pulmonary disease and asthma, 1990–2015: a systematic analysis for the global burden of disease study 2015. The Lancet Respiratory Medicine, 5(9), 691-706. https://doi.org/10.1016/s2213-2600(17)30293-x

Tang, M., Agrawal, P., & Jain, R. (2015). Habits vs environment. Proceedings of the ACM Web Science Conference. https://doi.org/10.1145/2786451.2786481

Toskala, E. and Kennedy, D. W. (2015). Asthma risk factors. International Forum of Allergy &Amp; Rhinology, 5(S1). https://doi.org/10.1002/alr.21557

Wiesch, D. G., Meyers, D. A., & Bleecker, E. R. (1999). Genetics of asthma☆☆☆★. Journal of Allergy and Clinical Immunology, 104(5), 895-901. https://doi.org/10.1016/s0091-6749(99)70065-5

Article DOI: 10.52589/AJSTE-GA5AXYDB
DOI URL: https://doi.org/10.52589/AJSTE-GA5AXYDB