Predictors of Adherence and Asthma Control in Two Federal Teaching Hospitals in Nigeria

Kosisochi C. Amorha, Mathew J. Okonta† and Chinwe V. Ukwe

Department of Clinical Pharmacy and Pharmacy Management, Faculty of Pharmaceutical Sciences, University of Nigeria, Nsukka, PMB 410001, Enugu State, Nigeria

ABSTRACT: Asthma is a common chronic disease in developing countries. The main objective of the study was to provide insights into adherence and asthma control predictors in two federal teaching hospitals in Nigeria, using validated instruments. For the data analysis, the level of statistical significance was set as $p < 0.05$. Seventy-eight patients with asthma provided consent for study participation. Every time domestic fuel was utilized at home, asthma control decreased by 1.246 units, $p = 0.029$. Every time an asthma patient utilized one of the hospitals which did not have a separate Asthma Clinic, adherence decreased by 1.483 units, $p < 0.001$. The study reveals the need for patients with asthma to minimize the use of domestic fuel. Renewable energy sources could be considered. A separate Asthma Clinic can provide ample time for asthma reviews.

Key words: Adherence; Asthma; Asthma Control; Pharmacists; Predictors

INTRODUCTION

More individuals have been diagnosed with asthma in developing countries, especially among urban populations.[1] Asthma affects both children and adults.[2] About 13 million persons have clinical asthma in Nigeria, making it an important public health disease.[3] Common asthma symptoms are difficulty in breathing, wheeze, cough and chest tightness.[4] These symptoms present differently, varying in frequency and intensity.[5] Poorly controlled asthma can lead to poor quality of life, economic burden to patients and the healthcare system, even death.[6] The management of asthma should comprise early identification of asthma triggers, avoidance of these asthma triggers, use of asthma action plans, rational use of asthma medications and other drugs, including correct inhaler techniques, self-monitoring of asthma symptoms, self-monitoring with the peak flow meter, regular review of asthma control by a healthcare provider.[5,7]

A well-controlled asthma patient can lead a normal life.[8] The Asthma Control Test (ACT™) and Asthma Control Questionnaire (ACQ) are examples of numerical tools for assessing symptom control in asthma.[5] Patients with well-controlled asthma would have no daytime or night symptoms of asthma, no limitation of activity, minimal need for reliever medications, no exacerbations, normal lung function, minimal side effects from the use of their asthma medications.[5] To optimize the benefits of therapy, adherence to a medication regimen is key.[9] Asthma exacerbations are reduced with improved adherence.[10] The burden from asthma, in terms of morbidity and mortality, is higher when there is poor self-management of the disease.[11] There is need for more studies, conducted in African settings, to provide insights into the possible factors that influence adherence to therapies for the management of asthma and asthma control. Considering the high number of patients diagnosed with clinical asthma in the country, more evidence to improve asthma management is needed. This pharmacist-led intervention study focused on providing insights into adherence and asthma control predictors in two Nigerian teaching hospitals.

Correspondence to: Dr. Kosisochi Chinwendu Amorha
Phone Number: +2348038539349
Email: kosisochi.amorha@unn.edu.ng
†Deceased.

METHODS

Research design/setting. This study was conducted in two Nigerian federal teaching hospitals: Lagos University Teaching Hospital (LUTH) and University of Nigeria Teaching Hospital (UNTH). LUTH and UNTH are located in Lagos State and Enugu State, respectively. It was a cross-sectional study (March 2016 through September 2017).

The Asthma Clinic of LUTH holds on Wednesdays. However, they also run a general Respiratory Clinic on Mondays. In UNTH, there is no specific asthma clinic but a general Respiratory Clinic on Tuesdays where patients with asthma are seen. Consultant Pulmonologists led the teams in both hospitals. They were supported by other Physicians: Senior Registrars, Junior Registrars, House Officers. Matrons, Nurses, Medical Record Officers and support staff of other disciplines were in separate offices from the consulting rooms of the physicians. For the duration of the study, Pharmacists who were members of staff of the hospitals were never in the Asthma Clinics. The only Pharmacists in the Clinics were the Pharmacist researchers.

Inclusion/exclusion criteria. Patients that were eligible for participation in the study included those: diagnosed asthmatic by a physician, who had no respiratory comorbidity, who were ≥ 16 years old, who could speak and write in English language, who agreed to receive text messages and phone calls related to the study, who agreed to complete multiple questionnaires. Patients with mental-related disorders, those who were pregnant or lactating were excluded.

Ethical approval. The authors received approval from the ethical committees (LUTH and UNTH), to proceed with the study. Informed consent for participation, oral and written, was obtained from the patients.

Sample size and selection. Few patients regularly attended the Asthma Clinics for reasons ranging from forgetfulness, busy work schedules, financial constraints, lack of discomforting symptoms of asthma. The sample size was not calculated. Rather, the study was time-driven with patients recruited within 12 months. Only patients who provided consent for participation and met the eligibility criteria, participated in the study.

Data collection. The two validated study instruments were the Asthma Control Test (ACT[TM]) and 8-item Morisky Medication Adherence Scale (MMAS-8-Item). The ACT[TM] instrument has five items, with 'five' as the highest score and 'one' as the lowest score for each item. Thus, the highest possible score is 25 while the lowest possible score is 'five'. Higher overall counts indicated greater asthma control. A score of 25 represented perfectly-controlled asthma. Well-controlled asthma referred to ACT[TM] score above 19. The instrument utilizes a four-week recall. It was developed and validated by GlaxoSmithKline.[12]

The adherence tool utilized in this study was an improvement of the original 4-item Morisky scale.[13-16] Only the last item was Likert-scaled (five-point), as other items of the MMAS-8-Item have either 'yes' or 'no' options. The adherence scores were categorized as high (8), medium (6, 7), or low adherence (0, 1, 2, 3, 4, 5). [13-15] The authors sought and received permission to use the adherence tool.

Analysis of data. Data analysis was conducted with SPSS tool (Version 25). Descriptive statistics such as mean, frequencies, percentages, standard deviation, were utilized. Pearson's Chi-Square test was used to test the association between variables. Multiple linear regression was used to predict adherence and asthma control. Statistical significance was set as P-values less than 0.05. The instructions for scoring both instruments were used for the categorization of adherence and asthma control.[12-15]

RESULTS AND DISCUSSION

Seventy-eight patients with asthma, 39 from each hospital, were recruited in the study, based on eligibility. The ratio of females to males who participated in the study was 1.6:1. The ratio of females to males in UNTH was 2: 1. Almost four-fifths (79.5%) of the participants utilized kerosene stoves for cooking, kerosene lanterns for lighting, or generator sets for electricity. Only a tenth (10.3%) of

the participants reported that they were previously trained on the use of peak flow meters. More patients with asthma who were between 20 to 29 years old (17.9%) were receiving care in UNTH compared to those in LUTH (5.1%), $\chi^2 = 27.106$, df = 6, p < 0.001 (Table 1). More patients in UNTH reported that there were no restrictions on their activities at home, school, or work due to asthma, LUTH – 46.2%, UNTH - 61.5%. After categorization into poorly-controlled asthma and well-controlled asthma, 76.9% of patients in UNTH had well-controlled asthma compared to 69.2% in LUTH (Table 2).

Table 1. Demographic details, N = 234.[25]

Variables	Hospital 1	Hospital 2	Total	χ^2	P
Age (in years)				27.106	* < 0.001
16-19	9 (7.7)	15 (12.8)	24 (10.3)		
20-29	6 (5.1)	21 (17.9)	27 (11.5)		
30-39	15 (12.8)	18 (15.4)	33 (14.1)		
40-49	15 (12.8)	15 (12.8)	30 (12.8)		
50-59	42 (35.9)	30 (25.6)	72 (30.8)		
60-69	9 (7.7)	15 (12.8)	24 (10.3)		
≥ 70	21 (17.9)	3 (2.6)	24 (10.3)		
Gender				2.600	0.107
Female	66 (56.4)	78 (66.7)	144 (61.5)		
Male	51 (43.6)	39 (33.3)	90 (38.5)		
Home Domestic Fuel Use				0.944	0.331
Yes	96 (82.1)	90 (76.9)	186 (79.5)		
No	21 (17.9)	27 (23.1)	48 (20.5)		
Economic Status				23.194	* < 0.001
LC	3 (2.6)	3 (2.6)	6 (2.6)		
MC	111 (94.9)	90 (76.9)	201 (85.9)		
UC	3 (2.6)	3 (2.6)	6 (2.6)		
I won't say	0 (0.0)	21 (17.9)	21 (9.0)		
Previous Training on Use of Peak Flow Meter				1.671	0.196
Yes	9 (7.7)	15 (12.8)	24 (10.3)		
No	108 (92.3)	102 (87.2)	210 (89.7)		
History of Cigarette Smoking				3.162	0.075
Yes	3 (2.6)	9 (7.7)	12 (5.1)		
No	114 (97.4)	108 (92.3)	222 (94.9)		
Education Level				12.689	* 0.005
Post-SSCE	72 (61.5)	66 (56.4)	138 (59.0)		
SSCE	45 (38.5)	39 (33.3)	84 (35.9)		
FSLC	0 (0.0)	9 (7.7)	9 (3.8)		
No Formal Education	0 (0.0)	3 (2.6)	3 (1.3)		
Occupation				43.649	* < 0.001
Civil Servant	12 (10.3)	39 (33.3)	51 (21.8)		
Health Worker	6 (5.1)	3 (2.6)	9 (3.8)		
Self-employed	39 (33.3)	18 (15.4)	57 (24.4)		
Unemployed	6 (5.1)	3 (2.6)	9 (3.8)		
Private Company	9 (7.7)	9 (7.7)	18 (7.7)		
Retiree	24 (20.5)	9 (7.7)	33 (14.1)		
Student	12 (10.3)	33 (28.2)	45 (19.2)		
Engineer	9 (7.7)	3 (2.6)	12 (5.1)		

* p < 0.05; N = number of physical contacts; Hospital 1 = LUTH; Hospital 2 = UNTH; LC = Low Class (< NGN 50,000); MC = Middle Class (NGN 50,000 – NGN 250,000); UC = Upper Class (> NGN 250,000). As of the time the study was conducted, exchange rates ranged between: $1 = NGN 199 (March 2016) and $1 = NGN 361 (September 2017). Classification into different economic classes was done by the authors, based on perceived purchasing power.

A larger percentage of patients in UNTH (35.9%) reported forgetfulness in taking their medications compared to their LUTH counterparts (15.4%). There was medium or high adherence among 56.4% and 84.6% of patients with asthma in UNTH and LUTH, respectively (Table 3).

The use of domestic fuel was a significant predictor of poor asthma control. Every time domestic fuel was utilized at home, asthma control decreased by 1.246 units, P = 0.029. The hospital site was a significant predictor for adherence. Every time an asthma patient utilized UNTH, adherence decreased by 1.483 units, p < 0.001 (Table 4).

Table 2. Asthma control test, at 6 months.

Items	Responses		Responses		Responses		Responses		Responses	
	LUTH n (%)	UNTH n (%)	LUTH n (%)	UNTH n (%)	LUTH n (%)	UNTH n (%)	LUTH n (%)	UNTH n (%)	LUTH n (%)	UNTH n (%)
S1	All of the time		Most of the time		Some of the time		A little of the time		None of the time	
	0 (0.0)	0 (0.0)	1 (2.6)	1 (2.6)	9 (23.1)	5 (12.8)	11 (28.2)	9 (23.1)	18 (46.2)	24 (61.5)
S2	More than once a day		Only once a day		3 - 6 times per week		Not more than twice per week		Never	
	0 (0.0)	0 (0.0)	0 (0.00)	2 (7.7)	5 (12.8)	3 (7.7)	19 (48.7)	19 (48.7)	15 (38.5)	15 (38.5)
S3	≥ 4 nights per week		2 or 3 nights per week		Once-a-week		Once or twice		Never	
	0 (0.0)	0 (0.0)	0 (0.0)	2 (7.7)	9 (23.1)	7 (18.0)	12 (30.8)	20 (51.3)	18 (46.2)	10 (25.6)
S4	≥ 3 times per day		Not > 2 times per day		2 or 3 times per week		Not > once a week		Never	
	0 (0.0)	0 (0.0)	2 (7.7)	4 (10.3)	10 (25.6)	4 (10.3)	13 (33.3)	11 (28.2)	14 (35.9)	20 (51.3)
S5	zero control		Poorly-controlled		Somewhat-controlled		Well-controlled		100% controlled	
	0 (0.0)	0 (0.0)	1 (2.6)	0 (0.0)	7 (18.0)	8 (20.5)	22 (56.4)	26 (66.7)	9 (23.1)	5 (12.8)

All items had a four-week recall

Well-controlled asthma implied an ACT[TM] score of 20 – 25. After categorization into poorly-controlled asthma and well-controlled asthma, the proportion of patients with well-controlled asthma in UNTH and LUTH was 76.9% and 69.2%, respectively.

S1 – The number of times asthma has caused limitation of activities

S2 – The number of times I have had difficulty in breathing

S3 – The number of times my asthma symptoms have woken me before the usual time in the morning or at night

S4 – The number of times I have used my rescue inhaler or nebulizer medication

S5 – My level of asthma control

This study revealed that domestic fuel use and hospital site were significant predictors for asthma control and adherence, respectively. The patients with asthma who participated in this study were mostly females. It is assumed that there is a connection between the female sex hormones and asthma development with the prevalence and severity of asthma being higher in adult females.[17] Nonallergic asthma is more common in females.[18] There is less severe morbidity, hospital visits,

hospitalizations, and death rates among male patients with asthma.[19]

Domestic fuel comprised the use of kerosene, diesel, fuel for stoves, lanterns and generator sets. Most of the participants reported utilizing at least one of these domestic fuels. The erratic power supply in most parts of Nigeria makes the use of generator sets almost inevitable, as it is the main source of energy in some areas.

Few patients were conversant with monitoring their peak flow. Self-monitoring of peak expiratory flow rates may be an objective means of monitoring response to therapy, identifying asthma triggers, and adhering to the written asthma action plan.[5] All patients who participated in this study were provided peak flow meters, free of charge, and taught how to use the instrument. This was one of the highlights of the research.

Table 3. Adherence at 6 months.

Variables	6 MONTHS	
	LUTH Yes (%)	UNTH Yes (%)
1st Item	6 (15.4)	14 (35.9)
2nd Item	4 (10.3)	12 (30.8)
3rd Item	6 (15.4)	9 (23.1)
4th Item	2 (5.1)	14 (33.3)
5th Item	33 (84.6)	31 (79.5)
6th Item	10 (25.6)	17 (43.6)
7th Item	7 (17.9)	15 (38.5)
8th Item		
Never/Rarely	22 (56.4)	0 (0.0)
Once in a while	11 (28.2)	14 (35.9)
Sometimes	5 (12.8)	11 (28.2)
Usually	1 (2.6)	0 (0.0)
All the time	0 (0.0)	0 (0.0)

After categorization of the adherence scores: Score of '8' = high adherence; Score of '6' or '7' = medium adherence; Scores of '0', '1', '2', '3', '4', or '5' = low adherence. More patients reported medium/high adherence in LUTH (84.6%) as compared to their UNTH counterparts (56.4%).

Item 1 – I forget to take my asthma medication(s), sometimes

Item 2 – There were days when I did not take my asthma medication(s), in the past two weeks

Item 3 – I have previously cut back or stopped taking my medication(s) (because I felt worse when I took it), without telling my physician

Item 4 – Sometimes, when I travel or leave my home, I forget to bring along my asthma medication(s)

Item 5 – I took my asthma medication(s) yesterday

Item 6 – Sometimes, when I feel like my asthma is under control, I stop taking my medication(s)

Item 7 – Sometimes, I struggle to stick to my asthma plan

Item 8 – The number of times I find it difficult to remember to take all my medication(s)

Table 4. Predictors of asthma control and adherence, N = 234.

Variables	Unstandardized coefficient (B)		Unstandardized coefficient (S.E.)		Standardized coefficient (Beta)		t		P-value	
	Asthma control	Adherence	Asthma control	Adherence	Asthma control	Adherence	Asthma control	Adherence	Asthma control	Adherence
Constant	21.869	9.855	1.879	1.178			11.641	8.366	< 0.001	< 0.001
Site	0.067	-1.483	0.461	0.289	0.009	-0.322	0.145	-5.133	0.885	< 0.001*
Gender	-0.681	-0.255	0.472	0.296	-0.094	-0.054	-1.443	-0.864	0.150	0.389
Home domestic fuel use	-1.246	-0.317	0.568	0.356	0.143	-0.056	2.195	-0.891	0.029*	0.374
Prior peak Flow meter use	-1.315	-0.631	0.755	0.474	-0.113	-0.083	-1.741	-1.332	0.083	0.184

Asthma Control: $R = 0.204$; $R^2 = 0.042$; Adjusted $R^2 = 0.025$; $F_{(4, 229)} = 2.483$, $p = 0.045$.

Adherence: $R = 0.344$; $R^2 = 0.118$; Adjusted $R^2 = 0.103$; $F_{(4, 229)} = 7.693$, $p < 0.001$ *$p < 0.05$.

More patients in UNTH reported better asthma control than their LUTH counterparts. The use of domestic fuel was a significant predictor of poor asthma control. Every time domestic fuel was utilized at home, asthma control decreased. In developing countries, homes are laden with air pollutants.[20] The factors that influence the association of urbanization with geographical differences in asthma prevalence in low- and middle-income countries (LMICs) are poorly understood[1]. Lagos, the commercial capital of Nigeria, has a high level of urbanization and pollution compared to other Nigerian cities.[3] LUTH, located in Lagos Mainland, has a bulk of her patients from the bustling city.

An erratic power supply supports the use of generator sets by numerous families. The fumes from different exhausts, sometimes, find their way into the homes of unsuspecting citizens, including asthmatics. Generator sets are a common source of air pollution in Lagos State, the commercial capital of Nigeria, and account for up to half of the State's total energy demand.[21] There are documented cases of families losing loved ones from the inhalation of toxic fumes from their indoor generator.[22] Poor roads, under-utilized waterways, lack of a metro system for a city that has more than 20 million occupants could be responsible for commuters, including asthmatic patients, getting stuck in traffic for hours, inhaling polluted air.[22] In 2018, Lagos State was estimated to have lost $2.1 billion attributed to air pollution, representing 2.1% of the State's Gross Domestic Product.[21] Indoor and outdoor allergens worsen the symptoms of asthma.[23]

There were more medium/highly adherent asthmatic patients in LUTH than in UNTH. The hospital site was a significant predictor for adherence. Every time an asthma patient utilized UNTH, adherence decreased. Both LUTH and UNTH had similarities in practice. They are both reputable federal tertiary teaching hospitals in Nigeria with highly qualified health professionals. The major difference was the separate Asthma Clinic Day that held weekly (on Wednesdays) in LUTH.

Patients with asthma were specifically reviewed on Asthma Clinic Days, besides the general Respiratory Clinic Days that held on Mondays. However, in UNTH, there was no specified Asthma Clinic Day, such that all patients with respiratory illnesses were only attended to during consultation hours on Tuesdays. It is expected that hospitals would provide support to promote adherence to medications since poor adherence to medications increases the number and length of hospitalizations.[24] On Asthma Clinic Days, more focus is given to asthmatic patients, with the opportunity to promote adherence and proper use of inhaler devices.

This study was conducted in two teaching hospitals in Southern Nigeria and findings might not reflect what is obtainable in other hospitals or settings. Few patients showed up for their asthma review and this reflected in the number of participants.

CONCLUSION

The study reveals the need for patients with asthma to minimize the use of domestic fuel. Renewable energy sources could be considered. In addition, differences in hospital practices can influence adherence. A separate Asthma Clinic can provide ample time for asthma reviews.

ACKNOWLEDGEMENTS

COMPETING INTERESTS

The authors have no competing interests.

REFERENCES

1. Rodriguez, A., Brickley, E., Rodrigues L, Normansell, R.A., Barreto, M. and Cooper, P.J. 2019. Urbanisation and asthma in low-income and middle-income countries: a systematic review of the urban-rural differences in asthma prevalence. *Thorax*. **74**, 1020-1030.

2. Dharmage, S.C., Perret, J.L. and Custovic, A. 2019. Epidemiology of asthma in children and adults. *Front Pediatr*. **7**, 246.

3. Ozoh, O.B., Aderibigbe, S.A., Ayuk, A.C., Desalu, O.O., Oridota, O.E., Olufemi, O., Egbagbe, E., Babashani, M., Shopeyin, A., Ukwaja, K. and Dede, S.K. 2019. The prevalence of asthma and allergic rhinitis in Nigeria: A nationwide survey among children, adolescents and adults. *PLoS One*. **14**, e0222281.

4. Gherasim, A., Dao, A. and Bernstein, J.A. 2018. Confounders of severe asthma: diagnoses to consider when asthma symptoms persist despite optimal therapy. *World Allergy Organ J*. **11**, 29.

5. Global Initiative for Asthma (GINA). Global Strategy for Asthma Management and Prevention, 2021. Available from: https://www.ginasthma.org (Accessed 18 October, 2021).

6. Gosavi, S., Nadig, P. and Haran, A. 2016. Factors contributing towards poor asthma control in patients on regular medication. *J. Clin. Diagn. Res*. **10**, OC31-OC35.

7. Quirt, J., Hildebrand, K.J., Mazza, J., Noya, F. and Kim, H. 2018. Asthma. *Allergy Asthma Clin Immunol*. **14**, 50.

8. Rees, J. 2006. Asthma control in adults. *Br. Med. J*. **332**, 767-771.

9. Basharat, S., Jabeen, U., Zeeshan, F., Bano, I., Bari, A. and Rathore, A.W. 2018. Adherence to asthma treatment and their association with asthma control in children. *J. Pak. Med. Assoc*. **68**, 725-728.

10. Engelkes, M., Janssens, H.M., de Jongste, J.C., Sturkenboom, M.C.J.M., Verhamme, K.M.C. 2015. Medication adherence and the risk of severe asthma exacerbations: a systematic review. *Eur. Respir. J*. **45**, 396-407.

11. Eakin, M.N. and Rand, C.S. 2012. Improving patient adherence with asthma self-management practices: what works? *Ann Allergy Asthma Immunol*. **109**, 90-92.

12. GlaxoSmithKline (GSK). Asthma control test. Available from: https://www.asthmacontroltest.com (Accessed 18 October, 2021).

13. Morisky, D.E., Ang, A., Krousel-Wood, M. and Ward, H. 2008. Predictive validity of a medication adherence measure for hypertension control. *J. Clin. Hypertens*. **10**, 348-354.

14. Krousel-Wood, M.A., Islam, T., Webber, L.S., Re, R.S., Morisky, D.E. and Muntner, P. 2009. New medication adherence scale versus pharmacy fill rates in seniors with hypertension. *Am. J. Manag. Care*. **15**, 59-66.

15. Morisky, D.E. and DiMatteo, M.R. 2011. Improving the measurement of self-reported medication nonadherence: Final response. *J. Clin. Epidemio*. **64**, 258-263.

16. Morisky, D.E., Green, L.W. and Levine, D.M. 1986. Concurrent and predictive validity of a self-reported measure of medication adherence. *Med. Care*. **24**, 67-74.

17. Koper, I., Hufnagl, K., and Ehmann, R. 2017. Gender aspects and influence of hormones on bronchial asthma – Secondary publication and update. *World Allergy Organ*. **10**, 46.

18. Leynaert, B., Sunyer, J., Garcia-Esteban, R., Svanes, C., Jarvis, D., Cerveri, I., Dratva, J., Gislason, T., Heinrich, J., Janson, C., Kuenzli, N., de Marco, R., Omenaas, E., Raherison, C., Real, F. G., Wjst, M., Zemp, E., Zureik, M., Burney, P.G.J., Anto, J.M. and Neukirch, F. 2012. Gender differences in prevalence, diagnosis and incidence of allergic and non-allergic asthma: a population-based cohort. *Thorax*. **67**, 625-631.

19. Tam, A., Morrish, D., Wadsworth, S., Dorscheid, D., Man, S.F. and Sin, D.D. 2011. The role of female hormones on lung function in chronic lung diseases. *BMC Womens Health*. **11**, 24.

20. Dutt, D., Srinivasa, D.K., Rotti, S.B., Sahai, A. and Konar, D. 1996. Effect of indoor air pollution on the respiratory system of women using different fuels for cooking in an urban slum of Pondicherry. *Natl Med J India*. **9**, 113-117.

21. The World Bank. The cost of air pollution in Lagos. 7 Sept 2020. Available from: https://www.worldbank.org/en/topic/environment/publication/the-cost-of-air-pollution-in-lagos (Accessed 18 October, 2021).

22. Egbejule, E. Choking on your commute: How air pollution is strangling Lagos. The Guardian. 18 Dec 2015. Available from: https://www.theguardian.com/global-development-professionals-network/2015/dec/18/choking-on-your-commute-how-air-pollution-is-strangling-lagos (Accessed 18 October, 2021)

23. Balmes, J.R., Cisternas, M., Quinlan, P.J., Trupin, L., Lurmann, F.W., Katz, P.P. and Blanc, P.D. 2014. Annual average ambient particulate matter exposure estimates, measured home particulate matter, and hair nicotine are associated with respiratory outcomes in adults with asthma. *Environ. Res*. **129**, 1-10.

24. Mongkhon, P., Ashcroft, D.M., Scholfield, N. and Kongkaew, C. 2018. Hospital admissions associated with medication non-adherence: a systematic review of prospective observational studies. *BMJ Quality & Safety*. **27**, 902-914.

25. Amorha, K.C., Okonta, M.J. and Ukwe, C.V. 2020. Impact of pharmacist-led educational interventions on asthma control and adherence: single-blind, randomised clinical trial. *Int J Clin Pharm*. https://doi.org/10.1007/s11096-020-01187-x.