RESEARCH ARTICLE

Characteristics of Patients with Asthma and Asthma Control: A Retrospective Analysis of Reported Data from Primary Healthcare Centers in Agadir city, Morocco (2013 - 2019)

Youssef Bouchriti [1,2*], Oumaima Elghazali [3], Ahmed Kharbach [4], Hicham Gougueni [2], Mohamed Ait Haddou [2], Abderrahmane Achbani [5]

[1] High Institute of Nursing and Technical Health, Agadir, Morocco

[2] Applied Geosciences and Environment Team, Faculty of Agadir Sciences, IBN ZOHR University, Agadir, Morocco

[3] Faculty of Letters and Human Sciences, Mohammed V University, Rabat, Morocco

[4] Laboratory of Biostatistics, Clinical Research and Epidemiology (LBRCE), Faculty of Medicine and Pharmacy, Mohammed V University, Rabat, Morocco

[5] Laboratory of Cell Biology and molecular genetics, Department of Biology, Faculty of Agadir Sciences, IBN ZOHR University, Agadir, Morocco

ABSTRACT

The study aims to describe the profile of asthma patients in Agadir city (Morocco) during a period of 7 years (2013 to 2019) to identify the factors associated with asthma control. Practically, a retrospective analysis was conducted on data collected from 6 primary healthcare centers (PHC) in the city. The reported data are the age, gender, location, date of first consultation, dates of consultations, and treatment of 701 patients and care centers (PHC). Also, the proportional odds model for ordinal logistic regression was used to determine the most variables can be associated with asthma control. The analysis reveals a spatial and temporal variation according to gender. The average age of patients is 43 years. The two-thirds of all recorded cases were reported in 2018 and 2019. Furthermore, the proportion of female and male represents 63% and 37% of the total reported cases, respectively. Generally, the female proportion is higher than male for all age groups. Moreover, the analysis reveals that the asthma control was reported for 19% of cases while the rest was uncontrolled. This control seems be more observed for males (OR: 1.28; 95% CI [0.87; 1.87]), for patients with age between 29 and 44 years (OR: 2.3; 95% CI [1.54; 3.44], p < 0. 001), and for patients who were cared for at the PHC1 center (OR: 21.06; 95% CI [11.13; 39.85], p < 0.001) and at the PHC2 center (OR: 13.19; 95% CI [6.54; 29.54], p < 0.001). Eventually, the current study emphasizes that the gender and care centers are the most associated factors of asthma control.

Keywords: asthma control, epidemiology, retrospective analysis, ordinal logistic regression, associated factors

Correspondence:

Youssef Bouchriti

Address: High Institute of Nursing and Technical Health, Agadir, Morocco and Applied Geosciences and Environment Team, Faculty of Agadir Sciences, IBN ZOHR University, Agadir, Morocco

Email: youssef.bouchriti@gmail.com

INTRODUCTION

Asthma considered as a chronic inflammatory disease of the airways that results in symptoms related to diffuse, variable, and reversible obstruction, either spontaneously or under treatment [1]. Asthma most often begins early in life and presents variable evolutions and unstable phenotypes that can progress or regress over time [2]. Also, it is under-diagnosed and under-treated kills about 1000 people every day and affects up to 339 million people, and its prevalence is increasing [3,4]. Generally, the World Health Organization (WHO) considers the asthma as a real public health problem.

The asthma prevalence is variable worldwide and have been assessed using various international assessment scale. Commonly, the two largest global asthma assessments are the International Study of Asthma and Allergy in Children (ISAAC) and the European Community Respiratory Health Survey (ECRHS). The ISAAC project is the most comprehensive international survey of asthma symptoms [5]. The global prevalence for ISAAC phase III is between 2.1% and 32.2% [6], while it is between 2.0% and 11.9% (stage 1) and 1.2% and 13.0% (stage 2) for ECRHS [7].

The Eastern Mediterranean Region Office of WHO has inadequate research and data for asthma [8]. Besides, more than 80%

of asthma-related deaths occur in low-and middle-income countries [9], as in North African countries (e.g. Morocco). In this context, the Moroccan government develops referral centers of care for the population, especially the poor ones, which called the primary health care centers (PHC).

Generally, it has no national guidelines for asthma treatment in Morocco. However, according to Health Ministry, the doctors working in PHC are asked to follow the guidelines of the Global Initiative for Asthma (GINA) [10], which include emergency medication, depending on the patient's age and asthma symptoms, and control treatment.

In fact, several studies based on ISAAC project confirmed a trend upwards of the national asthma prevalence since 1986. The prevalence percentage reported is between 5.5 and 14.4 for the year 1986 [11], between 5.2 and 10.0 for 1998 [12] and between 6.4 and 16.2 for 2006 [13]. According to the "Asthma Insights and Reality in the Maghreb (AIRMAG)" study, the prevalence percentage reported in Morocco for the year 2009 is about 4.4% [IC95% 3.5 -5.3] for children under 16 years (3.7 % of the general population) [14,15]. The 12-month prevalence of wheezing for children 13-14 year old is 9.9% in Casablanca, 5.6% in Marrakech, and 6.8% in Rabat. Furthermore, most recent statistic studies reveal a relatively high prevalence of asthma for Moroccan children and poor control for the symptoms [17] reported that the asthma prevalence in Morocco is 10-20%.

Generally, research conducted in Morocco reveal that the reported data were collected from hospital departments not from PHCs. The only study that reported data from primary health care centers was that of the city of Casablanca in 1999. However, until now, no study was conducted to determine the prevalence of asthma in Agadir city.

The Agadir city, located in the south of Morocco and characterized by arid climate. The daily temperature can reach 46°C in July and can go down to 1°C in January. The average of the minima is 13.16°C and the maxima is 24.6°C. The yearly precipitation varies from 244 to 500 mm. The rainy season extends from November to April. The population density in the city is more or less and the essential economic activity is the agri-food industry in addition to tourism [16].

The present study reports a retrospective analysis to describe the characteristics and control of asthma in Agadir city.

METHOD

Study Design

The study represents a retrospective analysis of asthma cases reported in PHC multicenter at Agadir. The data collection operation started from the first week of October 2018 to the end of May 2019. The collected data are asthma patient's records, including the age, gender, location, date of first consultation, dates of consultations, and treatment of 813 patients from 15 care centers (PHC). The records with missing variables or imprecise information were excluded. For this reason, only 701 patient's files collected from 6 PHC were used for the analysis. For information, no ethical approval was required for this study.

Statistical Analysis

The data were inserted in a spreadsheet and analyzed using Epi Info™ software version 7.2 [17]. Categorical variables are described by absolute and relative frequency, and continuous variables by the mean and standard deviation. The Wilson score method was adopted for calculating 95% confidence intervals of the proportions.

The variables considered for the study, which can be associated with asthma control levels are determined by the proportional odds model for ordinal logistic regression using R software [18].

RESULTS

The asthma control records reveal that 135 (19.26%) and 566 (80.74%) of patients had respectively controlled and uncontrolled asthma symptoms (**Table 1**). Due to the imprecise medicament information prescribed to patients we excluded the treatment variable in this study.

Characteristics of Patients with Asthma

Distribution of PHC-reported asthma cases by variables

From 2013 to 2019, there were an irregularity in the number of cases reported at each PHC. In 2018 and 2019, the reported cases represent approximately 2/3 of all cases (66.06%) (**Table 1**).

In fact, the evolution of the cases reported to each PHC over the years indicates inexistence of a common model (**Table 2**). For PHC1, from 2013 to 2017 there was an increasing number of cases with a peak in 2017, while for the period 2017-2019 there was a decreasing number of cases. For PHC4, from 2014 to 2016 there was a decreasing trend (peak in 2014), a slight increase for the period 2016-2017, and a strong increase for the period 2017-2018. For PHC5, from 2013 to 2015 there was an increasing number of cases (peak in 2015), while the reported cases were very few for the period 2015-2018. Furthermore, the asthma prevalence for the period 2013-2019 is between 0.01% and 0.11% (**Table 2**).

Also, the proportion of female cases is 63% compared to male cases which represent 37%. The gender ratio of females to males is 1.7. It has been found that for all four age groups distributed by quartile, the proportion of female cases is higher than males.

Moreover, the mean age is 43 year with a range of 3 to 94 years, where the standard deviation is 19 years and the mode is 59 year. The average age by gender is 43 and 44 for females and males, respectively. This difference is not statically significant. However, the average ages per PHC and asthma control are statistically different (**Table 3**).

Table 1. Distribution of asthma cases reported by PHCs according to the variables in the study

Variable / modalities	Absolute frequency (relative frequency in %) n = 701	LCL-UCL (*) Wilson 95%
Year		
2013	17 (2.43)	1.52-3.58
2014	77 (10.98)	8.88-13.52
2015	66 (9.42)	7.47-11.80
2016	20 (2.85)	1.85-4.37
2017	58 (8.27)	6.45-10.55
2018	349 (49.79)	46.10-53.48
2019	114 (16.26)	13.72-19.18
PHC**		
PHC1	61 (8.70)	6.83-11.02
PHC2	42 (5.99)	4.46-8.00
PHC3	31 (4.42)	3.13-6.21
PHC4	145 (20.68)	17.85-23.84
PHC5	76 (10.84)	8.75-13.36
PHC6	346 (49.36)	45.67-53.05
Gender		
Female	443 (63.02)	59.59-66.68
Male	258 (36.80)	33.32-40.44
Age (years)		
3-28	179 (25.53) F : 107 (58.78), M : 72 (40.22)	22.45-28.89
29 - 44	173 (24.68) F : 121 (69.94), M : 52 (30.06)	21.63-28.00
45-58	174 (24.82) F : 111 (63.79), M : 63 (36.21)	21.77-28.15
59-94	175 (24.96) F : 104 (59.43), M : 71 (40.57)	21.90-28.30
First consultation		
1st trimester	318 (45.36)	41.71-49.06
2nd trimester	100 (14.27)	11.87-17.05
3rd trimester	106 (15.12)	12.66-17.96
4th trimester	177 (25.25)	22.17-28.59
Asthma control		
Controlled	135 (19.26)	16.51-22.34
Uncontrolled	566 (80.74)	77.66-83.49

* LCL : Lower Confidence Limits , UCL : Upper Confidence Limits

**: PHC1: Bensargao, PHC2: Bouargane, PHC3: Essalam, PHC4: Ihchach, PHC5: Talborjt, PHC6: CDTMR

Table 2. Evolution by year of reported cases of asthma by PHCs and asthma prevalence, Agadir, Morocco, n = 701, 2013-2019

PHC/année	2013	2014	2015	2016	2017	2018	2019	Total
PHC1	3	10	5	0	36	7	0	61
PHC2	0	0	0	0	0	42	0	42
PHC3	0	0	0	0	0	17	14	31
PHC4	0	46	27	17	19	36	0	145
PHC5	14	21	34	3	3	1	0	16
PHC6	0	0	0	0	0	246	100	346
Total	17	77	66	20	58	349	114	701
Prévalence%	0.01	0.02	0.02	0.01	0.02	0.11	0.03	-

Table 3. Means of age cross-tabulate by gender, PHC and control, and p-value Kruskal-Wallis Test, n =701, Agadir, Morocco, 2013-2019

	Nombre	Mean	Variance	Standard deviation	Kruskal-Wallis Test p-value
Age * gender					0.6230
F	443	42.97	341.9	18.49	
M	258	43.81	421.76	20.54	
Age * PHC					**0.0001***
PHC1	61	40.72	214.67	14.65	
PHC2	42	32.26	270.73	16.45	
PHC3	31	37.39	246.91	15.71	
PHC4	145	39.02	451.01	21.24	
PHC5	76	35.97	335.07	18.3	
PHC6	346	48.99	329.39	18.15	
Age * Control					**0.0010***
Controlled	135	38.8	239.03	15.46	
Uncontrolled	566	44.35	396.89	19.92	

Table 4. Asthma control association measures with gender, age, and PHC variables as exposure factors, n = 701, Agadir, Morocco, 2013 - 2019

	Unadjusted OR	95% CI	Statistical Test X^2 Corrected	p-value
Gender				
Female	0.7829	0.5337-1.1484	1.3332	0.2482
Male	1.2774	0.8708-1.8737	1.3332	0.2482
Age (years)				
3-28	1.0757	0.7025-1.6469	0.0510	0.8214
29-44	2.3041	1.5434-3.4396	16.3181	**<0.001**
45-58	0.9952	0.6034-1.5086	0.0000	**<0.001**
59-94	0.2911	0.1625-0.5212	18.0579	**<0.001**
PHC*				
PHC1	21.0584	11.1287-39.8480	139.653	**<0.001**
PHC2	13.1905	6.5422-29.5947	74.6733	**<0.001**
PHC4	0.9492	0.5944-1.5155	0.0101	0.9200

*: An expected cell count is < 5 for PHC3, PHC5 & PHC6. X^2 may not be valid.

We noted that all cases reported were mainly for the first consultation in the first three months of the year (45.36%).

Variables Associated with Asthma Control

The dependent variable is asthma control which grouped into uncontrolled or controlled. Gender, age, and PHC of control were considered as predictors. The location variable not considered in the analysis due to the patient's address recorded is not precise and the patients may be treated at another center far away from their residence.

Table 4 shows the obtained results from the single degree of freedom contingency table by considering asthma control as outcome variable and gender, age and PHC as exposure variables.

Asthma control seems to be more observed for males than females (OR: 1.28; 95% CI [0.87; 1.87]), which it is not statistically significant. The asthma control is also more observed in patients aged 29 to 44 year (OR: 2.3; 95% CI [1.54; 3.44], p < 0.001) and in patients aged less than 29 year, but it is not significant for the latter ones (OR: 1.08; 95% CI [0.7; 1.65]).

Patients who were managed at the PHC1 and PHC2 appeared to have optimal asthma symptom control, with (OR: 21.06; 95% CI [11.13; 39.85], p < 0.001) and (OR: 13.19; 95% CI [6.54; 29.54], p < 0.001), respectively.

Multivariate Analysis

The proportional odds model of the ordinal logistic regression determines the factors associated with levels of asthma control. This model estimates a single odds ratio that

Table 5. Asthma control by age, gender, and PHC variables by multiple logistic regression models

	Estimate	z value	Pr (>|z|)	Exp(coefficients) † =OR	Pr (>Chi)
(Intercept)	0.9561	2.011	0.0443*	20.6014	
Age	0.0098	1.157	0.2471	1.0098	0.2449
Gender (reference=Male)	-0.4535	-1.101	0.0271*	0.6354	0.2631
PHC (reference=PHC1)					<0.001**
PHC2	0.0738	0.140	0.8889	1.0767	-
PHC3	19.450	0.006	0.9951	<0	-
PHC4	-20.7380	-7.206	<0.001**	0.0650	-
PHC5	-20.1700	-0.011	0.9914	<0	-
PHC6	-20.1860	-0.023	0.9816	<0	-

Dependent variable: Asthma Control.

Predictors: age, gender, and PHC.

Valid model: the condition of at least 5 to 10 events per predictor variable is verified.

*: signification at 0.05.

**: signification at 0.01.

†: exponential of estimators

gives the risk of moving from uncontrolled to controlled asthma (**Table 5**).

The gender variable is statistically associated with controlled asthma whatever the age and eventual access to the same PHC. The level of control decreases by about 40%, independently of age and PHC, for females. This control is also associated with the PHC of consultation and control.

DISCUSSION

In this study, we identify some characteristics of asthma cases and its control in the population of Agadir city. The results indicate a spatial and temporal variation of the reported cases during the period from 2013 to 2019, which may be due, at first glance, to an increase in cases, whereas it seems to be a problem of reporting, traceability, geographical accessibility, and availability of medication [19]. At the national level, this variability was observed by region and by zone [19].

Moreover, the 2/3 of the reported cases are for the years 2018 and 2019. A half of the cases are reported by PHC6, which may due to the decision of the local authority that demands from asthmatic patients to be treated at the PHC6 center since 2018.

The estimated prevalence from 2013 to 2019 is between 0.02% and 0.11%, which is much lower than that recorded at the regional level (about 2.4%) [19], and at the national level and compared to other cities [11,12,14,15,20, 21].

These results show an indicative comparison and cannot be accepted, since the estimation of the prevalence in Agadir is based only on 6 PHCs while the other PHCs are excluded from the study, due to lack of traceability or imprecision of data. Besides, there are a high probability that several cases will present themselves to private-sector health services without being reported to the public sector. It is also important to note that the prevalence in other cities is calculated based on cases identified only in hospital centers (emergency services, respiratory and allergic diseases).

It must be noted that more studies are needed to understand the real prevalence and the actual numbers of asthma patients at the national scale [22].

Cases by gender are similar in proportion to the AIRMAG study [15]. The most affected age group depends on each PHC, where the average age is 43 year, which it is similar to the regional average age [19] and higher compared to the national average age [23].

Among all recorded cases, the first visit to the PHCs was in the first trimester (45.36%), which may generally be explained by meteorological conditions, climate change and pollen exposure [4,24].

Uncontrolled asthma is estimated at 80%, higher than the national level (56.3%) [23]. This high rate may be explained by sub-optimal adherence to treatment [25,26]. It can be stated that these asthmatics only come to the PHCs in case of complications and to get free drugs. Asthma control by PHCs physicians is therefore not optimal [19]. Probably attributed to insufficient therapeutic education, which is an important factor in ensuring optimal control [27], or the caregivers' level of knowledge [28].

In addition, the preliminary diagnostic process was incomplete [29] and the treatment of asthma was not considered to be in line with the GINA recommendations, mainly due to inaccessibility to treatment [30].

Our study showed that asthma control is associated with the gender variable: females control their asthma more than males. This control also depends on the PHC of control.

Other factors may also be responsible for the under-control of asthma such as adverse drug effects [31]. Also, the level of education, perceptions of asthma, and the frequency of medical consultations [23]. In addition, to not taking medication in the absence of symptoms, poor inhalation technique, and the high cost of medications [32].

The current study is a retrospective analysis and has some limitations. Indeed, information bias is possible, and many of the recorded variables of the patient are imprecise, incomplete and in most cases not recorded. Another limitation is the absence of similar research in similar PHCs.

The obtained results can be used as tool to better understand the epidemiological situation of asthma in Agadir city. However, to fully exploit these results, it is proposed to study emergency department use of asthma attacks and to investigate the correlation between asthma attacks and other environmental factors.

CONCLUSION

The results of the study suggest that reported cases of asthma in PHC are varied in time and space. This variability is also seen in asthma control, which is associated with gender and PHC of treatment. Improving the knowledge and management of patients with asthma is the most important issue we can recommend for adherence to treatment and control of this disease.

ABBREVIATIONS

OR: Odds Ratio; GINA: Global INitiative of Asthma; PHC: Primary Healthcare Center.

Declaration of interest: The authors report no conflicts of interest.

Financial Disclosure: No financial support was received.

REFERENCES

1. GINA. Global Initiative for Asthma. Global Strategy for Asthma Management and Prevention, 2017. Available at: www.ginasthma.org

2. Martin MA, Press VG, Nyenhuis SM, Krishnan JA, Erwin K, Mosnaim G, et al. Care transition interventions for children with asthma in the emergency department. J. Allergy Clin. Immunol., 2016; 138(6): 1518-25. doi: 10.1016/j.jaci.2016.10.012.

3. The Global Asthma Report 2018. Auckland, New Zealand: Global Asthma Network, 2018. ISBN: 978-0-473-46523-0 (Print) | 978-0-473-46524-7 (Electronic).

4. D'Amato G, Holgate S, Pawankar R, Ledford DK. Meteorological conditions, climate change, new emerging factors, and asthma and related allergic disorders. A statement of the World Allergy Organization. World Allergy Organ. J., 2015; 8(1): 25. doi: 10.1186/s40413-015-0073-0.

5. Kuruvilla ME, Vanijcharoenkarn K, Shih JA, Lee FE-H. Epidemiology and risk factors for asthma. Respir. Med., 149: 16-22. doi: 10.1016/j.rmed.2019.01.014.

6. Pearce N, et al. Worldwide trends in the prevalence of asthma symptoms: phase III of the International Study of Asthma and Allergies in Childhood (ISAAC). Thorax, 62(9): 758-66. doi: 10.1136/thx.2006.070169.

7. Janson C, Anto J, Burney P, Chinn S, de Marco R, Heinrich J, et al. The European Community Respiratory Health Survey: what are the main results so far? Eur. Respir. J., 18(3): 598-611. doi: 10.1183/09031936.01.00205801.

8. Masjedi M, Ainy E, Zayeri F, et al. Assessing the prevalence and incidence of asthma and chronic obstructive pulmonary disease in the Eastern Mediterranean Region. Turk Thorac J 2018: 19; 56-60. doi: 10.5152/TurkThoracJ.2018.17051.

9. World Health Organization. Global surveillance, prevention and control of Chronic Respiratory Diseases. A comprehensive approach. Geneva: WHO, p. 1-20. ISBN : 978-92-4-156346-8

10. Ministère de la Santé. Recommandations de bonnes pratiques médicales. L'asthme. Rabat: Royaume du Maroc. French. Available at: http://www.anam.ma/upload/document/RBPM-Asthme-severe.pdf

11. Chaulet P. Asthma and Chronic Bronchitis in Africa: Evidence from Epidemiologic Studies. Chest, 1989; 96(3 Supplement): 334S-339S. doi: 10.1378/chest.96.3_Supplement.334S.

12. Beasley R. Worldwide variation in prevalence of symptoms of asthma, allergic rhinoconjunctivitis, and atopic eczema: ISAAC. The Lancet, 351(9111): 1225-32. doi: 10.1016/S0140-6736(97)07302-9.

13. Bouayad Z, Aichane A, Afif A, Benouhoud N, et al. Prevalence and trend of self-reported asthma and other allergic disease symptoms in Morocco: ISAAC phase I and III. Int. J. Tuberc. Lung Dis. Off. J. Int. Union Tuberc. Lung Dis., 10(4): 371-7. PMID: 16602399.

14. El Ftouh M, Yassine N, Benkheder A, Bouacha H, Nafti S, et al. Paediatric asthma in North Africa: the Asthma Insights and Reality in the Maghreb (AIRMAG) study. Respir. Med., 103: S21-S29. doi: 10.1016/S0954-6111(09)70024-1.

15. Nafti S, Taright S, El Ftouh M, Yassine N, Benkheder A, et al. Prevalence of asthma in North Africa: the Asthma Insights and Reality in the Maghreb (AIRMAG) study. Respir. Med., 103: S2-S11. doi: 10.1016/S0954-6111(09)70022-8.

16. Kingdom of Morocco. Ministry of the Interior. Wilaya of the Souss-Massa Region. Monograph of the prefecture of Agadir Ida Outanane. French. 2018. Available at: http://www.ccis-agadir.com/document/Monographie%20Agadir%20Idaoutanane.pdf

17. CDC, Dean AG, Arner TG, Sunki GG, Friedman R, Lantinga M, et al. Epi InfoTM, a database and statistics program for public health professionals. CDC, Atlanta, GA, USA, 2011. 2016.

18. R, R Core Team (2019). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. 2019. Available at: https://www.R-project.org/

19. Sadeq M, Abouqal R, ElMarnissi A. Secular trends in consultations for asthma in early childhood, the 16 administrative regions of Morocco, 2004–2012. BMC Public Health, 15(1): 905. doi: 10.1186/s12889-015-2262-8.

20. Abid A. Follow-up of childhood asthma in Morocco. Pediatr. Pulmonol. Suppl., 18: 220. doi: 10.1002/(sici)1099-0496(1999)27:18+<220::aid-ppul70>3.0.co;2-u.

21. Nejjari R, Elaissaoui Y, Tebaa A, Rachida SB. 5PSQ-091 Asthma in the moroccan population. 2019. doi: 10.1136/ejhpharm-2019-eahpconf.524.

22. Masjedi M, Ainy E, Zayeri F, Paydar R. Assessing the Prevalence and Incidence of Asthma and Chronic Obstructive Pulmonary Disease in the Eastern Mediterranean Region. Turk. Thorac. J., 2018: 56-60. doi: 10.5152/TurkThoracJ.2018.17051.

23. Benkheder A, et al. Control of asthma in the Maghreb: results of the AIRMAG study. Respir. Med., 103: S12-S20. doi: 10.1016/S0954-6111(09)70023-X.

24. D'Amato G. Effects of climatic changes and urban air pollution on the rising trends of respiratory allergy and asthma. Multidiscip. Respir. Med., 6(1): 28-37. doi: 10.1186/2049-6958-6-1-28.

25. Engelkes M, Janssens HM, de Jongste JC, Sturkenboom MCJM, Verhamme KMC. Medication adherence and the risk of severe asthma exacerbations: a systematic review. Eur. Respir. J., 45(2): 396-407. doi: 10.1183/09031936.00075614.

26. Ghanname I, Chaker A, Hassani AC, Herrak L, Ebongue SA, et al. Factors associated with asthma control: MOSAR study (Multicenter Observational Study of Asthma in Rabat-Morocco). BMC Pulm. Med., 18(1): 61. doi: 10.1186/s12890-018-0624-6.

27. El Fadili S, Batahar SA, Sajiai H, Serhane H, Amro L. Évaluation du contrôle d'asthme à Marrakech. Rev. Fr. Allergol., 56(3): 323. doi: 10.1016/j.reval.2016.02.179.

28. Ménard S, Jbilou J, Lauzier S. Family caregivers' reported nonadherence to the controller medication of asthma in children in Casablanca (Morocco): Extent and associated factors. J. Asthma, 55(12): 1362-72. doi: 10.1080/02770903.2017.1414235.

29. Jnienea A, El Fassy Fihry MT, Mahraouic C, Benyounes A, et al. Diagnostic et prise en charge de l'asthme sévère dans 3 pays du Maghreb. Rev. Fr. Allergol., 57(4): 298-301. doi: 10.1016/j.reval.2017.01.007.

30. Mjida M, Souissi Z, El gueddari Y, Ben Younes A, Raharisson O, et al. Prise en charge thérapeutique des asthmatiques adultes et application des recommandations du GINA dans les pays du Maghreb et à Madagascar. Rev. Fr. Allergol., 59(3): 222-6. doi: 10.1016/j.reval.2019.02.213.

31. Moussaoui SE. Management of childhood asthma in the emergency department in Marrakesh, Morocco. Available at: https://www.ijirr.com/management-childhood-asthma-emergency-department-marrakesh-morocco

32. Chokhani R, Razak A, Naing W, Waked M, Bakhatar A, et al. Knowledge, attitude and practice survey on asthma amongst physicians of 5 countries from Asia and Middle-east-North-Africa. Eur. Respir. J., 2019; 54(suppl 63): PA4184. doi: 10.1183/13993003.congress-2019.PA4184.