Original article

Epidemiological study of school performance and asthma medications among asthmatic Egyptian school children

Background: *Childhood asthma is a major health problem in Egypt and worldwide. Barriers to reducing the burden of asthma include symptom-based rather than disease-based approaches, tendency of care to be ''acute'' rather than "regular" and cultural attitudes towards drugs and drug delivery systems.*
Objective: *To measure the disease effect on school performance and to map asthma medications with respect to types, routes and course of use.*
Methods: *This cross sectional study involved 206 Cairene asthmatic school children, enrolled from the school students' health insurance facility of El-Matareya Teaching Hospital and the pediatric outpatient clinic of Saint Mark Charity Hospital representing different social classes and residential locations. Their ages ranged between 5 and 15 years and they comprised 100 males and 106 females. They were assessed clinically and by peak expiratory flowmetry. Parents or caregivers were interviewed about disease symptoms, school achievement and attendance and medications used including relievers and controllers, route and course of use, whether continuously, intermittently and/or during attacks.*
Results: *Asthma had a strong impact on school achievement and school absence; 77.3% of study population reported school absence due to asthma and 41.3% reported weak to average school achievement. School performance was associated with asthma severity; the majority of moderate asthmatics (64.6%) had average and weak school performance. Number of days of school absence demonstrated highly significant relation with asthma severity; 43.6% of moderate asthmatics had 5-6 absent days/month and 33.4% had 3-4 absent days/month. Combined β2-agonists and xanthines was the most commonly used (54.8%) reliever therapy followed by β2-agonists alone (44.2%) while corticosteroids were the most common controllers used (97.6%). Therapy was taken mainly by oral than inhalation route. Other medications like cromolyns, anti-histamines, anti-leukotrienes and anti-cholinergics were rarely used. Both rectal and injection routes were rarely used also.*
Conclusion: *Asthma has a social burden on asthmatic children as it affects both school achievement and school attendance. Medical management of asthma in Egyptian children still lags behind available medical knowledge. Patients' and health care givers' education is a cornerstone in improving the current status of asthma management in Egypt.*

Keywords: asthma medications; asthma severity; children; school performance.

Mohamed A. Tageldin, Gamal S. Aly*, Salah Mostafa*, Hany Khalil.**

*From the Chest Department, *Medical Section of Institute of Postgraduate Childhood Studies, Ain Shams University, **Saint Mark Charity Hospital, Cairo, Egypt.*

Correspondence:
Dr. Hany Khalil, Saint Mark Charity Hospital, Cairo, Egypt.
E-mail:Khalil_hany@yahoo.com

INTRODUCTION

It is estimated that as many as 300 million people of all ages, and all ethnic backgrounds, suffer from asthma and the burden of this disease to governments, health care systems, families, and patients is increasing worldwide. The rate of asthma increases as communities adopt western lifestyles and become urbanised. With the projected increase in the proportion of the world's population that is urban from 45% to 59% in 2025, there will likely be a marked increase in the number of asthmatics worldwide over the next two decades. It is estimated that there may be an additional 100 million persons with asthma by 2025. [1]

It is estimated that asthma accounts for about 1 in every 250 deaths worldwide. Many of the deaths are preventable, being due to suboptimal long-term

medical care and delay in obtaining help during deadly exacerbations.

Asthma is being increasingly diagnosed among Egyptian children. Of major concern is a 10% annual increase in mortality.[2] It is a common cause of emergency room visits and hospital admissions. It was estimated that up to one in four Egyptian children with asthma is unable to attend school regularly because of poor asthma control.[3]

Barriers to reducing the burden of asthma include generic barriers like poverty, poor disease education, and poor health services, infrastructure and environmental barriers like indoor and outdoor air pollution, tobacco smoking, and occupational exposures. Moreover, symptom-based rather than disease-based approaches to the management of asthma and tendency of care to be ‘‘acute’’ rather than “regular” are significant barriers. Patient barriers include; lack of information, under-use of self-management, over-reliance on acute care and cultural attitudes towards drugs and drug delivery systems like for example steroids and inhalers[1].
We, therefore, sought to measure the disease effect on school achievement and school absence and to map the asthma medication types, routes of administration and course of therapy to estimate the patients' compliance and adherence to the standard regimen of therapy.

METHODS

Subjects and study design

The study included 206 asthmatic children who matched the inclusion criteria: age between 5 to 15 years, asthma diagnosed since ≥ 1 year and absence of chronic illnesses other than atopic diseases like nasal and or skin allergy. The majority of cases were enrolled from asthmatic school children covered by school students health insurance at El-Matareya Teaching Hospital (Cairo, North and East regions), and the Saint Mark Charity Hospital pediatric outpatient clinic (Cairo North and City Center regions) between January 2004 and January 2005. An informed consent was obtained from the parents or caregivers prior to enrollment and the study protocol was approved by the ethics committee of the Institute of Postgraduate Childhood Studies.

Clinical examination

Asthma severity was classified as mild intermittent, mild persistent, moderate persistent, or severe persistent, based on the criteria proposed by the Egyptian Guidelines for Asthma Management. [4]

Peak flowmetry

Peak expiratory flow rate (PEFR), was measured for every patient and used as a co-factor to determine asthma severity. Proper instructions on how to perform the forced expiratory maneuver were given to patients and the highest values of two or three recordings were taken. [5]

Questionnaire

Parents or caregivers as well as older children were asked about their disease using a comprehensive detailed questionnaire. Asthma severity was classified by symptoms frequency, nighttime symptoms and limitation of physical activity. School achievement and school absence were assessed in relation to disease exacerbation and/or severity.

Participants were asked to list any medications they receive including relievers e.g. β2-agonist, xanthines, or anti-cholinergics and/or controllers e.g. corticosteroids, leukotriene modifiers, or anti-histamines, defining the type, route of administration e.g. inhalation, oral, rectal, injection, or combined. The course of therapy; whether continuous, or intermittent was recorded.

Statistical Methods

Data were analyzed via a statistical software package (SPSS; Statistical Package for Social Sciences, Inc, Chicago, Ill version 12). Frequency distribution of variables was performed for asthma severity, school achievement, school absence, and medication types, routes and course of administration in order to measure the weight of each variable. Chi-square testing was performed to evaluate the relation among these data. Multi-level frequency analysis was performed between asthma severity grades and details of therapy modalities including type, route and course of administration. Quantitative variable analysis for age and PEFR was done exploring the mean, median and standard deviation. For all tests, p values less than 0.05 were considered statistically significant.

RESULTS

The subjects recruited into the study were living in El-Matareya (n=66), El-Wayli (n=29), Ain Shams (n=26), Mostorod (n=24), El-Amireya (n=21), Ezbet El Nakhl (n=18), El-Marg (n=12) and other residential areas (n=10) of Cairo.

The majority of the study population (82.7%) presented with wheezy chest and diminished PEFR for expected (mean = 150.9 L/min), while 17.3% were enrolled during disease quiescence. About one half of the studied sample had intermittent asthma

(50.5%) while the rest had either mild (26.2%) or moderate (23.3%) persistent asthma. More than a quarter (27.3%) of children reported limitation of physical activity due to asthma (table 1).

School achievement and school absence strongly correlated with asthma; 77.3% of study population reported school absence due to asthma and 41.3% reported weak and average school achievement (5.3% and 36% respectively), (figure 1).

In addition, school performance was significantly associated with asthma severity; the majority of moderate asthmatics (64.6%) had average and weak school performance (14.6% and 50% respectively), (figure 2).

Numbers of days of school absence were significantly associated with asthma severity; 43.6% of children with moderate asthma had average absence of 5-6 days/month and 33.4% had 3-4 absent days/month (figure 3).

Table 1. Frequency analysis of asthma symptoms, physical signs and severity.

Physical Activity	Frequency	Percent
Not limited	149	72.7%
Limited	56	27.3%
Total	205	100%
Chest examination		
Normal	31	17.3%
Wheezy	148	82.7%
Total	179	100%
Asthma Severity		
Mild Intermittent	104	50.5%
Mild Persistent	54	26.2%
Moderate Persistent	48	23.3%
Total	206	100%

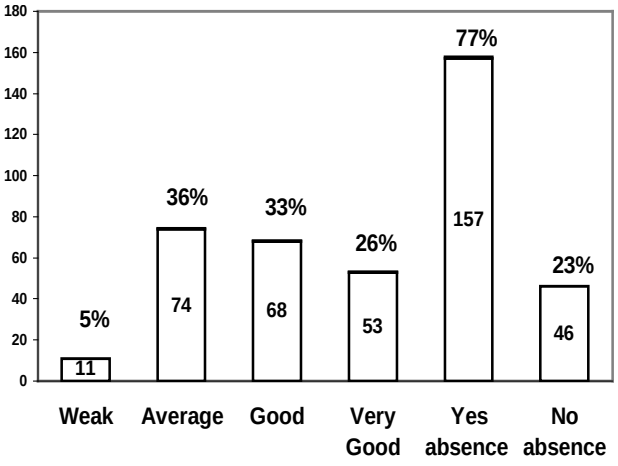
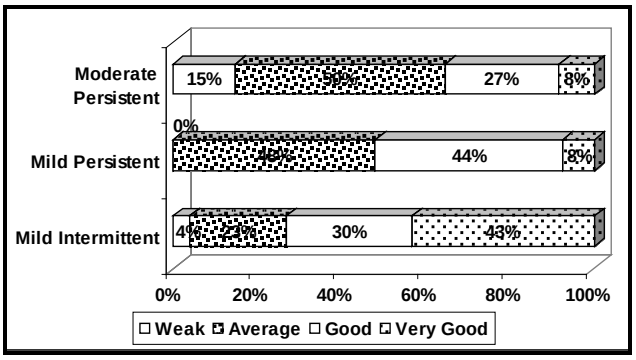
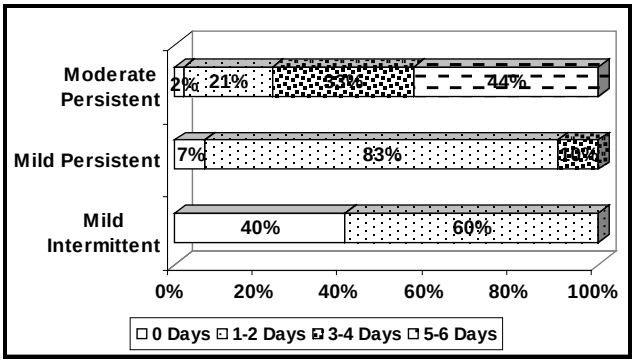


Figure 1. Frequency analysis of school performance and school absence co-related with asthma.



P = 0.000

Figure 2. School performance in association with asthma severity.



P = 0.000

Figure 3. Numbers of days of school absence in association with asthma severity.

The results revealed that combined β2-agonists and theophylline constituted the most common (54.8%) bronchodilators used in children with mild (90.7%) and moderate (95.8%) persistent asthma followed by β2-agonists alone (44.2%) especially in mild intermittent (80.8%) asthmatics. Other bronchodilators like anti-cholinergics (ipratropium bromide) were rarely used (table 2 & figure 4).

The oral route was the predominant route of administration of bronchodilators (in 61.2% of studied patients). Inhalation therapy was used by 26.6% of patients especially those with mild intermittent asthma (48.1%) (table 2 & figure 5).

Concerning the course, continuous, intermittent and during attack uses were almost equally encountered. The course of administration of bronchodilators was significantly related to asthma severity.

Multi-level frequency analysis revealed that the main form of therapy used continuously was combined oral β2-Agonists and xanthines (80%) whereas during attacks, inhalation therapy predominated (56%) especially with mild intermittent asthma (tables 3 & 4).

In our series, controller therapy was predominantly corticosteroids (97.6%); other

medications like sodium cromoglycate, anti-histamines and leukotriene receptor blockers were rarely used. Oral route was the main route (69.9%) followed by the inhalation route (26.2%) (table 2).

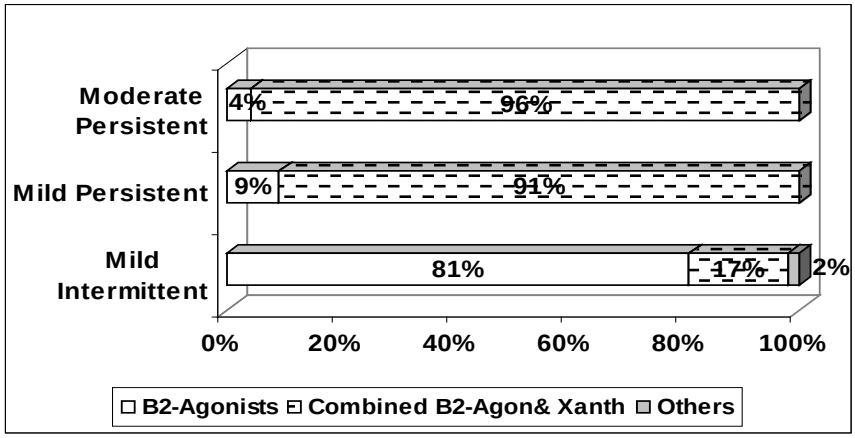
There was a significant relation between the route of administration and asthma severity. The inhalation route was mainly used in mild intermittent asthma (48.1%) (figure 7). Also, the course of administration of controller therapy differed with grades of asthma severity. Continuous use was more prevalent in moderate persistent asthma (86.7%) while intermittent use dominated in mild persistent asthma (64.2%). In mild intermittent asthma, the controller therapy was used only during exacerbations (58%) (figure 8).

Also multi-level frequency analysis revealed that oral corticosteroids as controllers dominated both the continuous (87%) and the intermittent use of controller therapy (71%). During attacks, inhaled corticosteroids was the main line of preventive therapy (54%) followed by oral corticosteroids (39%), (tables 5, 6 and 7).

Our data suggested that there was an inadequate use of inhaled corticosteroids in the long-term treatment of asthma. Almost all the children had no written asthma action plan, nor did they have spacers to use for inhalation therapy.

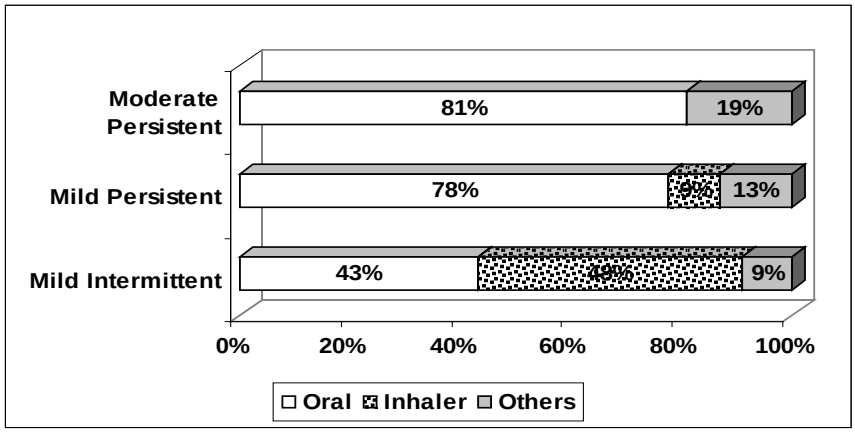
Table 2. Frequency analysis of asthma medications (bronchodilators and controllers medications).

Medications/types, routes & course	**Frequency**	**Percent**
Bronchodilator		
Types		
B2-Agonists alone	91	44.2%
Theophylline alone	1	0.5%
Ipratropium bromide alone	0	0%
B2-Agonists + Theophylline	113	54.8%
B2-Agonists + Theophylline + Ipratropium bromide	1	0.5%
Route of administration		
Oral only	126	61.2%
Inhaler only	55	26.6%
Oral + Inhaler	20	9.7%
Oral + Rectal	3	1.5%
Oral + Injection	2	1.0%
Course of therapy		
Continuous	65	32.7%
Intermittent	74	37.2%
During Attacks	59	29.6%
Intermittent + During Attacks	1	0.5%
Controller therapy		
Types		
Corticosteroids alone	201	97.6%
Cromolyns alone	1	0.5%
Anti-histamines alone	0	0%
Anti-leukotrienes alone	0	0%
Long Acting β2-Agonists alone	0	0%
Corticosteroids + Anti-histamines	4	1.9%
Route of administration		
Oral only	144	69.9%
Inhaler only	54	26.2%
Oral + Inhaler	8	3.9%
Course of therapy		
Continuous	62	31.3%
Intermittent	77	38.9%
During Attacks	59	29.8%



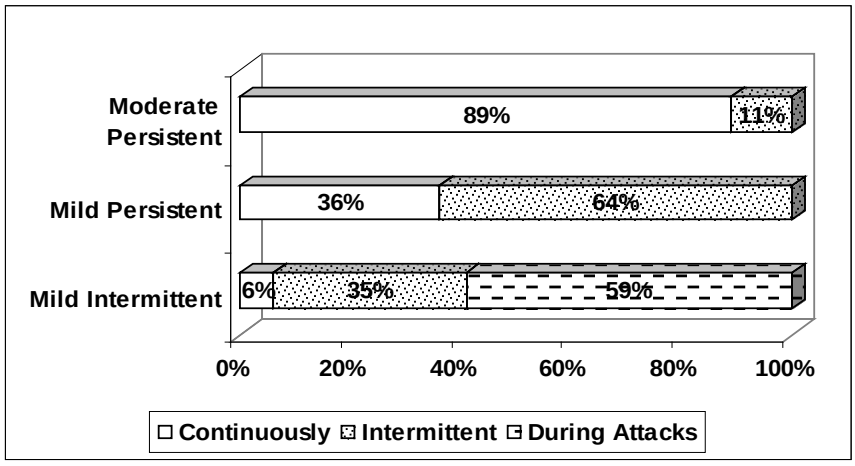
P = 0.000

Figure 4. Bronchodilator types in relation to asthma severity.



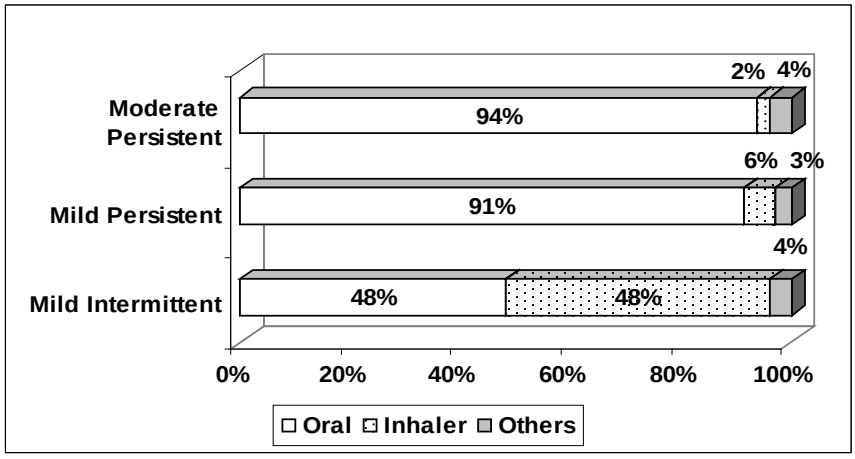
P = 0.000

Figure 5. Routes of bronchodilator therapy in relation to asthma severity.



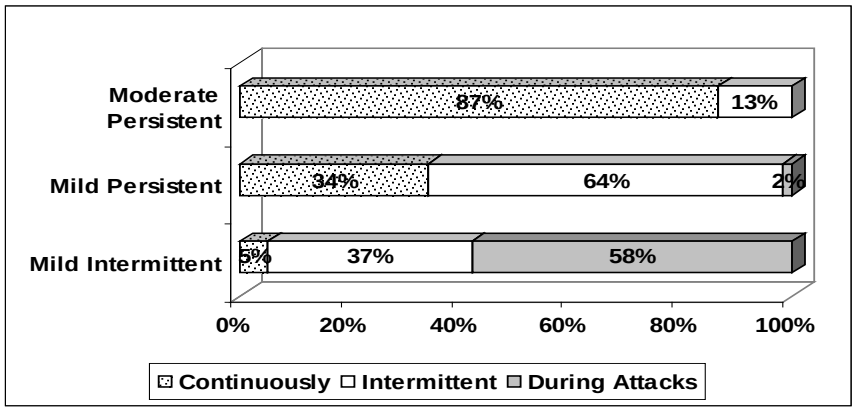
P = 0.000

Figure 6. Course of bronchodilator therapy in relation to asthma severity.



P = 0.000

Figure 7. Controller medication routes in relation to asthma severity



P = 0.000

Figure 8. Course of controller medication in relation to asthma severity

Table 3. Continuous use (n=65) of different routes of administration of bronchodilators in association with asthma severity*.

Timing	Route		Asthma Severity			Total
			Mild Intermittent	Mild Persistent	Moderate Persistent	
Continuously	Oral	β2-Agonists	1(50)			1 (1.9)
		β2 & Xanth	1(50)	17(100)	34(100)	52(98.1)
		Total	2(100)	17(100)	34(100)	53(100)
	Inhaler	β2-Agonists	2(100)	1(100)		3(100)
		Total	2(100)	1(100)		3(100)
	Inhaler & Oral	β2-Agonists	1(50)			1(20)
		β2 & Xanth	1(50)	1(100)	2(100)	4(80)
		Total	2(100)	1(100)	2(100)	5(100)
	Oral & Rectal	β2 & Xanth			2(100)	2(100)
		Total			2(100)	2(100)
	Oral & Injection	β2 & Xanth			2(100)	2(100)
		Total			2(100)	2(100)

* Values are given as count (%)
Xanth = Xanthines.

Table 4. During attacks (n=59) use of different routes of administration of bronchodilators in association with asthma severity*.

Timing	Route		Asthma Severity			Total
			Mild Intermittent	Mild Persistent	Moderate Persistent	
During Attacks	Oral	β2-Agonists	18(81.8)			18(81.8)
		β2 & Xanth	4(18.2)			4(18.2)
		Total	22(100)			22(100)
	Inhaler	β2-Agonists	33(100)			33(100)
		Total	33(100)			33(100)
	Inhaler & Oral	β2-Agonists	3(75)			3(75)
		β2,Xanth&Ach	1(25)			1(25)
		Total	4(100)			4(100)
During attacks & intermittent	Oral & Rectal	β2 & Xanth		1(100)		1(100)
		Total		1(100)		1(100)

* Values are given as count (%)
Xanth = Xanthines. Ach = Anticholinergics

Table 5. Continuous use (n=62) of different routes of administration of preventive therapy in relation to asthma severity*.

Timing	Route		Asthma Severity			Total
			Mild Intermittent	Mild Persistent	Moderate Persistent	
Continuously	Oral	Steroids	2(100)	17(100)	35(94.6)	54(96.4)
		Steroids & A-hist			2(5.4)	2(3.6)
		Total	2(100)	17(100)	37(100)	56(100)
	Inhaler	Steroids	2(100)	1(100)		3(100)
		Total	2(100)	1(100)		3(100)
	Inhaler & Oral	Steroids	1(100)		2(100)	3(100)
		Total	1(100)		2(100)	3(100)

* Values are given as count (%)
A-hist = Antihistamines

Table 6. Intermittent use (n=77) of different routes of administration of preventive therapy in relation to asthma severity*.

Timing	Route		Asthma Severity			Total
			Mild Intermittent	Mild Persistent	Moderate Persistent	
Intermittent	Oral	Steroids	21(100)	29(96.7)	5(100)	55(98.2)
		Steroids & A-hist		1(3.3)		1(1.8)
		Total	21(100)	30(100)	5(100)	56(100)
	Inhaler	Steroids	15(93.8)	2(100)	1(100)	18(94.7)
		Cromolyns	1(6.2)			1(5.3)
		Total	16(100)	2(100)	1(100)	19(100)
	Inhaler & Oral	Steroids		2(100)		2(100)
		Total		2(100)		2(100)

* Values are given as count (%)
A-hist = Antihistamines

Table 7. During attacks (n=59) use of different routes of administration of preventive therapy in relation to asthma severity*.

Timing	Route		Asthma Severity			Total
			Mild Intermittent	Mild Persistent	Moderate Persistent	
During Attacks	Oral	Steroids	23(100)			23(95.8)
		Steroids & A-hist		1(100)		1(4.2)
		Total	23(100)	1(100)		24(100)
	Inhaler	Steroids	32(100)			32(100)
		Total	32(100)			32(100)
	Inhaler & Oral	Steroids	3(100)			3(100)
		Total	3(100)			3(100)

* Values are given as count (%)
A-hist = Antihistamines

DISCUSSION

From the results of the current investigation it is observed that school achievement and school absence are strongly related to asthma severity.

This comes in accordance with a relevant Egyptian study that revealed that at least one quarter of asthmatic (32/120) and epileptic children (10/42) were unable to attend school regularly because of their illness, compared with only 0.9% (1/113) and 3.2% (3/93) of diabetic and rheumatic children, respectively. Their results suggest that it is the specific nature of the disease that is the primary determinant of the severity of physical impact rather than the quality of delivered care.[3]

School absenteeism is frequent due to insufficient control of asthma. This insufficient control is especially evident at schools where the usual risk factors of asthma are present. Allergenic risk with animal danders carried by other children, or school-acquired regular practice of sports, may be triggers for asthmatic child.[6]

Regarding the bronchodilators used in our series, combined therapy with β2-agonists and theophylline were quite prevalent. Theophylline and oral β2-agonists seem to have an additive effect on the control of asthma.[7] However; it remains unclear whether the combination has any clear clinical advantage compared to either drug used alone.

The role of theophylline in the short and the long-term treatment of children with asthma is limited worldwide, but the low cost of this treatment may be behind its frequent use in some countries like Egypt. Theophylline is significantly more effective than placebo at controlling symptoms and improving lung function, even at doses below the normally recommended therapeutic range.[8]

The oral route of bronchodilator administration in our series dominated followed by inhalation route, and this may reflect the prevalent use of theophylline. The inhalation route was mainly used in mild intermittent asthma due to the frequent use of rapid-acting inhaled β2-agonists known to be superior to other drugs in the treatment of acute episodes of wheeze.[9] Other routes namely parenteral and rectal were rarely used. The onset of action of bronchodilators is substantially quicker when they are given via inhalation than when these drugs are administered orally.[10]

Patients with moderate persistent asthma tended to use continuous bronchodilation whereas this was not the case with mild persistent asthmatics who were mainly administrating bronchodilators on intermittent basis. Standard asthma therapy holds that persistent asthma patients may be maintained on continuous long acting bronchodilator therapy. Rapid acting β2-agonists may be needed to provide quick relief that may last from 1-5 hours in children.[11]

Many researchers agree that short-acting β2-agonists provide significant protection against bronchoconstriction induced by various challenges; they have been the mainstay of asthma treatment in children for many years. These drugs are by far the most effective bronchodilators available and therefore the preferred treatment for acute asthma.[9]

Corticosteroids were the main (97.6%) anti-inflammatory treatment used comparably by asthmatics of different grades of severity included in this study. Other preventive medications like cromolyns, anti-histamines and anti-leukotrienes

were rarely used. Inhaled corticosteroids are the most effective controller therapy, and are therefore the recommended treatment for persistent asthma at any step of severity. Dose-response studies and dose titration studies in children[12] demonstrate marked and rapid clinical improvements in symptoms and lung function at low doses of inhaled corticosteroids (e.g., 100 μg budesonide daily).[13]

Emphasis should be made that the predominant route of corticosteroid intake was the oral route whether this was as continuous or as intermittent courses. This was the case with persistent asthma patients. This represents a deviation from the recommended protocols of corticosteroid therapy provided by the guidelines at hand. An important reason behind this is perhaps that many of the patients comply better with oral therapy. Oral intake should be limited to acute exacerbations whether viral induced or otherwise.[14]

In the absence of spacers, many patients do not get the desired effect with inhalation therapy. The cost of inhalation versus oral therapy is another issue that can not be overlooked.

As noticed in the results of this study, most of the patients with moderate severity (87%) were maintained on continuous courses of oral corticosteroids. This raises much concern on the impact of this practice on their growth. Hence it becomes a necessity to provide patients with an action plan.

Worth mentioning is that most of the study population have school health insurance coverage which is limited only to certain medications such as β2-agonists (tablets, syrup, inhalers) and xanthines (tablets, syrup). Oral corticosteroids (tablets, syrup) and anti-histamines (tablets, syrup) were also among the available controller medications.

More broadly, our findings regarding medication usage coupled with the prevalence of children with mild and moderate persistent asthma and the frequency of respiratory symptoms suggest that this population was being treated in a way that is not in-line with both local and international asthma guidelines. Compounding the problem of inadequate medication is the observed low usage of asthma action plans or peak flow meters, which are both part of recommended patient education and self-management activities. These shortfalls could be related to inadequate quality of care, limitations in access to and continuity of care, communication gulfs between caregivers and providers, or other factors, and further investigation is needed to determine the root causes of this management gap.

It is deduced that the cost and availability of medications represent important barriers to effective management in a number of low- and middle-income families, even those covered by health insurance authorities and organizations. Other patient's barriers include; cultural factors, lack of information, underuse of self-management, over-reliance on acute care and use of alternative unproven therapies.

Programs based on locally adapted asthma management guidelines have been shown to result in marked changes in prescribing patterns, and reductions in morbidity and mortality from asthma. Also patient and patient's family education is very important to provide them with suitable information and training so that patient can keep well and adjust treatment according to a medication plan developed in advance with the health care professional. The emphasis must be on the development of an ongoing partnership among health care professionals, the patient, and the patient's family.

In conclusion, asthma has a social burden on asthmatic children as it affects both school achievement and school attendance. Still there is a gap between available medical knowledge and medical therapy and its utilization for the benefit of the asthmatic population. Under-treatment of asthma is a common problem. In particular, there is an inadequate use of inhalation therapy among Egyptians children; probably due to ignorance towards the proper use of this kind of therapy and the unexplained phobia from its side effects among the public.

Wrong attitudes towards corticosteroid therapy prevail and there is a strong need to spread proper information on its use among health care providers and patients.

ACKNOWLEDGEMENT

The authors thank Dr. Refaat Iskander, Chest Consultant at El- Matareya Teaching Hospital, for his sincere effort and help during the course of the study.

REFERENCES

1. **Masoli M, Fabian D, Holt S, Beasley R;** Global Initiative for Asthma (GINA) Program. The global burden of asthma: executive summary of the GINA Dissemination Committee report. Allergy 2004; 59:469-78.
2. Egyptian guidelines for asthmatic child by the Egyptian Paediatric Association, Cairo; 1999.

3. **Bassili A, Zaki A, Zaher SR, El-Sawy IH, Ahmed MH, Omar M, et al.** Quality of care of children with chronic diseases in Alexandria, Egypt: the models of asthma, type 1 diabetes, epilepsy, and rheumatic heart disease. Egyptian-Italian Collaborative Group on Pediatric Chronic Diseases. Pediatrics 2000; 106(1): E12.
4. Egyptian guidelines for asthma management by the Egyptian society of chest diseases and tuberculosis, Cairo; 1999.
5. **Sly RM.** Pediatric Allergy. New Hyde Park, NY, Medical Examination Publishing Company, 1985.
6. **Karila C, Luc C, Dubus JC.** The asthmatic child at school: difficulties encountered and proposed solutions. Arch Pediatr. 2004 Jun; 11 Suppl 2:120s-123s.
7. **Chow OK, Fung KP.** Slow-release terbutaline and theophylline for the long-term therapy of children with asthma: a Latin square and factorial study of drug effects and interactions. Pediatrics 1989; 84:119-25.
8. **Bierman CW, Pierson WE, Shapiro GG, Furukawa CT.** Is a uniform round-the-clock theophylline blood level necessary for optimal asthma therapy in the adolescent patient? Am J Med 1988; 85:17-20.
9. **Pedersen S.** Treatment of acute bronchoconstriction in children with use of a tube spacer aerosol and a dry powder inhaler. Allergy 1985; 40:300-4.
10. **Shaw RJ, Waller JF, Hetzel MR, Clark TJ.** Do oral and inhaled terbutaline have different effects on the lung? Br J Dis Chest 1982; 76:171-6.
11. **Formgren H.** Clinical comparison of inhaled terbutaline and orciprenaline in asthmatic patients. Scand J Respir Dis 1970; 51:203-11.
12. **Shapiro G, Bronsky EA, LaForce CF, Mendelson L, Pearlman D, Schwartz RH, et al.** Dose-related efficacy of budesonide administered via a dry powder inhaler in the treatment of children with moderate to severe persistent asthma. J Pediatr 1998; 132:976-82.
13. **Pedersen S, O'Byrne P.** A comparison of the efficacy and safety of inhaled corticosteroids in asthma. Allergy 1997; 52:1-34.
14. **Tal A, Levy N, Bearman JE.** Methylprednisolone therapy for acute asthma in infants and toddlers: a controlled clinical trial. Pediatrics 1990; 86:350-6.