

# Nocturnal Symptoms and Sleep Disturbances in Clinically Stable Asthmatic Children

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**SUMMARY** Presence of nocturnal symptoms is related to asthma severity. Clinically stable asthmatic children, too, report frequent nocturnal symptoms and sleep disturbances. The study determined these parameters in stable, asthmatic children, in their home environment. This case-control, questionnaire-based study in 70 school-going children comprised 40 asthmatics (Group 1) and 30, age/gender matched, healthy children (Group 2). Parents maintained peak expiratory flow (PEF) and sleep diaries for one week. Group 1 had significantly lower mean morning (250.3 vs. 289.1 l/minute) and mean evening PEF values (261.7 vs. 291.3 l/minute). Group 1 (38.95%), reported frequent nocturnal symptoms like cough (36.90%), breathlessness (32.80%), wheeze (27.68%) and chest tightness (14.35%). Sleep disturbances, significant in Group 1 (38, 95% vs. 14.35%), included daytime sleepiness (24.60%), daytime tiredness (20.50%), difficulty in maintaining sleep (15.38%), early morning awakening (14.35%), struggle against sleep during daytime (12.30%), and involuntarily falling asleep (17.43%). On a scale of 1-6, Group 1 scored significant sleep disturbances/patient (3 vs. 0.8); lethargy/tiredness in morning (2.9 vs. 2.2), poorer sleep quality (4.7 vs. 5.4), less parents' satisfaction with child's sleep (4.5 vs. 5.5) and daytime fitness (4.1 vs. 5.3). Group 1, when exposed to environmental tobacco smoke (22, 55%), reported significant nocturnal symptoms (18/22, 81%) and reduced mean morning and evening PEF values (17/22, 77%). It is concluded that clinically stable, asthmatic children reported increased nocturnal symptoms, sleep disturbances and poorer sleep quality. Lack of awareness of asthma-sleep association and its clinical implications could lead to poor asthma control and impaired daytime activity.

Asthma is the most common chronic respiratory disorder of children.<sup>1</sup> Although asthma affects all ages, most asthmatics experience symptoms initially in childhood and peak prevalence occurs between the ages of 6-11 years.<sup>2</sup> Nocturnal symptoms in the form of cough, breathlessness and wheeze are common events for most asthmatic individuals. The presence of nocturnal symptoms has been recognized as a distinct and frequent clinical problem, and is thought to be related to the severity of disease.<sup>3</sup> However, the mechanism of this particular aspect of asthma is still poorly understood. Although nocturnal symptoms have been recognized since antiquity, its importance was initially highlighted in an epidemiological study conducted in a community-based

population of adult asthmatics.<sup>4</sup> It was observed that even with optimal therapy, a large number of patients continued to experience disabling nocturnal symptoms of asthma. However, many patients do not frequently report nocturnal symptoms to their doctors and thus underestimate the severity of their asthma, leading to under treatment and increased morbidity.<sup>5</sup>

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A significant feature that has not received the attention it deserves is the affect of asthma on quality of sleep itself and the consequent adverse affect on individuals' daytime performance. Increased daytime sleepiness and tiredness because of frequent nocturnal awakenings has been documented in stable adult asthmatics.<sup>6,7</sup> However, few studies in asthmatics children have demonstrated frequent nocturnal awakenings during a period of clinical stability.<sup>8,9</sup> In children, nocturnal symptoms may cause patients and their parents to wake at night and may lead to poorer educational and cognitive performance.<sup>10,11</sup> Earlier studies provided data on sleep in asthmatics and attempts were made to identify the nature of sleep disturbances and its effect on daytime performance in such patients.<sup>7,12</sup> However, the data available from these studies largely represents the adult population and nature of specific sleep disturbance in children is not widely known. A recent study<sup>13</sup> described increased daytime symptoms of asthma and poor sleep quality in wheezing school-aged children because of frequent nocturnal awakenings.

In light of above, a questionnaire-based study was designed and conducted on outpatient basis, in 40 school-going, clinically stable asthmatic children to determine the occurrence of nocturnal symptoms of asthma and nature of sleep disturbances in their home environment.

## MATERIALS AND METHODS

### Study design

A case control, questionnaire based study was conducted in 70 school-going children. Of these, 40 asthmatic children were in the study group while 30 healthy children were in control group.

### Study group

The study group comprised 40 consecutive children with a clinical diagnosis of asthma, who presented to the Outpatient Department of the Vallabhbhai Patel Chest Institute, University of Delhi. All patients were in the age group of 6-16 years, had a significant reversibility ( $\geq 12\%$  and 200 ml in forced expiratory volume in one second [FEV<sub>1</sub>]) after inhalation of 200  $\mu\text{g}$  of salbutamol. On inclusion, patients were clinically stable as per the criteria de-

scribed earlier.<sup>7</sup> This was defined as asymptomatic on current therapy, no history of emergency room visits/hospitalization or use of oral steroids two weeks prior to or during the study period. None of the patients were on any other medications, including antihistamines, apart from anti-asthma therapy. Severity categorization was done as per the 'National Asthma Education Program', Expert Panel Report 2 (EPR-2).<sup>14</sup>

### Control group

The control group had 30 healthy children, recruited from a school in the vicinity. They were matched as far as possible for age, sex, weight, and height with the study group. None had any personal or family history of atopy, and were not receiving any medication.

### Methodology

Both groups underwent an identical workup. One parent in both groups responded to a questionnaire that elicited information on asthma and sleeping habits of the children. Subsequently, parents were requested to maintain their child's peak expiratory flow (PEF) diary and a sleep diary for one week. The study was approved by the Research Cell of the Institute.

### *Asthma/sleep questionnaire*

The questionnaire, filled by the same investigator, elicited information from a parent about their child's asthma and sleeping habits. The parent from the control group too, responded to both the questionnaires. The asthma questionnaire<sup>7</sup> used earlier by us was adapted and modified to suit the 6-16 year age group. These included questions regarding asthma symptoms, severity, duration, exacerbations, use of oral steroids, emergency room visits, hospitalizations, exposure to environmental tobacco smoke (ETS) and its effects, and details of anti-asthma therapy. A history of co-existent allergic rhinitis was elicited from all patients. Parent was asked about the average number of school days lost by the child and loss in their own workdays, due to child's asthma, in the past year. Questions regarding occurrence of nocturnal symptoms included cough, breathlessness, wheeze and frequency of night awak-

ening. In addition, parent was asked to classify the children into mild, moderate or severe category as per own criteria. These children were then also classified in these categories as per the severity criteria laid down in EPR-2<sup>14</sup> and compared for accuracy.

The sleep questionnaire sought information about dinnertime, sleeping habits and sleep disturbances due to asthma (Table 3). Questions describing the quality of sleep parameters were adapted from a previous study<sup>11</sup> and were modified to suit the 6-16 age group, as well as the Indian conditions and language. The quality of sleep in both groups was assessed with the help of five parameters<sup>12</sup> scored on a scale of 1 to 6 each: (a) overall quality of night sleep, (b) depth of sleep, (c) parents satisfaction with child's sleep during the night, (d) lethargy/tiredness on arising in the morning, and (e) parents' satisfaction with the daytime fitness of the child.

#### **Peak expiratory flow (PEF) diary**

In both groups, parents maintained a PEF diary of their children for one week. Subjects and / or parents received instructions on the proper use of peak flow meter. Best of three PEF values were recorded twice daily at the same time; on awakening and in the evening. In the study group, PEF was recorded prior to administration of anti-asthma therapy.

#### **Sleep diary**

Parents in both groups maintained their child's sleep diary during the same week they maintained the PEF diary and recorded dinner time, time of going to bed, time of going to sleep, interruptions in sleep and reasons, arising time and daytime sleepiness.

#### **Statistical analysis**

At the end of study, the severity of asthma among the mild, moderate and persistent groups was compared for significance by using One-way analysis of variance (ANOVA). Independence of two attributes was compared by Chi-square tests. Comparison of the mean morning and evening PEF recordings was done using Student's t-test. The results obtained from the sleep diary analysis were con-

firmed by Fishers' exact test. A significance level of  $p < 0.05$  was accepted for all analysis.

## **RESULTS**

The clinical profile and sleep disturbances of subjects in each group is summarized in Table 1. Of the 40 patients in study group, significantly more had ETS exposure (22, 55%). Of these 22 patients, 18 (81%) reported frequent nocturnal symptoms, 13 (33%) had daytime cough and wheezing, while 5 (12%) felt suffocation (Table 1). Seventeen (43%) patients experienced a significant decrease in mean morning and evening PEF values ( $p < 0.05$ ).

#### **Asthma questionnaire analysis**

The duration of symptoms in asthmatics ranged from 1 to 15 years (mean 5.5 years). Cough (32, 80%) was the predominant symptom at onset of disease, followed by breathlessness (19, 48%), wheeze (8, 20%) and chest tightness (3, 8%). All four symptoms were present in 15 (37.5%) patients. Half the patients (20, 50%) had perennial symptoms, while 16 (40%) had seasonal symptoms. Four patients (10%) had exacerbations during change of season while 36 (90%) had associated allergic rhinitis. The co-existence of allergic rhinitis in these patients was previously unrecognized.

#### **Assessment of asthma severity**

In study group, parents rated severity of asthma as per own criteria. Asthma was rated as mild in 12 (30%), moderate in 17 (42.5%), and severe in 11 (27.5%) children. When classified as per EPR-2, 20 (50%) patients had mild persistent, 18 (45%) moderate persistent, while 2 (5%) had severe persistent asthma. None in group 1 had mild intermittent asthma. While comparing the two classifications, it was observed that more children were placed in severe category by their parents as compared to EPR-2 based classification ( $p < 0.05$ ). In addition, children with severe persistent asthma had significantly more number of acute attacks, emergency room visits, use of oral steroids/patient/year and reported more lost school days in last 1 year (Table 2). Parents of 19 (47.5%) asthmatics reported child's poorer academic performance and loss of their own work hours due to asthma but were unable to correlate these with disease severity.

**Table 1** Clinical profile of the study group and control group

	Study group (n = 40)	Control group (n=30)	p values (significance)
<b>Male: female</b>	28:12	18:12	
<b>Age (years)</b>			
<b>Mean</b>	10.8	11.1	
<b>Range</b>	6-16	6-16	
<b>Height (cm)</b>			
<b>Mean</b>	132.9	134.8	
<b>Range</b>	112-167	102-167	
<b>Weight (kg)</b>			
<b>Mean</b>	27.82	30.2	
<b>Range</b>	16-58	13-59	
<b>Exposure to environmental tobacco smoke (ETS)</b>	22 (55)	11 (36.7)	
<b>Nocturnal symptoms on ETS</b>	18 (81) *	2 (18)	p < 0.001
<b>PEF (l/min); (mean ± SD)</b>			
<b>Morning</b>	250.3 ± 86.9*	289.1 ± 91.1	p < 0.01
<b>Evening</b>	261.7 ± 86.3*	291.3 ± 97.8	p < 0.05
<b>Circadian Variation<sup>#</sup></b>	3.2 ± 19.9	1.7 ± 16.4	p = 0.08
<b>Sleep questionnaire</b>			
<b>Subjects with disturbance</b>	38 (95)*	14 (46.7)	p < 0.05
<b>Average disturbance/year</b>	3/subject*	0.8/subject	p < 0.001
<b>Sleep diary</b>			
<b>Subjects with interruption</b>	22 (55)*	8 (26.7)	p < 0.05
<b>Total interruptions</b>	63*	18	p < 0.01
<b>Average interruptions</b>	1.6 /subject/week*	0.6 /subject/week	p < 0.01

• Percentage within brackets

• \*p value ≤ 0.05, (Student's t-test)

• <sup>#</sup>Mean circadian variation in peak expiratory flow (PEF) =  $\frac{\text{PEF evening} - \text{PEF morning}}{\text{PEF evening}} \times 100$

### Nocturnal symptoms of asthma

Of the 40 asthmatics, 38 (95%) reported frequent nocturnal symptoms. Among them, nocturnal cough was most frequently reported (36, 95%) followed by breathlessness (32, 84%), wheeze (27, 71%) and chest tightness (14, 37%). Nocturnal cough and breathlessness were present in 31 (81.5%), cough and wheeze in 27 (71%), while all four symptoms were present in 12 (31.5%) patients.

### Occurrence of nocturnal awakenings due to asthma

The same 38 (95%) asthmatics also experienced nocturnal awakening due to symptoms of asthma. Of these, 24 (60%) awoke once per night while 14 (35%) children had two or more awakenings per night. Among these 38 asthmatics, 16 (40%)

had awakenings at least one night in a month but less than one night/week. Eleven (27.5%) patients awoke 1-2 nights/week, 9 (22.5%) awoke 3-6 nights/week, while 2 (5%) reported awakening every night. Most patients reported sleep interruptions between midnight and 4.00 a.m.

### Patients' medication

In group 1, 39 (97.5%) took regular drugs for asthma. Of these, 29 (72.5%) were taking a combination of inhaled long acting  $\beta_2$  agonist and corticosteroid, while 10 (25%) took inhaled corticosteroid alone. One (2.5%) patient was not on regular treatment, but used an inhaled short acting  $\beta_2$  agonist as and when required. No patient used regular oral steroids. Until the completion of the study, the patients continued to be on the anti-asthma therapy they were on, prior to reporting to us. None of these patients were on any regular anti-rhinitis medication.

**Table 2** Markers of chronic asthma severity in children in the study group

	Total (n = 40)	Mild persistent (n = 20)	Moderate persistent (n = 18)	Severe persistent (n = 2)	p values (significance)
Average number of acute attacks/ patient / year in past 1 year	6.2	3.2	7.6	22.5	$p < 0.001^*$ $p < 0.01^\dagger$
Average number of rescue courses of oral steroids/patient/ year in past 1 year	4	2.5	3.5	12.5	$p < 0.01^*$ $p < 0.05^\dagger$
Average number of emergency room visits/patient/year in past 1 year	5.4	2.4	5.7	22.5	$p < 0.001^*$ $p < 0.01^\dagger$
Patients with history of prior hos- pitalization in past 1 year	4 (10)	0	3 (16)	1 (50)	$p < 0.001^*$ $p < 0.01^\dagger$
Average number of school days lost / patient/ year in past 1 year	17.9	14.6	19.9	33	$p < 0.001^*$ $p < 0.01^\dagger$
Patients with speech limiting at- tacks of wheeze	15 (37.5)	5 (25)	9 (50)	1 (50)	$p = 0.08^*$
Patients with activity limiting at- tacks of wheeze	33 (82.5)	16 (80)	15 (84)	2 (100)	$p = 0.28^*$

- Percentage within brackets
- $^\dagger$ Mild persistent vs. severe persistent,  $^\ddagger$ moderate persistent vs. severe persistent
- Mild persistent vs. moderate persistent was not significant in any marker of severity
- n, number of patients

**Table 3** Sleep disturbances in children based on sleep questionnaire

Sleep disturbances	Total (n = 40)	Total (n = 30)	p values
1. Daytime sleepiness (DTS)	24* (60)	1 (3)	* $p < 0.001$
2. Daytime tiredness (DTT)	20* (50)	5 (17)	* $p < 0.05$
3. Difficulty in maintaining sleep (DMS)	15* (38)	0	* $p < 0.001$
4. Early morning awakening (EMA)	14* (35)	0	* $p < 0.05$
5. Struggle against sleep during daytime (SASDD)	12* (30)	2 (6)	* $p < 0.05$
6. Involuntarily falling asleep (IFS)	17* (43)	9 (30)	* $p = 0.08$
7. Difficulty in initiation of sleep (DIS)	12* (30)	5 (17)	* $p = 0.15$
8. Dreams/nightmares	4* (10)	1 (3)	* $p = 0.25$

- Percentage within brackets.
- \* $p$  value  $\leq 0.05$ : (Student's t-test).

## Sleep questionnaire analysis

### Occurrence of sleep disturbances

In the study group, 38 (95%) patients gave history of sleep disturbances with significantly more disturbances/patient/year (Table 1). The remaining two asthmatics did not report nocturnal awakenings or sleep disturbances.

The nature of sleep disturbances among children of both the groups is summarized in Table 3. Significant sleep disturbances, reported by 24 (60%) asthmatics included daytime sleepiness, daytime tiredness, difficulty in maintaining sleep, early morning awakening, and struggle against sleep during daytime. Difficulty in initiation of sleep, involuntarily falling asleep and dreams/nightmares were more common in the asthmatics but this did not achieve statistical significance.

### **Quality of sleep**

Based on five parameters mentioned earlier indicating sleep quality, asthmatics had significantly worse scores compared to controls. These included poorer overall sleep quality during night (4.7 vs. 5.4,  $p < 0.01$ ), lethargy/tiredness on rising in morning (2.9 vs. 2.2,  $p < 0.05$ ), and less parents' satisfaction about child's night sleep (4.5 vs. 5.5,  $p < 0.01$ ) and daytime fitness (4.1 vs. 5.3,  $p < 0.001$ ). However, no significant difference was found in sleep depth between the two groups.

### **Peak expiratory flow diary analysis**

#### **Nocturnal asthma symptoms**

The diary analysis revealed that 22 (55%) asthmatics experienced nocturnal symptoms compared to 3 (10%) healthy controls ( $p < 0.001$ ). Of the 22 asthmatics, 17 (77%) had significant decrease in both morning and evening PEF values, recorded in the day following the occurrence of these symptoms. During the study week, cough was the most common nocturnal symptom (22, 55%), followed by wheeze (13, 22%) and chest tightness (19, 32%).

#### **Daytime asthma symptoms**

Of the 40 patients, 21 (52.5%) had daytime symptoms of asthma during the study week. Sixty such episodes were reported, averaging 1.5 episodes/child /week. Cough was most common (50, 83%) followed by breathlessness (19, 32%) and wheeze (13, 22%). Cough with breathlessness and/or wheeze was recorded in 21 (35%) episodes.

### **Sleep diary analysis**

#### **Sleep disturbances**

The sleep diary analysis (Table 1) revealed that 22 (55%) asthmatics experienced sleep interruptions compared to 8 (27%) healthy children ( $p < 0.001$ ). During 1-week study period, asthmatics recorded 63 sleep interruptions (mean 1.6/subject/week) compared to 18 in the control group (mean 0.6/subject/week)( $p < 0.001$ ). Of these 63 interruptions, 32 (51%) episodes were due to symptoms of asthma (cough, wheeze, chest tightness) while 9

(14%) were related to dreams/nightmares. The remaining 22 (35%) episodes were caused by miscellaneous reasons unrelated to asthma (example, getting up to pass urine or thirst etc.). In controls, all interruptions were because of miscellaneous reasons. Most interruptions, in both groups, were recorded between midnight and 4.00 a.m.

#### **Sleeping habits**

Asthmatics, on an average, took dinner at a significantly earlier time than controls (8:36 p.m. vs. 8:51 p.m.,  $p < 0.01$ ). On an average, in asthmatics, the time of going to bed was earlier (9:50 p.m. vs. 10:11 p.m.,  $p < 0.01$ ) than controls as was the time of sleeping (10:25 p.m. vs. 10:37 p.m.,  $p < 0.01$ ). Thus, average sleep latency time (time taken by an individual to go to sleep) was significantly increased in asthmatics (36.1 vs. 25.4 minutes,  $p < 0.001$ ). Further, asthmatics slept longer compared to controls (475.3 vs. 492.7 minutes,  $p < 0.01$ ). Average morning rising time in asthmatics was 6:36 a.m., compared to 6:31 a.m. in controls but the difference was not significant.

Mean duration (118.8 vs. 109.4 minutes) and number of episodes (63 vs. 18) of daytime naps were increased in asthmatics but the difference was not significant. The sleep diary did not reveal any correlation of sleep interruptions with the interval between dinner and bedtime in any group.

## **DISCUSSION**

Few studies<sup>8-10</sup> in child asthmatics have demonstrated the presence of nocturnal awakenings and poor sleep quality due to asthma. In our study of 40, clinically stable asthmatic children, 38 (95%) reported significant nocturnal symptoms of asthma, sleep disturbances and poorer overall sleep quality during one-week study period in their home environment. In a large series, Meijer *et al.*<sup>8</sup> reported the presence of nocturnal symptoms in almost half of 796 asthmatic children studied. However, the quality of sleep and nature of sleep disturbances were not analyzed in this study. Strunk *et al.*<sup>9</sup> reported nocturnal symptoms in a third of 1,041 stable asthmatic children enrolled in the Childhood Asthma Management Program. They postulated that presence of these symptoms could be an indicator of increasing

severity of asthma. Recognizing the significant morbidity caused by nocturnal symptoms, EPR-2<sup>14</sup> included these as an important feature in categorization of asthma severity. Recently, Desager *et al.*<sup>13</sup> surveyed 1,234 school children, aged 6-14 years, and reported decreased quality of sleep due to frequent nocturnal awakenings in about a third of 83 asthmatic children. The authors observed that wheezing children were four times more likely to have daytime sleepiness. In our study too, worsening of mean morning and evening PEF values followed the presence of nocturnal symptoms and sleep disturbances.

More than half of our patients and one-third of controls had significant ETS exposure. Of these, significantly more asthmatics reported increased nocturnal suffocation, cough and wheezing after exposure. Almost all patients experienced a fall in mean PEF values in the days following symptoms. Thus, ETS could be a trigger factor for exacerbation of asthma in an otherwise stable asthmatic, which manifested initially as nocturnal cough and breathlessness. Although ETS has been reported as a risk factor in development and exacerbation of childhood asthma,<sup>14</sup> its role in occurrence of nocturnal symptoms is yet to be highlighted. In a recent study,<sup>15</sup> children with ETS exposure were observed to be three times more likely to awake at night because of nocturnal asthma. In our country, an increased prevalence of asthma in adolescent school children was documented in association with ETS exposure<sup>16</sup> but an association with nocturnal symptoms was not described.

Three-fourths of our asthmatic children reported school absenteeism and was more in children with greater asthma severity. In addition, parents of almost half the children reported loss of work attendance and believed that frequent nocturnal awakenings in their child led to poorer academic performance. In spite of this, nocturnal symptoms were not reported to treating physician though most parents agreed that control of nocturnal symptoms could lead to improved academic performance. Diette *et al.*<sup>11</sup> observed that more than half of the 438 asthmatic children studied, missed school because of nocturnal awakenings. School absenteeism was more in patients with severe asthma and higher number of nocturnal awakenings. The authors hypothesized that even in stable asthmatics, nocturnal symptoms had

prognostic value and treatment regimens ought to be tailored to counter these symptoms.<sup>11</sup>

Janson *et al.*<sup>6</sup> identified early morning awakening as the most common sleep disturbance in stable adult asthmatics followed by difficulty in maintaining sleep and daytime sleepiness. In our earlier study<sup>7</sup> of young university students with clinically stable asthma, 93% patients with nocturnal symptoms reported significant sleep disturbances. Increased daytime sleepiness and tiredness was observed in two-third of patients. In our study, the commonest sleep disturbance, reported in more than two-thirds, was daytime sleepiness. This could be due to the fact that in children, daytime sleepiness was keenly observed by the parents and was reported more as compared to other sleep complaints. We detected significant daytime tiredness in half the patients. Desager *et al.*<sup>13</sup>, too, observed that wheezing children were five times more at risk of having daytime tiredness compared to non-wheezing children. Early morning awakening too, was reported more frequently in our patients but the sleep diary did not reveal any significant difference with controls. This was probably because children in both groups had to get up, approximately, at the same time to go to school. As in earlier studies,<sup>7,9,17</sup> we too, were unable to detect any correlation between the therapy prescribed for asthma and sleep disturbances. It seems perhaps even after optimum therapy, asthma itself may cause these disturbances.

Stores *et al.*<sup>10</sup> using polysomnography, compared subjective ratings of sleep quality, daytime sleepiness, cognitive function tests, mood, and behavior in 21 children with nocturnal asthma, with healthy children. Asthmatics had greater sleep disruption, daytime sleepiness, and lower cognitive function on memory recall. In our study, sleep disturbances were recorded in the home environment and could be more informative compared to that observed in an alien environment of hospital or laboratory.

Recently, upper airway obstruction was implicated as one of the causes for nocturnal sleep disturbances in children.<sup>18</sup> Desager *et al.*<sup>13</sup> also observed that nearly half of their 83 asthmatic children experienced snoring. They stated, "upper airways was a major factor in causing sleep problems in

wheezing children". It has been postulated that post-nasal drip with nasopharyngeal inflammation leads to lymphoid hypertrophy with prominence of adenoidal and tonsillar tissue, which may be associated with obstructive sleep apnoea.<sup>18</sup>

A relatively small number of patients in our study appear to be a limitation and could account for a higher number of sleep disturbances than previous studies.<sup>8,9,13</sup> Our findings in the study relied on self-reporting by children and patients for the accuracy of symptoms. Although the technique of usage of peak flow meter was checked during the study period, the accuracy of peak flow meter usage depends on effort and correct technique.

Our study showed that even clinically stable, asthmatic school children suffered from frequent nocturnal symptoms and sleep disturbances but were largely ignored by the parents who did not consider it important enough to report it to their physician. This may have important clinical implications as under treatment of these disabling symptoms may lead to poorer quality of life, increased treatment costs, and long-term morbidity due to asthma. Furthermore, lack of awareness of asthma-sleep association could possibly lead to poor academic performance and impaired daytime activity in these children.

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