Assessment of Impact of Air Pollution among School Children In Dhaka City

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Introduction

Air is indispensable for the survival of most living organisms on the earth, including human beings.

The ambient air quality has deteriorated both due to human activities, and natural sources.

Among the air pollutants Particulate matter (PM) is a matter of concern.

PM consists of mixture of particles that can be solid, liquid or both, are suspended in the air also called suspended particulate matters (SPM) and represent a complex mixture of organic and inorganic substances.

Introduction……

The particulate matters are categorized according to their aerodynamic diameter.

The coarse fraction is called PM_{10} (with an aerodynamic diameter smaller than 10μm), which may reach the upper part of the airways and the lungs.

Smaller or fine particles are called $PM_{2.5}$ (with an aerodynamic diameter smaller than 2.5 μm); these can penetrate more deeply into the lungs and may reach the alveolar region.

Introduction.....

- Studies in developed countries have identified the effects of particulate matter on health as the most important impact of air pollution.

- In developing countries, there are fewer studies than in developed countries, and more information is needed especially to assess the impact of the much higher concentrations of PM_{10} and $PM_{2.5}$ found in the large cities of developing countries.

Introduction.....

- PM10 and PM2.5 contributes to excess mortality and hospitalizations for cardiac and respiratory tract disease.
- PM2.5 may cause serious damage to developing lungs of children.
- Children are more vulnerable to the adverse effects of air pollution than adult.

Introduction.....

- Children have increased exposure to particles than adults and are more susceptible
  - children because of higher ventilation rates,
  - higher relative concentrations of particles into smaller lung volumes and
  - higher levels of physical activity.
- In addition adverse impacts in childhood can continue throughout their adult lives.

Background

- To address the need for information on the effects of air pollutants on health in South Asia at the high concentrations commonly found in large cities in South Asia.
- An assessment of "impact of PM_{10} and $PM_{2.5}$on the health of school children of Dhaka, Bangladesh" was conducted.
- Under a joint initiative by the United Nations Environment Programme RRCAP, Stockholm Environment Institute, Department of Environment and Department of Occupational & Environmental Health, National Institute of Preventive and Social Medicine (NIPSOM) of Bangladesh.
- Male Declaration sub-activity 4.1.2.

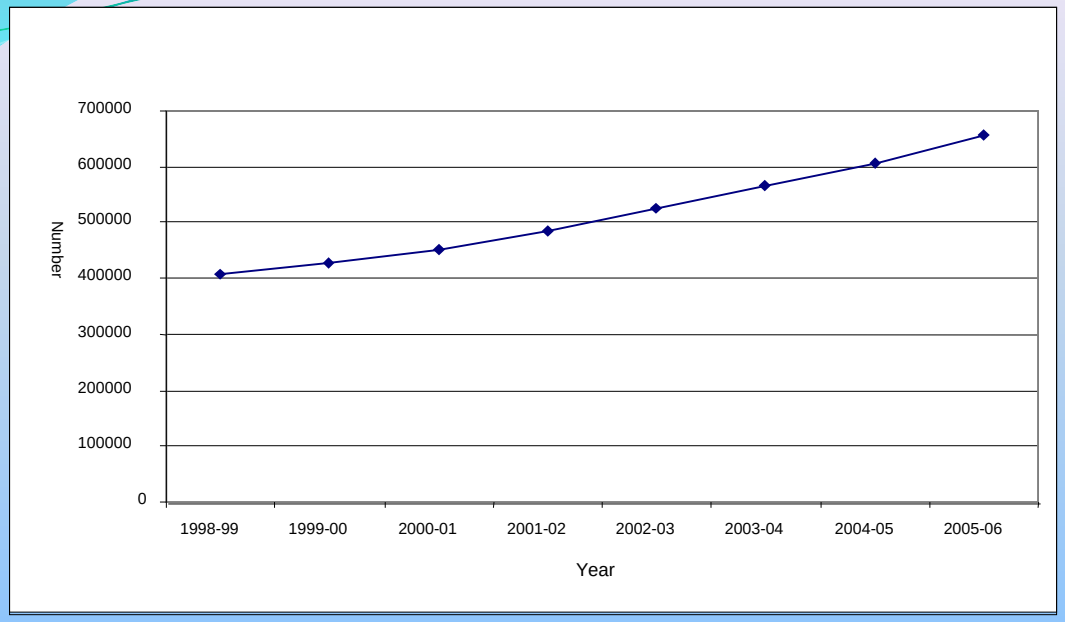
Background.....

Aim of the study was to determine whether there is an association between daily mean PM_{10} and $PM_{2.5}$ concentrations and respiratory health and lung function in asthmatic and non-asthmatic children in Dhaka.

Background.....

- Air pollution in Dhaka City is mainly contributed by motor vehicles, constructions and industry.
- The number of vehicles is increasing rapidly, and contributing to more and more air pollution.

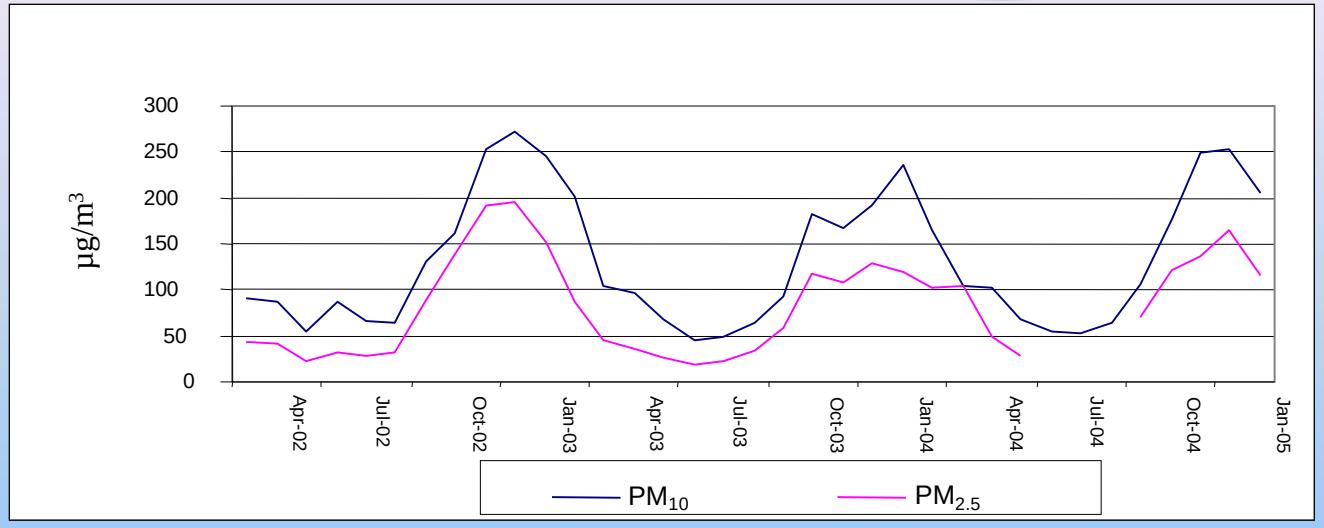
Background.....



The increasing number of Transportation vehicles and their improper management and operation are responsible for degradation of the air quality in Dhaka Bangladesh.

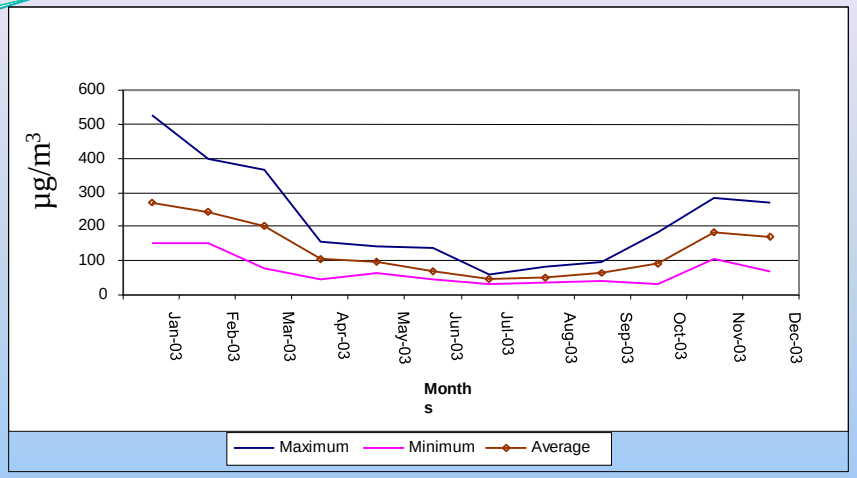
- **Rapid increase of motor vehicles from 1999 to 2006.**
- **More than 2,50,000 vehicles increased within 7 years.**

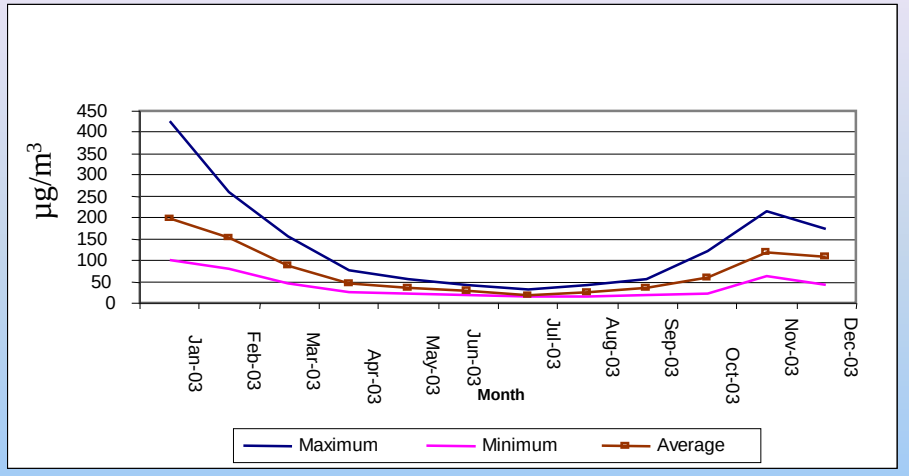
Background.....



The main air quality problem in Dhaka is the high level of particulate matter. Both PM_{10} and $PM_{2.5}$ levels are high being much above the proposed safety standards especially during the dry winter season.

Background.....





The Air Quality Monitoring Project (AQMP) provides data from a continuous air monitoring station installed at Sangsad Bhaban area (a relatively cleaner area) with comparatively low vehicular traffic load shows the state of different air pollution parameters during the year 2003 the PM_{10} and $PM_{2.5}$ concentrations were observed to be low during the period April to October.

METHODOLOGY

- The students of class Five to Nine were included for the baseline study. The schools were Dhanmondi Boys High School (DBS), Tejgaon Girls School (TGS) and Civil Aviation School (CAS) which are situated within 1 km radius of the Air Quality Monitoring Centre.
- A total of 1800 students were provided with pretested questionnaire for their response in assistance with their parents.

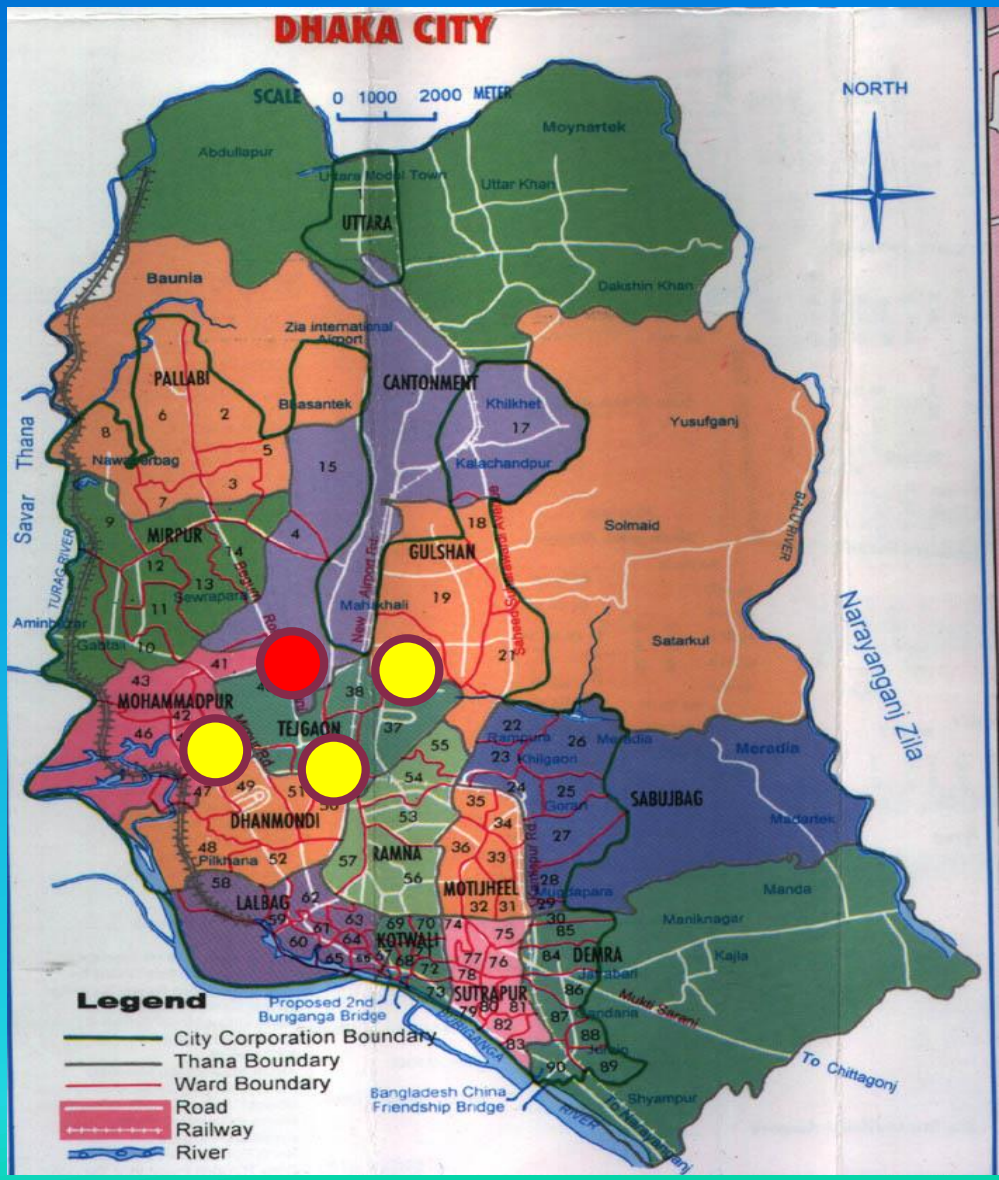
- Out of the total 1800 students, 1618 submitted the filled in questionnaire and examined for the clinical evidence of asthma.
- Ultimately total of 180 school children were randomly selected after use of excluding factors such as a smoker in the home.
- This total consisted of 120 children with clinical evidence of asthma and 60 non-asthmatic control children.

Methodology.....

On a daily basis under the supervision of teachers and technicians, Peak Expiratory Flow Rate (PEFR), a measure of lung function, was measured every morning and afternoon for the 42 days of data collection that spanned over the last week of February; 2nd, 3rd & 4th weeks of April; 1st & 2nd week of June and 7 days' of November 2007.

METHODOLOGY.....

- Daily measurements of PM_{10} and $PM_{2.5}$ concentrations were recorded from a monitoring site located within one kilometer of the schools in central Dhaka.
- Temperature, humidity and other data were also recorded.
- The data were analyzed for statistical associations using chi-square, t-tests, analysis of variance, correlation analyses, curvilinear regression and multiple regression and repeated measures analysis.

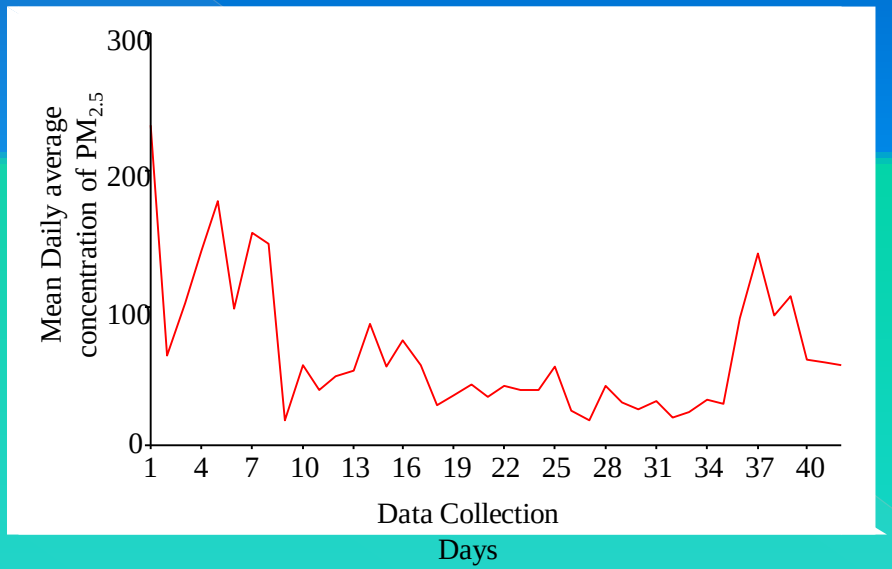


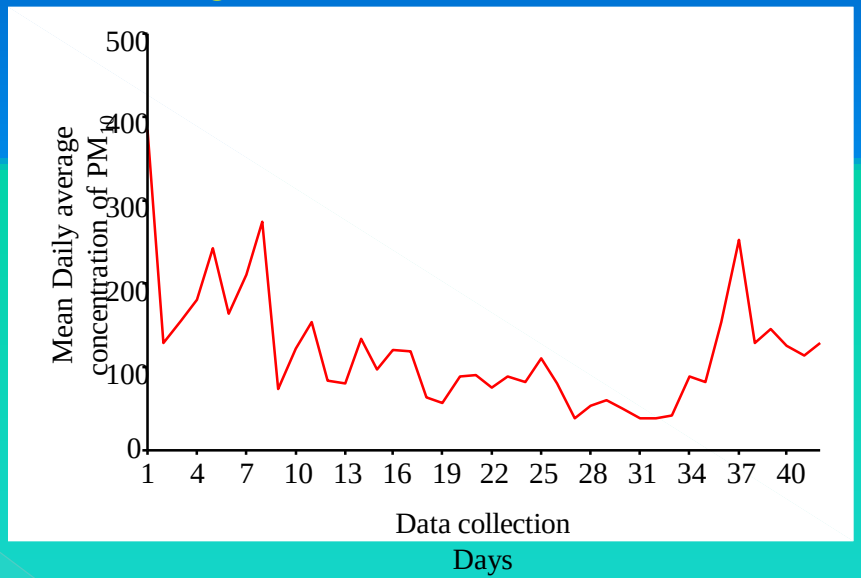
FINDINGS

- **Age of the study participants ranged from 9 to 16 years.**
- **The groups were found to be comparable ($p>0.05$) in terms of gender, age, academic level.**
- **No significant ($p>0.05$) differences between the asthmatic and non-asthmatic groups with respect to anthropometric measurements was found.**
- **Thus the data set of Asthmatic and Non-asthmatic was assumed to be homogenous with respect to the socio-demographic and anthropometric variables.**

FINDINGS

PM $_{10}$ and PM $_{2.5}$

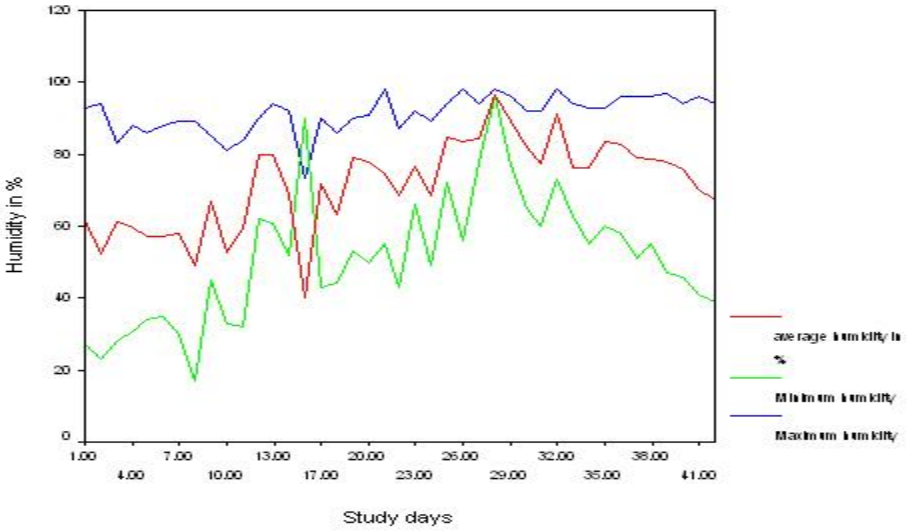


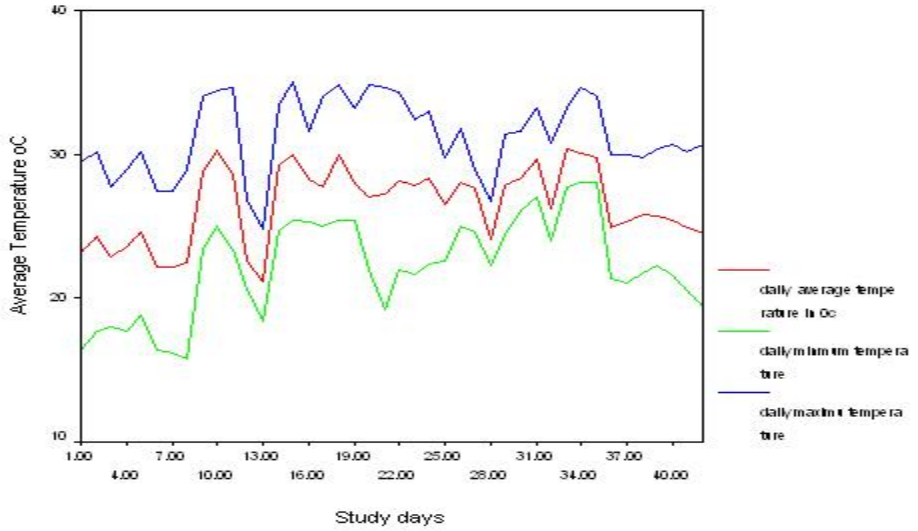


- **The daily mean concentrations of PM_{10} varied from 38 to 385 µg/m³ with a mean of 119 µg/m³. It exceeded the Bangladesh daily PM_{10} standard of 150 µg/m³ on 10 of the 42 days of health impact data collection.**
- **The daily mean concentrations of $PM_{2.5}$ varied from 18 to 233 µg/m³ with a mean of 67 µg/m³. It exceeded the Bangladesh daily $PM_{2.5}$ standard of 65 µg/m³ on 13 of the 42 days of health impact data collection.**

Findings....

Humidity and Temperature





Average Low Humidity was found in first 11 days of study period which was 48-59 %. After that the average humidity was increased and it was highest (98%) on 21th and 32nd day. The Lowest humidity was 17%.

Average Low Temperature was observed during first 10 days which was 22-24^{0}C and the Lowest Temperature was 15.80^{0}C on 8th day. The Temperature was again found to be low from the 36th day of the study. The Highest Temperature was 35^{0}C on 15th day.

Mean morning and afternoon PEFR of Male and Female students of different classes

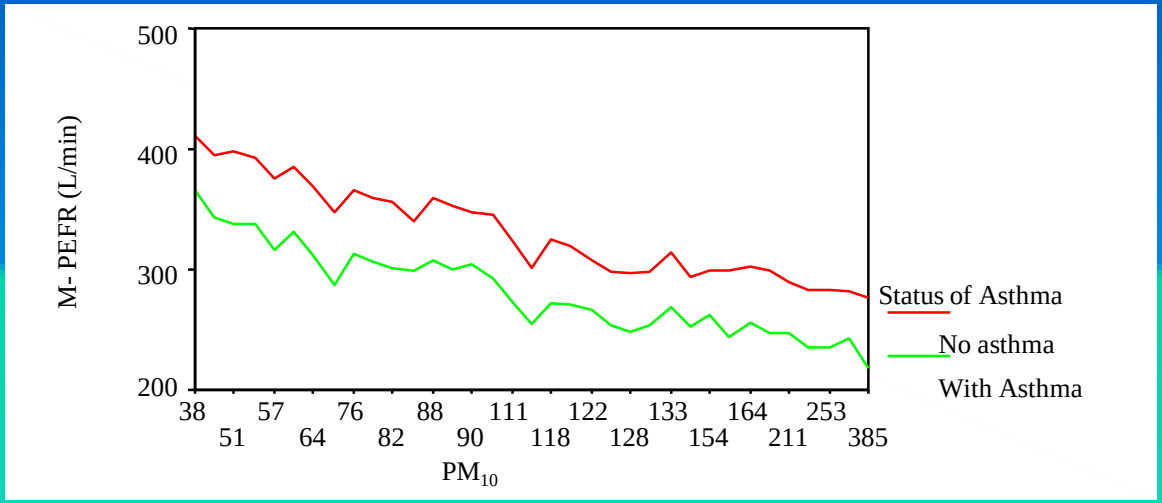
Academic Level	Gender	PEFR Morning (L/min)	PEFR Afternoon (L/min)	Paired t test
Class-V	Male	294.84	283.42	t=31.300; p=.000
	Female	286.72	273.99	t=31.830; p=.000
	Total	291.23	279.23	t=47.558; p=.000
Class=VI	Male	296.54	284.09	t=30.445; p=.000
	Female	296.14	288.28	t=2.031; p=.043
	Total	296.34	286.20	t=5.197; p=.000
Class-VII	Male	307.66	294.96	t=24.100; p=.000
	Female	312.14	298.64	t=20.367; p=.000
	Total	310.27	297.10	t=29.654; p=.000
Class-VIII	Male	298.43	284.53	t=23.136; p=.000
	Female	302.10	288.95	t=23.867; p=.000
	Total	300.47	286.99	t=33.196; p=.000
Class-IX	Male	327.80	313.06	t=22.652; p=.000
	Female	299.08	285.78	t=28.835; p=.000
	Total	314.83	300.74	t=34.078; p=.000
Total	Male	305.16	292.32	t=55.559; p=.000
	Female	299.95	288.18	t=12.250; p=.000
	Total	302.55	290.254	t=24.971; p=.000

Mean morning and afternoon PEFR of asthmatic and non-asthmatic students of different classes

Academic Level	Asthma Status	PEFR Morning (L/min)	PEFR Afternoon (L/min)	Paired t test
Class-V	Asthma	275.00	261.86	t=37.325; p=.000
	Non-asthma	317.10	307.98	t=37.856; p=.000
Class=VI	Asthma	283.70	270.32	t=36.324; p=.000
	Non-asthma	322.44	318.99	t=0.582; p=>0.05
Class-VII	Asthma	293.17	278.25	t=30.100; p=.000
	Non-asthma	341.20	331.19	t=11.774; p=.000
Class-VIII	Asthma	286.27	271.63	t=29.598; p=.000
	Non-asthma	349.62	340.17	t=18.438; p=.000
Class-IX	Asthma	290.55	274.89	t=35.315; p=.000
	Non-asthma	358.88	347.65	t=13.633; p=.000
Total	Asthma	286.20	271.88	t=77.152; p=.000
	Non-asthma	335.19	326.92	t=05.802; p=.000

Findings…….

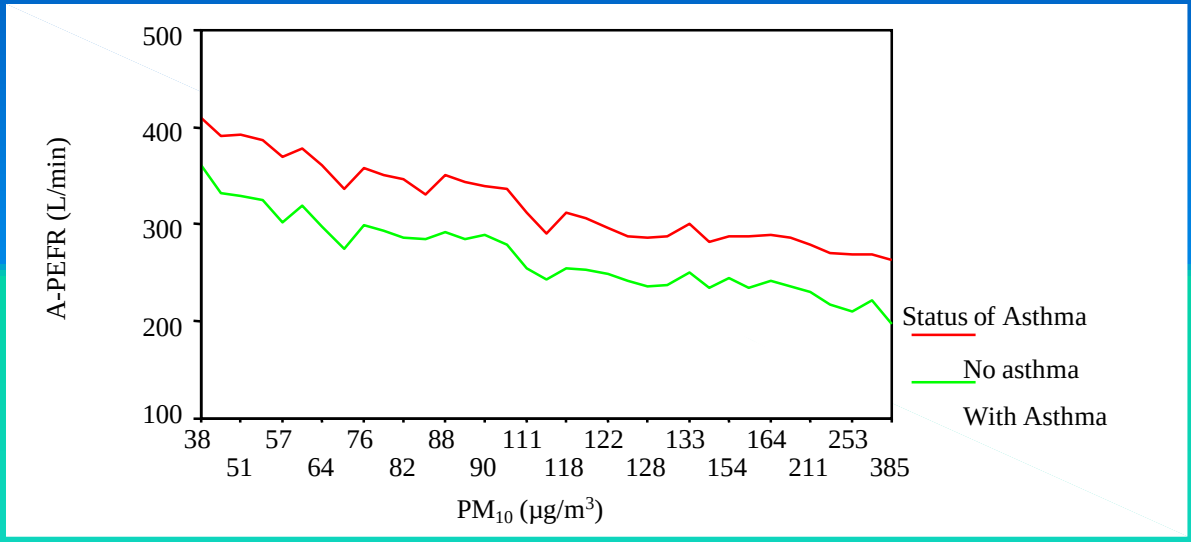
M-PEFR PM10



- **Non-asthmatic (335.19 L/min) students had a significantly higher mean morning PEFR than asthmatic (286.20 L/min) students (F=323.11; p=<0.001).**
- **A significant effect of PM_{10} concentration was observed on morning PEFR that alone accounted for 58.4% and the variance (F= 2624.20; p= <0.001) could increase up to 60.10% if asthma status was considered.**
- **Irrespective of asthma status, an increase in PM_{10} concentration result in reduction in the morning PEFR (β =1.07).**
- **The morning PEFR decreased by 37.60% in both asthmatic and non-asthmatic children from the lowest to the highest level of PM_{10} concentration.**

Findings…….

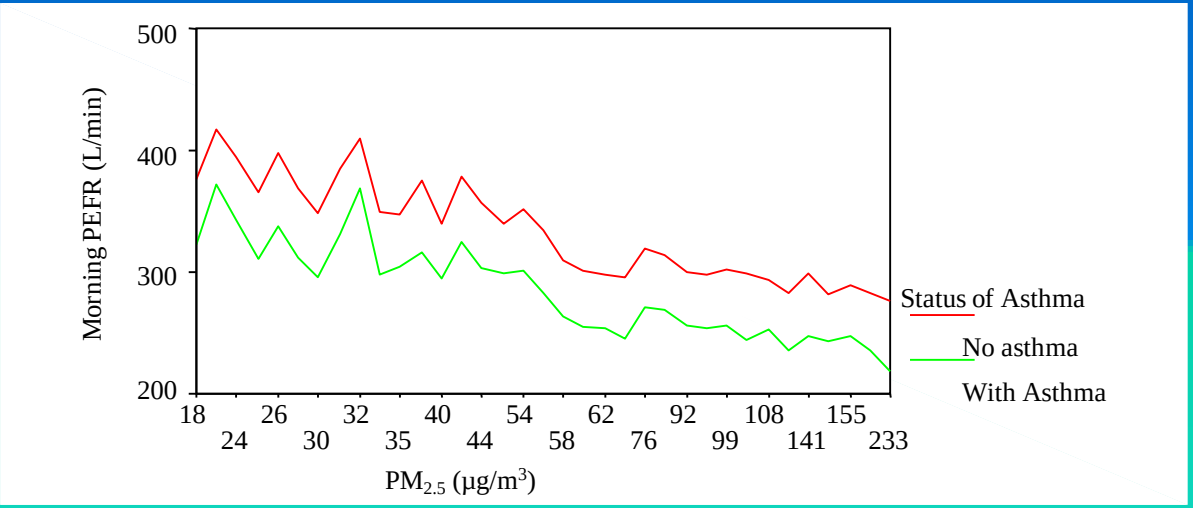
A-PEFR PM10



- **The non-asthmatic (326.92 L/min) students had a significantly higher mean afternoon PEFR than the asthmatic (271.88 L/min)students (F=380.48; p=<0.001).**
- **A significant effect of PM_{10} concentration on afternoon PEFR that alone accounted for 60.9% variance of the afternoon PEFR and the variance could increase up to 62.7% if asthma status was considered. (F=2913.29; p= <0.001).**
- **Irrespective of asthma status, the increase in PM_{10} concentration was associated with a reduction in the afternoon PEFR (β = 1.07).**
- **A 41.87% reduction of afternoon PEFR was observed due to change from the lowest to the highest level of PM_{10} concentration.**

Findings.....

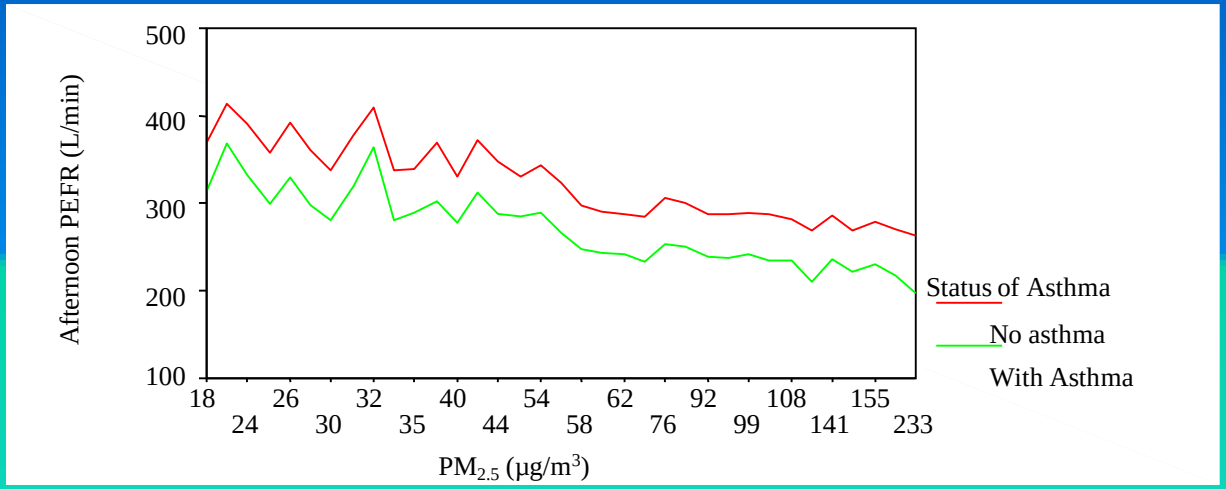
M-PEFR $PM_{2.5}$



- **Non-asthmatic students exhibited significantly higher mean-morning-PEFR than the asthmatic students (F=395.36; p=<0.001).**
- **A significant effect of $PM_{2.5}$ concentration was observed on morning PEFR that alone accounted for 48.7% and the variance (p= <0.001) could increase up to 51.30% if asthma status was considered.**
- **One SD increase of $PM_{2.5}$ concentration result in reduction of .73 SD PEFR.**
- **Morning PEFR decrease by 30% with an increase of $PM_{2.5}$ concentration from lowest to highest.**

Findings.....

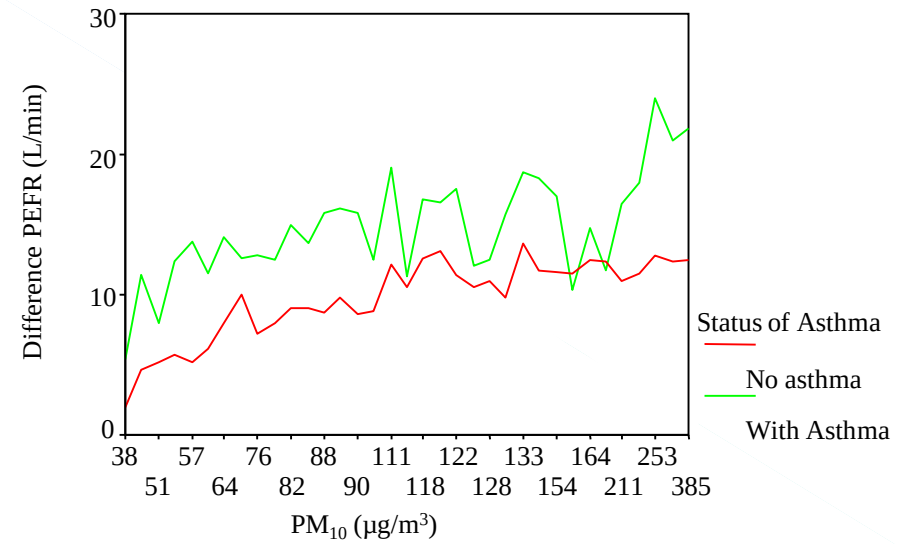
A-PEFR $PM_{2.5}$

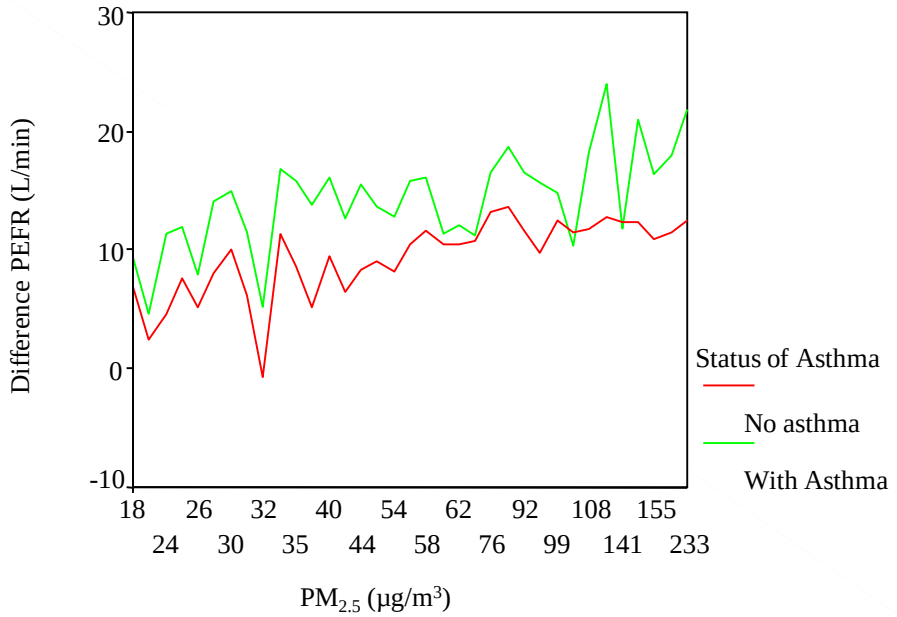


- **Non-asthmatic students had a significantly higher mean afternoon PEFR than the asthmatic students (F = 448.68; p=<0.001).**
- **A significant effect of $PM_{2.5}$ concentration on afternoon PEFR that alone accounted for 50.50% variance of the afternoon PEFR and the variance could increase up to 53.3% if asthma status was considered. (F=1910.51; p= <0.001).**
- **One SD increase of $PM_{2.5}$ concentration result in reduction of .718 SD PEFR.**
- **A 33.85% reduction of afternoon PEFR was observed due to change from the lowest to the highest level of $PM_{2.5}$ concentration.**

Findings....

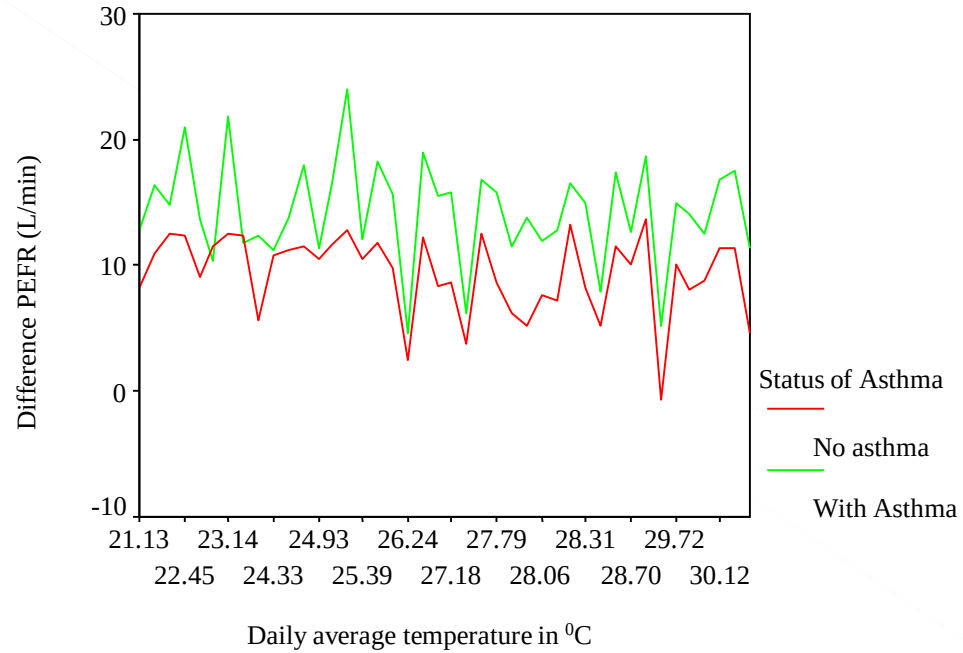
PEFR in relation to PM_{10} and $PM_{2.5}$ concentrations in both asthmatic and non-asthmatic children.

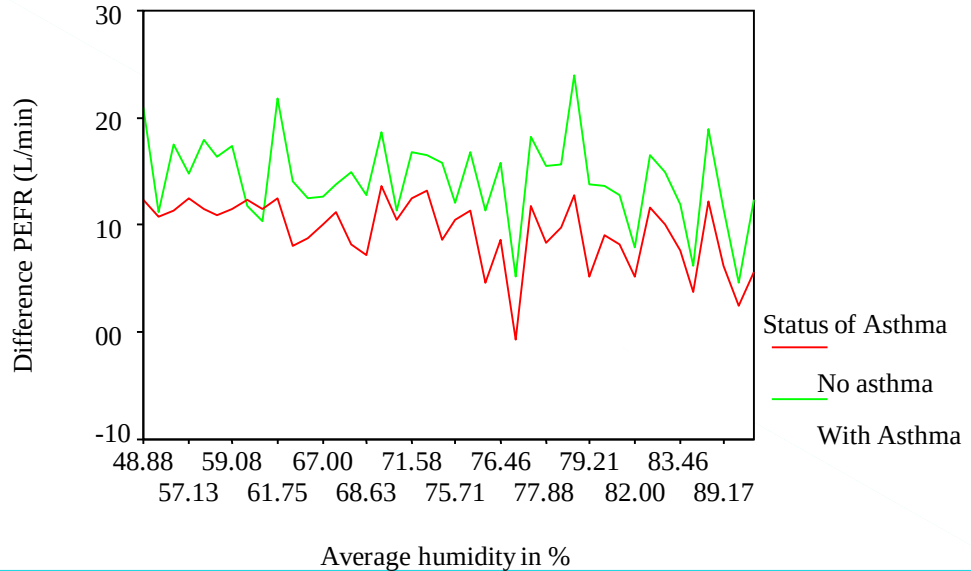




- PEFR decreased by about 40% in both asthmatic and non-asthmatic children when PM_{10} increased from its lowest level of 38 µg/m³ to its highest daily mean of 385 µg/m³.
- PEFR decreased by about 30% in both asthmatic and non-asthmatic children when $PM_{2.5}$ increased from its lowest level of 18 µg/m³ to its highest daily mean of 233 µg/m³.

Findings.....





- **PEFR increased in both asthmatic and non-asthmatic children with increases in temperature and humidity.**
- **PEFR increased by about 25% when minimum temperatures increased from 15°C to 27°C, and by about 40% when average humidity increased from 60 to 90%.**

Findings……..

Temperature and Humidity

The Temperature and Humidity were independently affecting the Morning, Afternoon and Difference PEFR with statistical significance.

After removing the effect of temperature and humidity, the PM_{10} and $PM_{2.5}$ concentrations were alone significantly influencing the Morning, Afternoon and Difference PEFR.

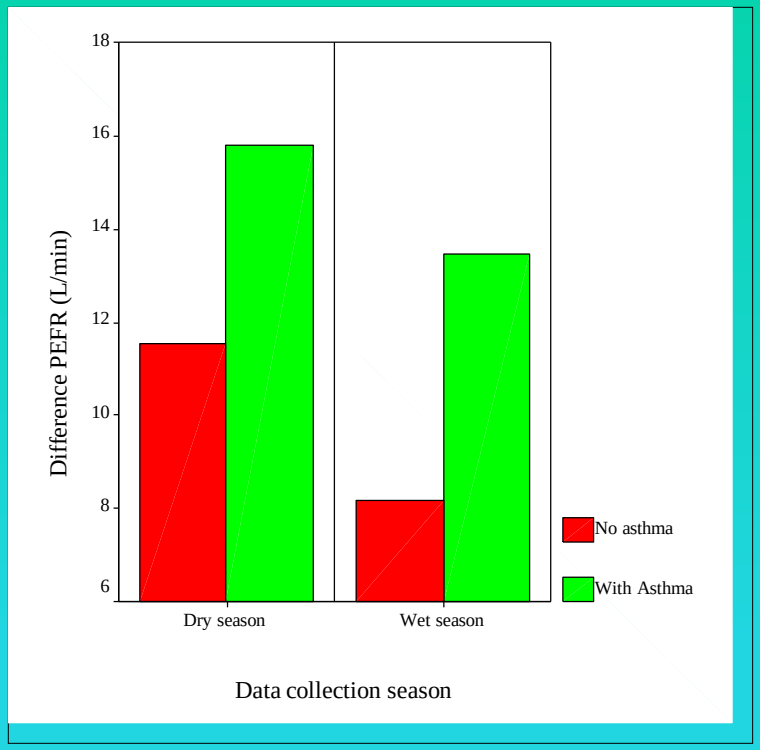
After removing the effect of PM_{10} and $PM_{2.5}$ it was observed that humidity could significantly influence the Morning and Afternoon PEFR with a positive direction but humidity could not affect the Difference PEFR.

Findings……..

- But the daily average temperature could significantly influence the Morning, Afternoon and the Difference PEFR, even after removing the affect of PM_{10} and $PM_{2.5}$.
- So it can be concluded that the difference between Morning and Afternoon PEFR change had not been contributed by Humidity status of the study period but was influenced by PM_{10} , $PM_{2.5}$ and daily average temperature (F= 397.30;35.60 & 16.24 respectively). It was also found that the PEFR change was mainly contributed by PM_{10} concentrations.

Findings…..

Seasonal Variation of PEFR and PM_{10} $PM_{2.5}$



- PM_{10} conc. varies from dry season to wet season with a higher mean of 104.04 µg/m3 in dry season than wet season (t=71.29, p=<.001).
- $PM_{2.5}$ conc. was also high during dry season with a mean value of 115.5 mg/m^3 whereas it was only 40.9 µg/m^3 during the wet season (t=771.98, p=<.001).
- The morning and afternoon PEFR difference was found to decrease from dry to wet season in both asthmatic and non asthmatic group, however, the extent of this decrease is more pronounced among the non-asthmatic group and is also highly statistically significant (F=40.18 and P=<001).

Findings

Total Expenditure for respiratory problem by Asthma Status

Respiratory Problems	Mean (±SD)-Taka	Min	Max	Significance
No asthma (35)	3478.86 (±4171.34)	200.00	19000.00	F=-21.456, p<0.001
With Asthma (73)	6918.68 (±3315.18)	1411.00	17200.00	
Total (108)	5803.43 (±3942.15)	200.00	19000.00	

- **Total annual expenditure for respiratory illnesses of asthmatic children (6918 Taka, about 100 USD) was twice the expenditure of non-asthmatic children (3478 Taka).**
- **There are about 2.37 million children of school age in Dhaka, and this study suggest about 25.8% have clinical symptoms of asthma, about 0.61 million children. The additional annual expenditure on respiratory illnesses for about 0.61 million children with asthma is about USD 30 million.**

Conclusion

It is evident from the study, that most of the days of the year, the pollutants load, both PM_{10} and $PM_{2.5}$, in the air and the humidity level of Dhaka, Bangladesh is quite high.

PM_{10} is the most predominant factor.

These factors particularly PM_{10} concentrations are detrimentally affecting the respiratory health of the children of Dhaka city.

Cost for the management of respiratory problems have adverse economical implication at the family and in turn on the national economy.

Recommendations

- Air pollution should be paid due attention as an important cause of morbidity and mortality and should be regarded as an economic burden to the nation.

- Major causes and sources of air pollution especially the particulate matter should be identified and necessary control measures should be undertaken.

- Planned green belt in Dhaka city, especially around the schools could be created.

- School health program with especial emphasis on respiratory health problems should be strengthened.

- Further study should be conducted to identify the specific pollutants which are mostly contributing towards adverse effects on respiratory health.

Thank You