# HAZARDOUS EFFECTS OF COAL POLLUTION ON COMPLETE BLOOD COUNT AND PEAK EXPIRATORY FLOW

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**ABSTRACT:** To find out the effects of coal power plant related air pollution on complete blood count and peak expiratory flow. After taking a detailed history and written consent, detailed data of 50 young persons was collected, excluding patients suffering from cardiac and respiratory problem. Peak expiratory flow meter was used to measure peak expiratory flow and complete blood count was calculated with an automated analyzer**.** 50% of young students recruited, had a peak expiratory flow below the normal range which suggests how coal induced pollution is affecting younger people. On observing complete blood count it was seen that most of the patients had a low Mean Corpuscular Hemoglobin Concentration(MCHC) and mean corpuscular volume(MCV), suggesting that high levels of pollutants in air are also contributing to changes in blood picture in almost 50% of our patients.

**Keywords:** Air Quality Index (AQI), Peak expiratory flow (PEF), Body Mass Index(BMI).

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## INTRODUCTION

Over the last few decades, Asian countries have experienced a substantial growth in development which has led to urbanization combined with motorization and increased energy consumption. This has also led to increase in number and types of emission of pollutants in the area[2] .Heavy industrial activity, population explosion and a significant increase in motor vehicle usage are posing severe environmental impact in region [4]. Pakistan is a country facing acute energy deficit for the past two decades. This shortfall of around 6000MW has negatively affected economic growth and reduced GDP by 4%[6].Coal has been been the cheapest source of energy production and generation. There is heavy reliance on coal as a source of energy because of its cost and role in development. This has caused an increase in air pollution which has posed a danger to environment, quality of life and health in countries where emission control measures are not being adopted. Despite having coal reserves of 186 million tons, only 114Mw energy is generated from coal[3].So up till now it remains major source of energy for developed countries[1].As coal is needed for energy by the world, environmental concerns have shifted policies towards efficient use of coal. High levels of particulate matter (PM2.5, PM10) have been reported [5].The Pakistan economic survey report of 2006-2007 indicated that the air quality in Pakistan has deteriorated due to increase in population and a much greater rise in private vehicles. This has led to increase in particulate matter which has caused 22000 premature deaths among adults and 700 deaths in children[9] .Countries are now trying to achieve maximum energy from coal and minimizing emissions at the same time. There is widespread evidence that short-term increase in ambient air pollution has resulted in increased mortality and morbidity in adults and children, even at levels below current air quality standards.[7]

The purpose of study was to gain insight into pulmonary inflammation caused by particulate air pollution. This would create awareness about reducing factors like traffic and restricting private cars along with taxing hydrocarbons. It would not only help policy makers to take specific precautions in future projects of this kind to reduce harmful effects but will also encourage further research on coal related pollution and prevalence of related pathologies.

## MATERIALS AND METHODS

A study was designed to observe the effects of coal pollution on complete blood count and Peak expiratory flow.

The persons included in the study were those living in and around Sahiwal, not suffering from any acute or chronic condition. Written consent was taken and all were requested to fill in a questionnaire. Collected data included demographic characteristics, parent smoking habits, parental education level, density of habitation, wood and coal heating.

Patients with impaired lung function due to asbestosis, pneumoconiosis or those suffering from COPD were excluded. Patients on anticoagulants,

wearing a pacemaker, with history of recent myocardial infarction(less than 3 months), angioplasty or bypass surgery were not included. In addition, patients with history of repeated hospitalizations, continuing oxygen therapy and on repeated antibiotics use were not included in the study.

The present study took place at Sahiwal in morning and afternoon. Healthy young adults were recruited as subjects after getting approval from the ethical committee. Patients were informed about the aims of the study, they agreed and were asked to fill in questionnaire. Total of 50 subjects were selected which included 32 males and 18 females. Blood was drawn by a technician after complete physical examination in which height and weight were also measured by us. Patient were asked about smoking, alcohol consumption, use of any medication or medical condition. Venous blood was analyzed for hemoglobin concentration and total RBC count .White blood cell count was measured using standard automated electrical hematology analyzer. White blood cells were counted including lymphocytes, monocytes, eosinophils, basophils and neutrophil granulocytes. Peak expiratory flow was measured using peak expiratory flow meter. We connected a clean mouthpiece and ensured that marker was set at zero. Patients were asked to stand up or sit upright. They were then instructed to take a deep breath in as much as was possible and hold it. A mouth piece was placed in their mouth and a tight seal was formed around it with the help of lips. The patient was then asked to breath into Peak expiratory flow meter as hard as he could. Peak expiratory flow was then observed and recorded. Pollution standard index of Sahiwal was recorded for reporting air quality, which is based on five major pollutants including particulate matter, sulfur dioxide, nitrogen dioxide, carbon monoxide and ozone in air. A key aim of study was to examine the effect of coal particles on blood cell and breathing.

**Statistical Analysis:** A statistical package SPSS was used for data analysis. The variables of hematological parameters were analyzed using the regression model with $F = 2.55$ and $p < 0.05$. Air pollution data was analyzed using predictors as BMI, WBC, MCH (27-32), Hct, Hb and MCV. Statistically significant differences in RBC in people exposed to various air pollutants mentioned above were analyzed and found a p-value $< 0.05$.

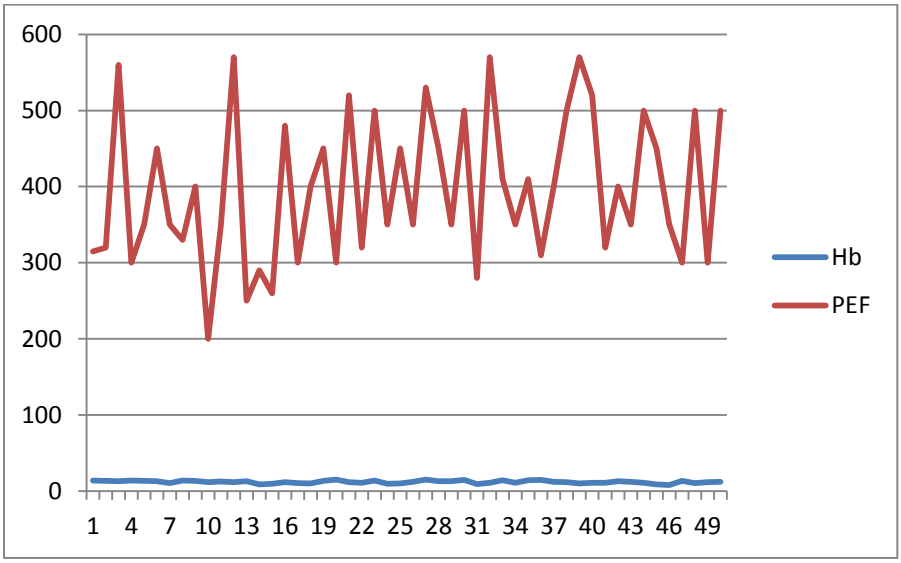


**Figure:1 Variation of peak expiratory flow.**

## RESULTS AND DISCUSSION

Coal power plants transfer dangerous air pollutants which can damage not only eyes, skin and respiratory system but also can influence brain and kidneys leading to cancer and also to impairment of vital systems of the body**.** These plants spread at least 84 pollutants out of 187 that have been identified by Environmental Protection Agency[8] Now as these plants have been installed to overcome energy crisis, they are a big hazard to respiratory system as it is most commonly effected. Researchers have observed that metals present in exhaust of the plants generate reactive oxygen species which seriously affects the ability of cell repair and leads to inflammation[10]. In follow up study done on patients living near polluted cities it was observed that mortality rate increased with prevalance of PM2.5 which was related to coal pollution[11]. So we conducted a study at Sahiwal to see the relation between pulmonary function and air pollution.

Pulmonary functions are determined by the strength of respiratory muscles and compliance of thoracic cavity along with resistance of air ways and elastic recoil of the lungs[12]. Peak expiratory flow rate is the maximum or peak flow rate that is achieved after a forceful expiratory effort after taking a deep inspiration. It is expressed in liters per minute. Its value is effected by parameters like age, sex, height, body weight and physical activity[13]. Some details on this issue can be seen in[14, 15]. It measures the amount of air passing through the bronchi and helps us to assess bronchial tone. Peak expiratory flow rate is a valuable parameter to assess lung functions[7].Its average value in young healthy males and females is 500 and 350 litres respectively.[8] Mostly a reading in the range of 400-600l/min is considered normal, while in diseases like asthma reading can be as low as 200-400 l/min. In our study 50% of young students living in Sahiwal had a peak expiratory flow below the normal range which suggests how coal induced pollution is affecting our younger population although no significant disease was found. AQI is a useful indicator of pollution. In our study when AQI was calculated it was found that there was a significantly high value for Sahiwal as compared to other cities of Pakistan. This poor quality of air is responsible for reduction in Peak expiratory flow values in very young healthy population of students. However no significant relation of PEF and BMI was found which suggested that probably PEF is independent of body mass index (Correlation Coefficient, $r = 0.087$ with $p > 0.549$). On observing complete blood count it was seen that most of the patients had a low Mean corpuscular hemoglobin concentration and mean corpuscular volume, suggesting that high levels of pollutants in air are also contributing to changes in blood picture in almost 50% of our patients. This suggests that most of our patients fall in the yellow zone according to international criteria. This zone indicates that such patients should be cautioned as their airways are narrowing and they may require medication.

**Outcomes of the study:** This study would help to create awareness to move away from fossils fuels and replace them with alternate energies, like solar or wind. It would help to motivate them to shift to more efficient systems. It will also help to update laws and regulations related to air pollution. Last but not least it would suggest that better coordination between different departments should be led by powerful environmental protection agencies**.** So this study would help to create awareness among young persons to take additional precautionary measures to avoid respiratory problems in future and will also help the coal power authorities to take additional measures to reduce air pollution by using effective control techniques. This would also help to develop rules to reduce the effect of environmental pollutants on public health.

**Table1. COMPARISON OF BLOOD PARAMETERS AND PEAK EXPIRATORY FLOW.**

| Sr. No | Hb | WBC | Hct | MCV | MCH (27-32) | MCHC (31-35) | RBC | PEF | BMI |
|---|---|---|---|---|---|---|---|---|---|
| **1.** | 14.2 | 7.9 | 49.9 | 99.4 | 28.3 | 28.5 | 5.02 | 315 | 24.5 |
| **2.** | 13.6 | 6.8 | 51 | 99 | 26.3 | 26.6 | 5.17 | 320 | 22.1 |
| **3.** | 13.4 | 6.5 | 49.2 | 87.9 | 23.9 | 27.2 | 5.6 | 560 | 19.5 |
| **4.** | 14 | 6.9 | 49.5 | 92.2 | 24.9 | 28.3 | 5.35 | 300 | 21.5 |
| **5.** | 13.8 | 7.7 | 5.45 | 51.4 | 25.3 | 26.8 | 5.45 | 350 | 26.7 |
| **6.** | 13.0 | 7.6 | 46.8 | 97.5 | 27.1 | 27.8 | 4.80 | 450 | 18.7 |
| **7.** | 10.8 | 9.3 | 42.4 | 68.5 | 17.4 | 25.5 | 6.19 | 350 | 18.6 |
| **8.** | 14.0 | 9.3 | 49.4 | 95.6 | 28.2 | 29.1 | 5.37 | 330 | 21.1 |
| **9.** | 13.7 | 8 | 53.3 | 95.0 | 24.4 | 25.7 | 5.61 | 400 | 21.3 |
| **10.** | 12.0 | 8.7 | 47.6 | 101.9 | 28.6 | 32.2 | 4.67 | 200 | 21.5 |
| **11.** | 12.8 | 6.6 | 49.8 | 101 | 26.0 | 25.7 | 4.93 | 350 | 19.9 |
| **12.** | 12.0 | 6.7 | 48.0 | 95.6 | 23.8 | 24.9 | 5.04 | 570 | 26.3 |
| **13.** | 13.2 | 4.5 | 50.7 | 92.2 | 24.0 | 26.0 | 5.50 | 250 | 18.9 |
| **14.** | 9.0 | 5.5 | 38.2 | 88.8 | 20.9 | 23.6 | 5.5 | 290 | 26.1 |
| **15.** | 9.9 | 5.2 | 41.4 | 92.6 | 24.1 | 23.9 | 4.47 | 260 | 17.9 |
| **16.** | 12.0 | 7.6 | 51.0 | 79.1 | 18.6 | 23.5 | 6.45 | 480 | 21.3 |
| **17.** | 10.5 | 6.2 | 41.9 | 101.0 | 27.6 | 25.1 | 3.81 | 300 | 18.4 |
| **18.** | 10.4 | 5.3 | 44.7 | 76.9 | 17.9 | 23.3 | 5.81 | 400 | 20.3 |
| **19.** | 13.7 | 5.9 | 50.7 | 98.2 | 27.7 | 27.0 | 4.94 | 450 | 20.9 |
| **20.** | 15.1 | 8.5 | 53.5 | 94.9 | 26.8 | 28.2 | 5.64 | 300 | 24.3 |
| **21.** | 11.9 | 7.2 | 45.6 | 111 | 29.2 | 26.1 | 4.08 | 520 | 22.2 |
| **22.** | 11.2 | 5.5 | 38.8 | 106 | 30.6 | 28.9 | 3.6 | 320 | 18.6 |
| **23.** | 14.2 | 6.4 | 47.8 | 87.4 | 26.0 | 29.7 | 5.47 | 500 | 20.5 |
| **24.** | 9.9 | 10.2 | 36.0 | 79.6 | 21.9 | 27.5 | 4.52 | 350 | 21.8 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **25.** | 10.3 | 6.6 | 38.0 | 78.4 | 21.2 | 27.1 | 6.6 | 450 | 21.3 |
| **26.** | 12.2 | 6.2 | 47.8 | 97.6 | 24.9 | 25.5 | 4.90 | 350 | 19.8 |
| **27.** | 15.3 | 9.3 | 56.6 | 96.1 | 26.0 | 26.0 | 5.89 | 530 | 18.3 |
| **28.** | 13.4 | 5.6 | 43.0 | 91.1 | 28.4 | 31.2 | 31.2 | 450 | 24.6 |
| **29.** | 13.2 | 9.5 | 43.8 | 90.7 | 27.3 | 27.3 | 4.83 | 350 | 20.1 |
| **30.** | 14.9 | 7.3 | 50.8 | 86.1 | 25.3 | 29.3 | 5.90 | 500 | 22.2 |
| **31.** | 9.4 | 7.1 | 34.5 | 79.9 | 21.8 | 27.2 | 4.32 | 280 | 21.6 |
| **32.** | 11.0 | 8.6 | 39.6 | 83.5 | 23.2 | 27.8 | 4.74 | 570 | 19.5 |
| **33.** | 14.5 | 6.9 | 47.2 | 80.7 | 24.8 | 30.7 | 5.85 | 410 | 19.0 |
| **34.** | 11.2 | 8.0 | 43.3 | 66.0 | 17.1 | 25.9 | 6.56 | 350 | 19.5 |
| **35.** | 14.4 | 8.9 | 52.2 | 99.8 | 26.4 | 30.9 | 5.45 | 410 | 23.1 |
| **36.** | 14.9 | 6.4 | 53.8 | 98.0 | 27.1 | 27.7 | 5.4 | 310 | 21.3 |
| **37.** | 12.2 | 5.2 | 51 | 80.3 | 19.2 | 23.9 | 6.35 | 400 | 22 |
| **38.** | 12.04 | 7.1 | 42.4 | 84.3 | 24.7 | 29.2 | 5.03 | 500 | 22.1 |
| **39.** | 10.1 | 6.7 | 40.6 | 77.9 | 19.4 | 24.9 | 5.21 | 570 | 19.6 |
| **40.** | 11.1 | 6.4 | 42.1 | 90.7 | 23.9 | 26.4 | 4.64 | 520 | 22.4 |
| **41.** | 11.2 | 9.5 | 39.1 | 87.5 | 25.0 | 28.6 | 4.48 | 320 | 18.6 |
| **42.** | 13.0 | 7.6 | 44.8 | 90.9 | 26.4 | 29.0 | 4.93 | 400 | 23.2 |
| **43.** | 12.4 | 6.9 | 44.7 | 92.7 | 25.7 | 27.7 | 4.82 | 350 | 19.8 |
| **44.** | 11.1 | 7.0 | 41.9 | 88.2 | 23.4 | 26.5 | 4.75 | 500 | 22.6 |
| **45.** | 8.8 | 7.8 | 35.1 | 84.4 | 21.2 | 25.1 | 4.16 | 450 | 21.4 |
| **46.** | 8.2 | 5.0 | 30.9 | 84.4 | 22.4 | 26.5 | 3.66 | 350 | 19.7 |
| **47.** | 13.6 | 8.3 | 48.0 | 86.0 | 24.4 | 28.3 | 5.58 | 300 | 22.0 |
| **48** | 10.8 | 6.8 | 40.5 | 87.9 | 23.4 | 26.5 | 4.61 | 500 | 23.1 |
| **49.** | 12.0 | 8.2 | 42.8 | 93.2 | 26.1 | 28.0 | 4.59 | 300 | 21.5 |
| **50.** | 12.4 | 7.1 | 42.4 | 84.3 | 24.7 | 29.2 | 5.03 | 500 | 22.6 |

**ANOVA[a]**

| **Model** | | **Sum of Squares** | **df** | **Mean Square** | **F** | **Sig.** |
|---|---|---|---|---|---|---|
| | Regression | 181.351 | 6 | 30.225 | 2.552 | .033[c] |
| 1 | Residual | 509.200 | 43 | 11.842 | | |
| | Total | 690.551 | 49 | | | |

a. Dependent Variable: RBC

c. Predictors: (Constant), BMI, WBC, MCH (27-32), Hct, Hb, MCV

**Conclusion:** Air pollution is associated with increase incidence of chronic disease and mortality. It is a source of many substances that may enter the blood stream and produce harmful effects on the bone marrow, spleen and lymph nodes. The aim of our study was to evaluate any effects of these pollutants on blood and find the abnormalities in Peak expiratory flow in persons exposed to them. Persons exposed to high levels of pollution show association of pollutants with changes in blood picture. The investigation has shown that exposure to air pollutants is strongly linked with changes in blood picture and Peak expiratory flow. Toxic materials from air lead to changes in hematocrit and hemoglobin. Persons exposed to air pollution have high incidence of anemia.

We think that in future the increase in pollutants associated with habitat destruction will be more demanding for public and private sectors. This will help to adopt meaningful measures for protection of the exposed population.

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