Shivani Awasthi. / IJIDD / Vol 6 / Issue 1 / 2016 / 1-7.

International Journal of
Innovative Drug Discovery
e ISSN 2249 - 7609
Print ISSN 2249 - 7617
www.ijidd.com

EVALVATION OF AIR POLLUTION IMPACT IN HUMAN HEALTH AT J.P CEMENT PLANT, REWA, (M.P).

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ABSTRACT

Air pollution is a major environmental health problem affecting the developing and the developed countries alike. The effects of air pollution on health are very complex as there are many different sources and their individual effects vary from one to the other. In fact in the developing world the highest air pollution exposures occur in the environment. Air pollutants that are inhaled have serious impact on human health affecting the lungs and the respiratory system; they are also taken up by the blood and pumped all round the body. These pollutants are also deposited on soil, plants, and in the water, further contributing to human exposure.

KEY WORDS: Air pollution, Environmental health problem.

INTRODUCTION

Although a number of physical activities (volcanoes, fire, etc.) may release different pollutants in the environment, anthropogenic activities are the major cause of environmental air pollution. Hazardous chemicals can escape to the environment by accident, but a number of air pollutants are released from industrial facilities and other activities and may cause adverse effects on human health and the environment. By definition, an air pollutant is any substance which may harm humans, animals, vegetation or material. As far as humans are concerned an air pollutant may cause or contribute to an increase in mortality or serious illness or may pose a present or potential hazard to human health. The determination of whether or not a substance poses a health risk to humans is based on clinical, epidemiological, and/or animal studies which demonstrate that exposure to a substance is associated with health effects. In the context of human health, ‘‘risk’’ is the probability that a noxious health effects may occur [1]. The amended Clean Air Act mandated national ambient air quality standards for pollutants that are relatively common and widespread but may reasonably be anticipated to endanger public health. Six pollutants that met these basic criteria (criteria pollutants) were eventually selected, including particulate matter (PM), sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, and lead [2].

The contribution of industrial activities to the atmospheric emissions in the study region is relevant, accounting around 80% of total emissions in the municipality of Estarreja. In the air quality assessment performed for the period 2000-2009, exceedances to limit and target values of SO2, PM10 and O3 concentrations were verified. Most critical pollutants like PM10 and O3 surpass the regulated standards consecutively. Air pollution episodes can be related either with local emissions (industry and traffic) and specific meteorological conditions or with advection and long range transport [3].

Sources of exposure

The majority of substances considered as environmental pollutants are produced through human activities such as the use of internal combustion engines (automobiles), power plants and industrial machinery. Because these activities are performed on such large scale, they are by far the major contributors of air pollution, with cars estimated as responsible for approximately 80% of today’s pollution. Minor sources of pollution such as lawn mowers, cooking stoves, stationary diesel fuel tanks, heaters, gasoline stations, laundries, other cleaning services, etc. are currently being evaluated as well. All the exposure sources mentioned above can be classified as anthropogenic.

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Natural sources of pollution include soil erosion (the wind carries airborne particulate matter produced through erosion), evaporation of sea water (which carries with it various materials), volcanic eruptions and forest fires (which send toxic substances directly into the atmosphere) [4].

Pollutant categories

The main change in the atmospheric composition is primarily due to the combustion of fossil fuels, used for the generation of energy and transportation. Variant air pollutants have been reported, differing in their chemical composition, reaction properties, emission, persistence in the environment, ability to be transported in long or short distances and their eventual impacts on human and/or animal health. However, they share some similarities and they can be grouped to four categories:

A.- Gaseous pollutants (e.g. SO2, NOx, CO, ozone, Volatile Organic Compounds)

B.- Persistent organic pollutants (e.g. dioxins).

C- Heavy metals (e.g. lead, mercury).

D- Particulate Matter.

Gaseous pollutants contribute to a great extent in composition variations of the atmosphere and are mainly due to combustion of fossil fuels [5]. Nitrogen oxides are emitted as NO which rapidly reacts with ozone or radicals in the atmosphere forming NO_2. The main anthropogenic sources are mobile and stationary combustion sources. Moreover, ozone in the lower atmospheric layers is formed by a series of reactions involving NO_2 and volatile organic compounds, a process initiated by sun light. CO, on the other hand, is a product of incomplete combustion. Its major source is road transport too. While the anthropogenic SO_2 results from the combustion of sulphur-containing fossil fuels (principally coal and heavy oils) and the smelting of sulphur containing ores, volcanoes and oceans are its major natural sources. The latter contribute only ~2% of the total emissions. Finally a major class of compounds that fuel combustion and especially combustion processes for energy production and road transport are the major source of emission are the so called volatile organic compounds (VOCs). This is a class of compounds, which includes chemical species of organic nature such as benzene. Even though the majority of gaseous pollutants are inhaled and mainly affect the respiratory system they can also induce haematological problems (CO, benzene) and cancer. Persistent organic pollutants form a toxic group of chemicals. They persist in the environment for long periods of time, and their effects are magnified as they move up through the food chain (bio-magnification). They include pesticides, as well as dioxins, furans and PCBs. Generally, the generic term 'dioxins'' is used to cover polychlorinated dibenzo-dioxins (PCDDs) and polychlorinated furans (PCDFs) while polychlorinated biphenyls (PCB) are called ''dioxin like compounds'' and can act similarly in terms of dioxin-type toxicity [6]. Dioxins are formed during incomplete combustion and whenever materials containing chlorine (e.g. plastics) are burned. Emitted in the atmosphere, dioxins tend to deposit on soil and water but, being water insoluble, they are contaminate ground water sources. Most dioxins in plants come from air and dust or pesticides and enter the food chain where they bio-accumulate due to their ability to be stably bound to lipids. Heavy metals include basic metal elements such as lead, mercury, cadmium silver nickel, vanadium, chromium and manganese. They are natural components of the earth's crust; they cannot be degraded or destroyed, and can be transported by air, and enter water and human food supply. In addition, they enter the environment through a wide variety of sources, including combustion, waste water discharges and manufacturing facilities. To a small extent they enter human bodies where, as trace elements, they are essential to maintain the normal metabolic reactions. However, at higher (although relatively low) concentrations they can become toxic [7]. Most heavy metals are dangerous because they tend to bio-accumulate in the human body. Bioaccumulation means an increase in the concentration of a chemical in a biological organism over time, compared to the chemical's concentration in the environment. Compounds accumulate in organisms any time they are taken in and stored faster than they are broken down (metabolized) or excreted. Particulate matter (PM) is the generic term used for a type of air pollutants, consisting of complex and varying mixtures of particles suspended in the breathing air, which vary in size and composition, and are produced by a wide variety of natural and anthropogenic activities .Major sources of particulate pollution are factories, power plants, refuse incinerators, motor vehicles, construction activity, fires and natural windblown dust. The size of the particles varies (PM2.5 and PM10 for aerodynamic diameter smaller than2.5 mm and 10 mm respectively) and different categories have been defined: Ultrafine particles, smaller than 0.1 mm in aerodynamic diameter, Fine particles, smaller than 1 mm, and Coarse particles, larger than 1 mm. The size of the particles determines the site in the respiratory tract that they will deposit: PM10 particles deposit mainly in the upper respiratory tract while fine and ultra fine particles are able to reach lung alveoli. So far, no single component has been identified that could explain most of the PM effects. Among the parameters that play an important role for eliciting health effects are the size and surface of particles, their number and their composition. The composition of PM varies, as they can absorb and transfer a multitude of pollutants.

However, their major components are metals, organic compounds, material of biologic origin, ions, reactive gases, and the particle carbon core. There is strong evidence to support that ultra fine and fine particles are more hazardous than larger ones (coarse particles), in terms of mortality and cardiovascular and respiratory effects. In addition, the metal content, the presence of PAHs and other organic components such as endotoxins, mainly contribute to PM toxicity. [8].

Pollution impact on human health

The effects of atmospheric pollution on human health are the result of a chain of events starting on the pollutants emission, going through transportation, dispersion in the atmosphere and by the individual inhalation (inhaled dose). The evaluation of those effects implies the knowledge of the several chain links. Human exposure can be defined as an event that occurs when an individual is in contact with a pollutant [9]. The European legislation recognizes and recommends using human exposure as an assessment indicator of health impact. To have exposure it is required that the concentration of a pollutant (a physical environmental characteristic) in a certain location is not zero, and simultaneously, an individual is present in that location [10]. The definition of exposure refers to an instantaneous occurrence between a person i and a concentration pollutant c, for a certain period of time. Exposure does not necessarily imply a pollutant inhalation or ingestion; it is only related with the pollutants levels in the environment. On the other hand, the dose concept is used when a pollutant crosses the physical barrier (body). When analyzing the exposure to atmospheric pollutants, the inhaled dose is referred as the amount of pollutants inhaled by an individual in a determined time. Different methodologies can be applied to determine the individual exposure, using direct measurements or estimations based on exposure concentration data and the time of contact. The general approach for exposure estimation can be expressed by $EXPi = \sum_{n=1}^{j} C_j T_{Ij}$

Where *Expi* is the total exposure for the person i over the specified period of time; *Cj* is the pollutant concentration in each microenvironment j and ti,j is the time spent by the person i in microenvironment j. The calculation of the inhaled dose is conducted recurring to the following equation: , $C_J * T_{IJ} * Vij$ Where V_{IJ} is the person ventilation rate *i* in the microenvironment j. Exposure can be used to infer health effects by the study of dose-response relationships. These correlations can be established by the simultaneous determination of individual exposure and associated health effects.

Medical tests are performed to evaluate the respiratory function of a person which is quantified by the following parameters: pH, NO, CO, % carboxy-haemoglobin (COHb) measurements on the breath condensate, broncodilation test with spirometry, urinary cotitine measurements, forced expiratory volume in 1 first second (FEV1), forced vital capacity (FVC), ratio FEV1/FVC, peak expiratory flow (PEF), flow at 50% of FVC (F50), forced expiratory flow between 25–75% of FVC (F25), mid-expiratory flow rate (MEF). These health indicators allow identifying short-term cause-effect relations as a contribution to the assessment of air pollution impacts on human health. [11]:

SYMPTOMS AND LUNG FUNCTION

There are more than 40 published studies evaluating associations between daily respiratory symptoms and/or lung function and particulate air pollution. Although many of these studies focused on asthmatics and exacerbation of asthma, others followed (flow. Non asthmatics and evaluated changes in acute respiratory health status more generally. Small, often statistically insignificant, associations between particulate pollution and upper respiratory symptoms were observed. Associations with lower respiratory symptoms exposure and cough, however, were typically larger and usually statistically significant. Exacerbation of asthma, based on recorded asthma attacks or increased bronchodilator use, was also associated with particulate air pollution. Associations between more general measures of acute disease have been studied, including adult workers due to illness [12] and school absences in grade school children. Measures of lung function have also been used as an objective and potentially sensitive indicator of acute response to air pollution. Various studies have taken repeated measurements of the lung function of panels of children and/or adults. These studies have typically reported very small but often statistically significant decreases in lung function associated with elevated levels of particulate air pollution concentrations. Lagged effects of up to 7 days were observed [13].

METHODOLOGY

Air quality monitoring of 4 selected site have been carried out .People live in these villages surrounding j.p cement plant were studied for the impact of air pollution .To fulfill this purpose the fallowing quantification were done during the present investigation .

Determination of RPM:- The sampled RPM with glass fabric filter paper was kept in a hot air oven at 105 c^0 for 2 hrs then cooled and weighed.

Calculation of RPM –

$$\mathbf{RPM\ (\mu g/m^3) = 1\times10^6 / k}$$

Where,
I =Dust accumulated on filter paper.
K =Total volume of air passed through filter paper (m^3).
I =B2-B1
B2 = Weight of the filter paper after sampling (gm).
B1 =Weight of the filter paper before sampling (gm).
K =G × T
Where,
G =Average flow rate, G = A1 +A2 /2
A1 = Initial flow rate indicated by Manometer.
A2 = Final flow rate indicated by Manometer.
T = Time of Sampling (minutes).

Determination of the Nitrogen oxides

Nitrogen oxides were collected by bubbling air through a sodium hydroxide sodium arsenite solution. Any water lost by evaporation during sampling was replaced by adding distilled water up to the calibration mark on the absorption tube .1ml hydrogen peroxide solution, 10ml sulfanilamide solution and 1.4 ml NEDA solution was added with mixing after the addition of each reagent after 10 minute color development interval, absorbance was measured at 540 nm spectrophotometrically.

Calculation: - Volume of sampled air was calculated as:-

$$V = E1 + E2 \div 2 \times T$$

Where,
V = Volume of air sampled.
E1 = Initial rotameter reading (LPM)
E2 = Final rotameter reading (LPM)
T = Time of sampling (minutes)
Mass of the Nitrogen oxide in µg /m^3 = (µg No x ml) × 1000 × F ÷ V × 0.82.

Where,
F = Initial absorbing reagent for sampling.
V = Volume of air sampled (lit)
0.82 = Overall average of efficiency.
10^3 = Conversion of liter of cubic meter.

Determination of sulphur dioxide:- S02 was absorbed from air in a solution of sodium tetrachloromercurate (TCM). 1ml sulfamic acid was added to the sample and allowed to react for 10 minutes to the destroy the nitrite from oxide of Nitrogen .Than 2ml of 0.2% formaldehyde solution and 2ml pararosaniline hydrochloride was added .After 30 minutes the absorbance was read at 560 nm on spectrophotometer .

Calculation: - Volume of sampled air was calculated as

$$V = E1 + E2/2 \times T$$

Where,
V =Volume of air sampled.
E1 =Initial rotameter reading (LPM).
E2 = Final rotameter reading (LPM)
T = Time of sampling (minutes).
Mass of sulphur oxides in µg /m^3 = (µg $S0_2$ml) ×1000× F / V

Where,
F = Initial absorbing reagent for sampling.
V = Volume of air sampled (lit).
10^3 = Conversion of liter to cubic meter.

Air pollution index:- Several air pollutants indices have been developed taking different pollutants in to consideration. Almost all of these have arbitrary limits given hardly any emphasis to the dose response relationship. The air pollution indices for the air quality under present investigation were calculated by the followed indices;-

API = 1÷4 (ISPM/SSPM + IRPM /SRPM + ISO2 /SS02 +INOX /SNOX) × 100
Where,
ISPM, IRPM, ISO2 and INOX represent .Individual value of suspended particulate matter, respireable particulate matter, S02, NO2 and SSPM, SRPM, SSO2 and SNOX, their ambient air quality stander respectively.

Index range	Quality of air
0-25	Clean air
26-50	Light air pollution
51 -75	Moderate air pollution
76 -100	Heavy air pollution
More than 100	Severe air pollution

Impact on human health

A questionnaire based survey was conducted in 4 villages located around the cement plants to get prevalence of following diseases;-

Respiratory diseases –Asthma, Bronchitis and Cough.
Skin diseases – Occupation dermatomes, Allergy etc.
Eye diseases- Eye irritation, eye watering, redness etc.
Kidney – Stone, Blood pressure problems.
Other diseases –Anemia, fever, vitamins D deficiency.

OBSERVATION-: The present study was carried out in industrial area of jaypee cement Rewa (M.P).

Study sites:- J.p cement limited is part of jaiprakesh industries limited. Two cement plants are located about 15 K.M from Rewa. JRP is located Naubasta while JBP is located at village Bela, both plants are located in district Rewa (M.P). An area within radius of 10 K.M around the project site has been defined as the study area for the collection of primary and secondary data. 4 sampling sites are located at different direction from source of emission–: Amriya village, Atrauli village, Bankuiyan village and Bholgarh village. Following observation were made.

Table 1. Incidence of the pollution oriented diseases among the people of the Amriya village

S.No	Disease	% of Incidence			
		Male	Female	Children	Total
1	Respiratory diseases	1.78	00.00	3.78	5.57
2	Cardiovascular diseases	7.33	20.44	2.78	30.55
3	Gastrointestinal diseases	6.66	12.89	2.78	22.23
4	Skin diseases	12.11	18.44	0.00	30.55
5	Eye diseases	1	10.11	0.00	11.11

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6	Ear diseases	00.00	0.00	0.00	0.00
7	Dental diseases	0.00	2.78	0.00	2.78
8	Other diseases	11.11	10.56	5.6	27.23

Table 2. Incidence of the pollution oriented diseases among the people of Atrauli village

S.N	Disease	% of incidence			
		Male	Female	Children	Total
1	Respiratory diseases	8.55	9.76	3.10	21.44
2	Cardiovascular diseases	4.38	5.97	1.22	11.57
3	Gastrointestinal diseases	12.32	15.17	4.11	31.60
4	Skin diseases	13.24	6.58	5.28	25.10
5	Eye diseases	9.65	9.58	4.17	19.43
6	Ear diseases	1.23	3.01	0.84	5.05
7	Dental diseases	1.56	0.87	0.55	2.98
8	Other diseases	6.21	7.57	6.61	20.39

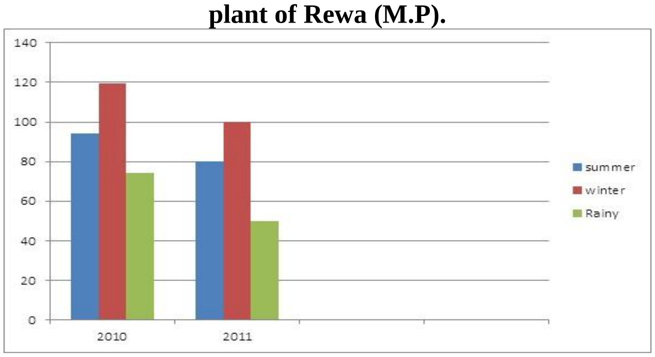
Table 3. Incidence of the pollution oriented diseases among the people Bankuiya village

S.N	Disease	% of incidence			
		Male	Female	Children	Total
1	Respiratory diseases	15.28	19.22	2.90	37.40
2	Cardiovascular diseases	5..34	13.98	2.40	21.72
3	Gastrointestinal diseases	27.54	14.46	3.88	45.80
4	Skin diseases	4.62	7.80	2.88	15.30
5	Eye diseases	2.08	14.53	4.83	21.44
6	Ear diseases	3.12	1.05	0.40	4.57
7	Dental diseases	1.87	0.80	0.00	2.67
8	Other diseases	11.27	4.57	4.47	20.31

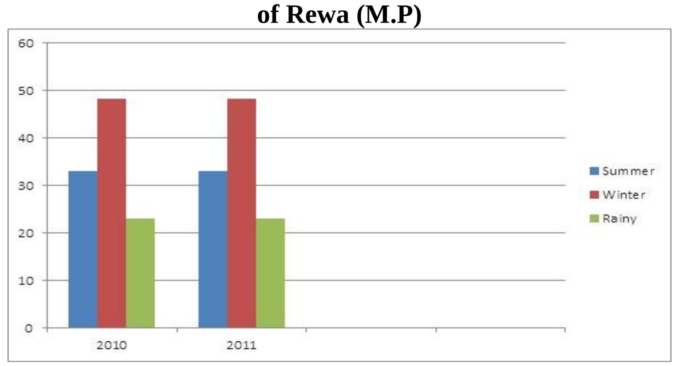
Table 4. Incidence of thepollution oriented diseases among the people of Bhlolgarh

S.N	Disease	% of incidence			
		Male	Female	Children	Total
1	Respiratory diseases	11.99	12.01	9.03	33.03
2	Cardiovascular diseases	9.84	8.42	8.44	27.10
3	Gastrointestinal diseases	3.98	3.30	2.20	9.48
4	Skin diseases	5.86	4.57	3.47	13.80
5	Eye diseases	3.67	2.48	2.72	8.93
6	Ear diseases	5.26	4.82	2.24	12.32
7	Dental diseases	2.65	9.76	5.82	18.23
8	Other diseases	10.71	11.61	4.10	26.42

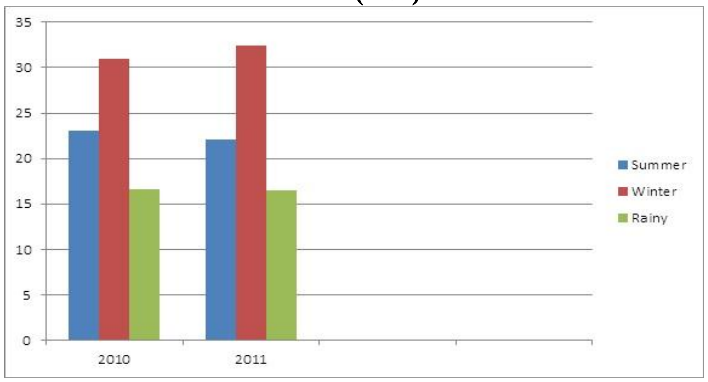
Graph 1. Seasonal average concentration of RPM in the ambient air of selected villages around jaypee cements plant of Rewa (M.P).



Graph 2. Seasonal average concentration of NOX in the ambient air of selected villages around jaypee cement plant of Rewa (M.P)



Graph 3. Seasonal average concentration of So_2 in the ambient air of the selected villages around jaypee cement plant Rewa (M.P)



DISCUSSION

A large number of epidemiological studies carried out worldwide shown interaction between ambient air pollution levels and adverse health effects ,including increased mortality .Air pollution has both acute and chronic effects rang anywhere from minor irritation of eyes and upper respiratory system to chronic respiratory disease ,lung cancer and health .

In the cement plant source of air pollution is dust, $So_{2,}$, NOX, CO to the surrounding ambient air. The emissions of these gases are cause of air pollution and human health effect in this region.

CONCLUSION

Vindhya region of M.P is one of the richest belts of good quality of lime stone deposits and contributes about 12% of the total cement production in India. Jaypee cement plant are located at 20 K.M from Rewa towards north –west direction .The average seasonal air RPM concentration for selected sites were recorded in the rangn119.26 µg / m^3 in winter months ,in summer season 94.39µg /m^3 and Rainey season 74.37µg/m^3 in 2010. The RPM concentration of 2011 was in summer season 80 µg/$m^{3,}$ the winter season 100 µg/m^3 and rainy season 50 µg/m^3. The average seasonal concentration of No_x Recorded in the ambient air of the selected sites during 2010 and 2011 .No_x concentration in summer was 33.03 µg /m^3 , Rainey season 23.16µg /m^3 and in winter season 119.26 µg /m^3. The higher emission of No_x exhibited in winter season . Almost similar trend were observed for air sampler of 2011. $S0_2$ concentration in the ambient air during winter months 2010 as 31.02 µg/m^3 in winter season, 23.09 µg/m^3 in summer season and Rainy season were 16.63 µg/m^3. The ambient air sampler of 2011 also exhibited higher concentration of SO_2 during winter months 32.39 µg/m^3, than those of the summer 22.03 µg/m^3 and Rainy season 16.45 µg/m^3 month sampler. Amriya village mostly appear diseases were cardiovascular diseases and gastrointestinal diseases. In the Atrauli village cardiovascular diseases was more common. In the Bankuiya village Respiratory diseases was appear in most of number. In the Bholgarh village respiratory diseases occurs higher percentage than other diseases.

ACKNOWLEDGEMENT: None

CONFLICT OF INTEREST:
The authors declare that they have no conflict of interest.

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