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Assessment of Air Pollution and its Impact on Human Health Behavior in Jhansi City, Uttar Pradesh, India

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Abstract

"Health is wealth", which depends on the interaction of various biotic and abiotic factors at individual, family, community, national and international level. Enduring exposure of various health hazards generated as a consequence of rapid modernization is deteriorating the health and making us ill. Additionally, the contamination in air, water and food has caused brutality in its behavior. Conditions are even more substantial in socio-economically compromised areas. Jhansi, due to considerably lesser political interest is a socio-economically backward area. Like many other cities of India the ambient air quality of Jhansi is also being depreciated day after day. Poor traffic control, uneven roads and extensive automobile exhausts are additionally helping in its quality drop. Certain man made pollutants e.g. O_3 (produced by photochemical reaction) and other particulate matters (<10 μ in size) are airing the illness. Since, they can cross the innate immune barriers of human respiratory system and plays a significant role in genesis and amplification of hypersensitive allergic reactions. Various asthmatic, allergic and other respiratory effects of certain air pollutants have been reported. Chief air contaminating resource in the area is poorly maintained three wheeler automobiles emission. The ambient air quality of seven important and crowded places of city was assessed. Furthermore, the health risk assessment questionnaire (HRAQ) based survey was conducted to estimate the exposure and it's after effect on health of middle class subpopulation (activity-wise) in the area. Total 2000 individuals' data was collected and analyzed through developed *In-silico* tool. The outcomes are discussed here in detail in the present study.

1. Introduction

Quality of life can be achieved by good health [7] which can be reached and maintained by health related issues (environmental, socio-economical and occupational etc.) identification and their effective management. In today's changing environment the ability of human kind to intuitively assess and manage the health risks has become fundamental for its survival and evolution [34]. Chronic and acute exposure of various environmental respiratory particulate matters (RPM), suspended particulate matters (SPM), CO and other toxic chemicals, donated as a consequence of rapid industrialization and modernization have increased the opportunities for human health illness. In developing countries the major part of crisis is contributed by vehicular emission (40-80%) [2, 12]. The current technological advancement is found insufficiently coping with vehicular growth [1] which is anticipated to worsen the conditions in future within India. Poor traffic control, uneven roads and extensive automobile exhausts are supplementing the effects. Moreover, continuous population influx from rural areas to core city in search of better life are overstretching the urban infrastructure and making it fragile [12].

Since, the developmental progress of nation cannot be stopped in the name of saving environment only but the risks may be reduced by appropriate understanding of causes associated and their proper mitigation. Thus, it is highly required to assess the urban air pollution status and to appraise its impact on human health behavior so that proper managing efforts can be done and implemented. Therefore, an attempt is made in the present investigation to identify and characterize the health human health risk assessment [21]. The level of SPM, RPM, NOx, SO_2 and CO was measured to check the ambient air quality at seven different places of Jhansi city considering most crowded. A health risk assessment questionnaire (HRAQ) [6] based survey was conducted simultaneously to assess the level of exposure and it's after effect on human health behavior. Total 2000 individuals' data was collected and analyzed through HHRAM *In-silico* tool developed in earlier efforts [6]. The results are discussed herewith in detail.

Description of study area

Jhansi is located in the plateau of central India, an area dominated by rocky reliefs and minerals underneath the soil. From Population point of view it is 77th ranked among most populated cities of India with total population of 504,292 peoples [5]. This is located at 25.4333 N 78.5833 E with an average elevation of 284 metres (935 feet) [29]. Being on a rocky plateau, Jhansi experiences extreme temperatures with general mercury read of about 47 degree Celsius highest. The ambient air quality of the city is being declined day by day due to unrestrained and awfully mixed vehicular density on insufficient and badly cared road space. Lack of adequate parking facilities, low turnover of old vehicles with too frequent breakdowns, undisciplined drivers, indifferent pedestrians together with bad traffic management strategies, has profound effect on air pollution [27, 12]. The careless attitude and negligence of the rulings has taken the dilemma to a threatening dimension. Being socio-economically underdeveloped area the solid biomasses are widely used by families as cooking fuel which has increased the size of indoor air pollution able to weaken the human health. Additionally, persistent malnutrition and poor hygienic conditions have aggravated the impact on human health [26, 12].

Major part of air pollution in Jhansi city is contributed by three wheeler exhaust because they are the main mode of public transport. Since, most of them are very old hence the exhaust emission level is higher than the permissible limit. As a result, the level of unburnt hydrocarbons, carbon monoxide (CO) and other particulates [9] has been reached at alarming stage. Moreover, limited road and unplanned traffic has enriched the vehicular emission [35]. Furthermore, the level of SPM, RPM, SO_2, NOx and CO has also been reached at considerable point. There is one thermal power station in the district about 25 Km away from Jhansi city at Parichha. The plant has one stage, having two units with the capacity of 890 MW (2units of 210 mw and 2units110 mw) [18]. Number of generators also contributes inhalable air pollutants during power cuts. Cigarette smoking (Micropollution) is another source of air pollution, with its serious adverse effect on health. The opted area for assessment was mainly residential, devoid of adequate amount of plants.

2. Materials & Methods

The protocol adopted by Goshe [12] in their study to measure the air pollution status was followed in my study for the same. Seven stations mentioned in table-1 covering round municipal area of Jhansi were selected for Ambient Air Quality Assessment (AAQA). The stations were selected randomly at the height of about 8-10m from ground level and placed on the roof of nearby domestic houses. The houses were about 200m away from the traffic circle [12]. The sampling was done twice in a week (one on holiday and one on working day) during September to November 2008. The air samples of 24h were collected in three sift of 8 h corresponding to daytime (8-16 h), evening time (16-24 h) and nighttime (24-8 h) [4]. During entire monitoring period the wind direction, wind velocity, humidity and temperature were micrometeorologically assessed [14].

Table-1: Showing detail of Ambient Air Quality Stations (AAQAS)

Location	Ambient Station No.	Position	Height from ground level
Bus station	AAQAS-1	At the rooftop of residential house next to Naveen Mandi	10 m
Kachehry Chauraha	AAQAS-2	At the rooftop of residential house at railway station road	10 m
Elite Churaha	AAQAS-3	At the rooftop of residential house at Nandini cinema road	10 m
Manik Chauk (Bada Bazar)	AAQAS-4	At the rooftop of residential house near to Jhansi fort	10 m
Sipri Bazar	AAQAS-5	At the rooftop of residential house near Chitra chauraha	10 m
Sadar Bazar	AAQAS-6	At the rooftop of residential house at sadar Bazar	10 m
Medical College Chauraha	AAQAS-7	At the rooftop of residential house at Veerangana Nagar	10 m

Mean of concentrations measured in all three shifts at all stations are shown in the graphs as AAQAS-0.

For SPM and RPM sample collection glass fiber ambient (GF/A) filter paper was used in a high volume sampler (HVS). The SPM samples were allowed to deposit on GF/A filter paper (used in Respirable Dust Sampler) at a flow rate of 1.1-1.5 m3/min [16]. Particulates with size range of 0.1-100 μm were collected by HVS [15]. Both HVS and RDS were manufacture by M/S. Envirotech Ltd. New Delhi. For the collection of SO_2 the HVS, having impingers (bubbler trains) in series was operated at an average flow rate of 0.5 L/min for 24 h using sodium tetrachloromercurate as absorbing solution [19]. Sodium hydroxide as absorbing solution was used for collection of NOx at an average flow rate of 0.5 L/min for 24 h [20]. The ice cooled impinger samples [13] were analyzed spectrophotometrically using West and Gake methods and Jackob and Hocheiser modified method for SO_2 and NOx analysis [3]. Samples of CO were collected by HVS at rate of 2L/min for 5 min in vacuum (700 cc of Hg) sausage tube and then the level in the air was determined by gas chromatography.

As per potentially affective interventions strategy of the study particular sections of the population were targeted to offline survey through health risk assessment questionnaire (HRAQ) [6]. The surveyed population was grouped on the parameter of their life standard and environmental status [22]. Low income population was mainly targeted because they have an elevated risk of ill health behavior possibly due to their poor socio-economic status [30]. For quality of data and better volunteers' response the HRAQ implemented in survey was developed in English and Hindi both [6]. Consequently it became more robust and meaningful by its greater accuracy and better insight. Total 2000 individuals' consented data [22] of Jhansi city was collected and analysed.

3. Results

The mean SPM concentration was varied from 135.4 μg/m³ at AAQAS-6 to 224.2 μg/m³ at AAQAS-1 with an overall mean concentration of 156.9 μg/m³. The SPM permissible limit i.e. 200 μg/m³ (stipulated by National Ambient Air Quality Standard) was crossed at station-1 i.e. Bus station which may be the result of increased vehicular traffic in the area. The shift wise mean SPM concentrations, shown in Figure 1 were found to be 142.3, 170.3 and 158.1 μg/m³ during day, evening and nighttime respectively. The minimum SPM concentration was observed at AAQAS-2 during nighttime (101.3 μg/m³) while maximum was measured at AAQAS-1 (235.2 μg/m³) during evening time.

The RPM concentration was found ranging minimum 63.1 μg/m³ at AAQAS-6 during night time to maximum 172.1 μg/m³ at AAQAS-1 during evening time. Mean value was varied from 146.6 μg/m³ at AAQAS-1 to 79.5 μg/m³ at AAQAS-6. The overall mean concentration (113.3 μg/m³) was exceeded the permissible limit i.e. 100μg/m³). Results are shown in figure 2.

Figure 1: Shift wise SPM conc. at selected ambient stations

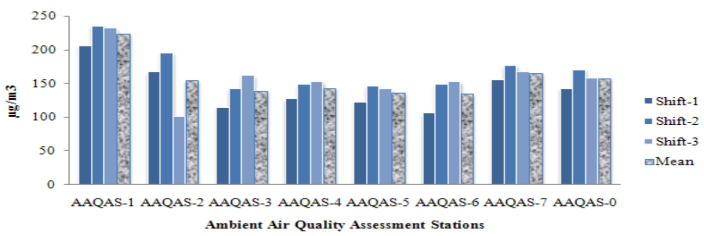


Figure 2: Shift wise RPM concentration at selected ambient stations

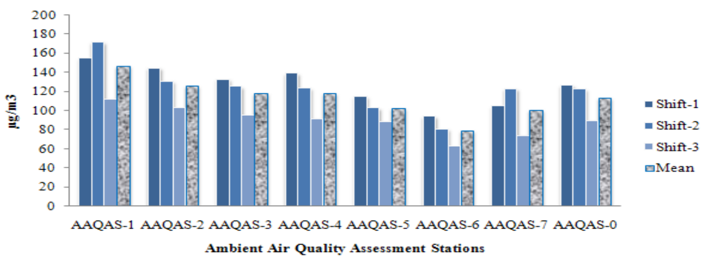
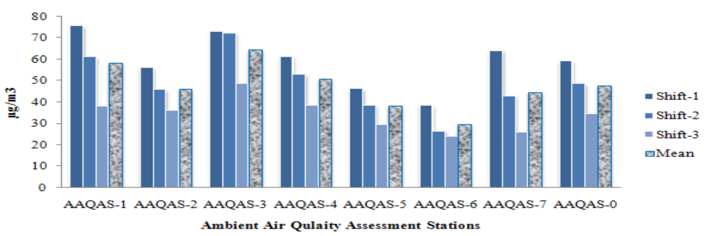


Figure 3: Shift wise NOx concentration at selected ambient stations



As per figure-3 the mean NOx concentration was ranged between 29.8 μg/m³ at AAQAS-6 to 64.7 μg/m³ at AAQAS-1 with overall mean concentration of 47.5 μg/m³. During day time at Bus stand (station-1) and during evening at Elite chauraha (station-3) the concentrations were found very near to cross the permissible limit i.e. 80 μg/m³. The maximum NOx concentration was measured at AAQAS-1 (75.7 μg/m³, Daytime) while the minimum was seen at AAQAS-6 (24.3 μg/m³) during nighttime.

Mean SO_2 concentration shown in figure-4 was ranged between 7.5 μg/m³ at AAQAS-6 to 30.4 μg/m³ at AAQAS-1. Concentrations were found under the permissible limit i.e. 80 μg/m³ set by NAAQS.

Mean CO concentration shown in figure-5 was found variable between 2158.0 μg/m³ minimum at AAQAS-6 to 3347.8 μg/m³ maximum at AAQAS-4. In respect to permissible limit (2290 μg/m³) the overall mean concentration was found 2673.16 μg/m³. Shift wise CO concentration was varied between 1803.9 μg/m³ minimum at AAQAS-6 during night time to 3791.7μg/m³ maximum at AAQAS-4 during day time. The temperature was varied between 12°C to 35.2°C with an average of 23.6°C during air sampling. The average humidity and wind speed was 73.2% and about 2.4 km/h. Though, there was no rain fall during study but low visibility was observed some days due to mild fog in the morning.

Figure 4: Shift wise SO2 concentration at selected ambient stations

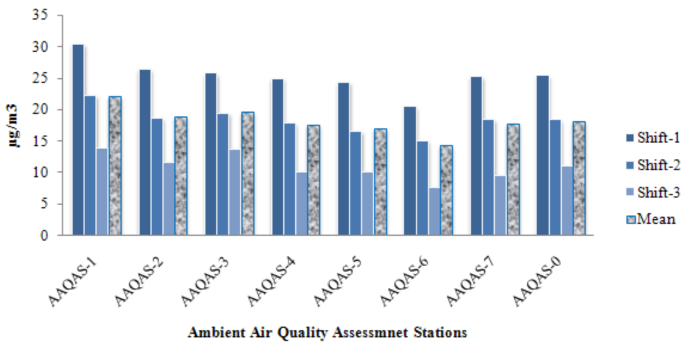


Figure 5: Shift wise CO concentration at selected ambient stations

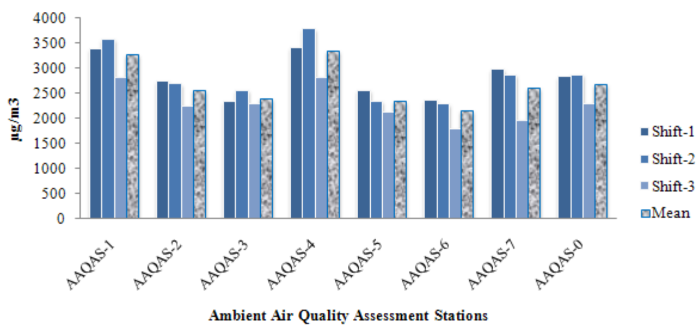
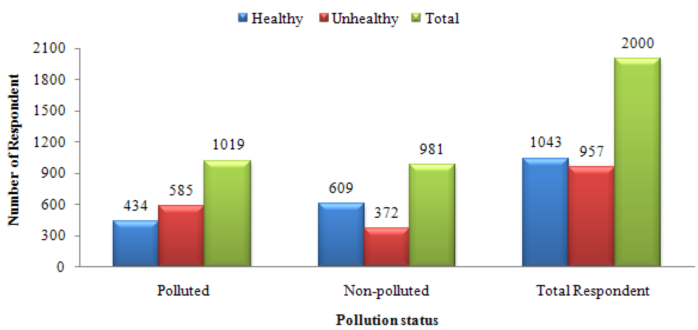


Figure 6: Showing comparative health status of volunteers living in polluted and non-polluted areas



Out of 2000 individuals' surveyed to see the after effect of air pollutants' exposure on human health total 981 were found living in non-polluted areas against the 1019 (51%) volunteers living in polluted area (Fig. 6). Under comparative health analysis it was observed that the people living in less polluted to highly polluted areas were comparatively unhealthier than those living in non-polluted areas (Fig-6). The count of healthy volunteers was raised from 434 to 609 towards pollutted to non-pollutted areas while the total number of respondents living in polluted areas were higher (1019) than the people living in non-pollutes areas (981) (Fig-6). Healthy and unhealthy status of volunteer was decided on the basis of health information provided by them. The respondents with state of ill health behavior were considered unhealthy while otherwise with complete fitness were considered healthy volunteers.

4. Discussion

The observation of increased air pollutants at AAQAS-1 (Bus station area) may be due to higher vehicular emission around the area while AAQAS-6 (Sadar Bazar) due to close to military cant area face disciplined traffic and so lesser pollution. The submicron (10^{-6}m) pollutants due to buoyancy remain suspended in the lungs and other parts of respiratory tract which ultimately leads to damage in the cellular mechanism and brings about adverse health outcomes [12] as observed among surveyed volunteers. Though, the health impact due to air pollution depends on various factor viz. pollutant type, its concentration in the air, length of exposure, other pollutants in the air, and individual susceptibility [24, 31, 32] etc. It is often seen that the different people are affected in different ways by air pollution but the poor, undernourished, very young, very old and people with preexisting respiratory disease and other health illness are remain more at risk [23, 32].

Out of numerous pollutants present in polluted state, exposure to respirable particulate matter has been shown to induce a systemic inflammatory response involving stimulation of the bone marrow, which can contribute to cardio-respiratory morbidity [25, 28, 33]. Increase pollution level of the residential area may cause the latent exposure to polycyclic aromatic hydrocarbons especially benzo[a]pyrene [17, 24] which can lead to the enhanced risk of infection and diseases by causing immune suppression. Benzo[a]pyrene, a known carcinogen, also can increase the risk of lung and other types of cancers [17]. In addition to chronic exposure of the pollutants, acute exposures of some oxides of nitrogen and sulfur may cause increased bronchial reactivity and susceptibility to bacterial and viral infections [10]. Interestingly, the important role of air pollutants in genesis and augmentation of allergic disorder has also been reported and it is described as a disease of civilized society [11]. An increased level of carbon monoxide may freely combine with hemoglobin due to its super reactive nature to form carboxyhemoglobin and therefore the oxygen carrying capacity of hemoglobin may get reduced with final consequences to various cardio-vascular diseases [8]. Additionally, adverse pregnancy outcomes, including miscarriage, stillbirth, low birth weight, and early infant mortality may be resulted [32]. Thus the long term exposure of discussed air pollutants in higher concentration may be the reason for increased health illness among the population living in polluted areas.

5. Conclusions

Rapid technological advancement in nearly every sector of life has lifted the standard but this upsurge also led to the number of adverse health issues which have been reached at alarming stage at some points. The after effects of air pollutants' exposure were noticed at threatening dimension in the present study. Not any well defined guidelines and synchronized approach for air pollution induced human health risk assessment of Indian population are available so far. A systemic and improved planning for traffic management viz. restricted use of main road arteries, taxing heavy vehicles entering to city limits, careful observation of three wheelers' emission and most importantly corruption less look after of environmental health can restrain the situation to normal. Moreover, road improvements at regular intervals may reduce the pollution at significant level. Conclusively, the remediation strategy of government within set framework can protect the human and environmental health now and in the future as well.

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