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# THE RELATIONSHIP BETWEEN CONSISTENCY OF DUST IN THE AIR AND THE OCCURRENCE OF CARDIOVASCULAR EVENTS IN AHWAZ AT 2014

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## ABSTRACT

**Introduction**: Exposure to high consistency of Particulate Matter (PM) is a risk factor for cardiovascular disease. In terms of industrially and geographically, Ahvaz city is exposed to severe pollution, particularly by dust. Considering the high prevalence of heart disease in the city, studying the impact of particulate matter on cardiovascular diseases to improve public health appears necessary. **Materials and Methods:** This retrospective study was done based on hospital records data. The followings were compared based on $PM_{10}$: prevalence of risk factors, demographic findings and cardiovascular events including unstable pectoral angina, ST-elevation MI, Non ST elevation MI, cardiac failure, arrhythmia and new cases of arrhythmia, incidence of acute myocardial infarction and acute cerebral infarction, need for cardiopulmonary resuscitation, worsening of symptoms, and incidence of cardiac arrest during dusty and cleared days. Abundance statistical comparison of results was carried out between contaminated and cleared groups using chi-square test ($\chi 2$) by SPSS version 22. **Results**: 210 cases of 320 examined cases were related to polluted days and 110 cases were related to clear days. Statistical analysis of studied cardiac events showed that there is a significant difference only in occurrence of unstable

angina in two groups of clear and polluted ($p < 0.05$). **Conclusion**: The results of this study showed that exposure to dust can cause to increase the risk of cardiovascular events especially unstable angina.

**KEYWORDS**: cardiovascular event; unstable pectoral angina; dust; $PM_{10}$; Ahvaz.

## INTRODUCTION

Studies have shown that exposure to high concentrations of Particulate Matter (PM) is a risk factor for cardiovascular and mortality disease and prolonged contact with the PM is associated with Ischemic Heart Disease (IHD).[1] This relationship is based on the assumption that exposure to PM can cause pulmonary oxidative stress, ischemia, inflammation, atherosclerosis and an increased risk of IHD and death. Long-term exposure to PM is associated with inflammatory chronic pulmonary injury and subclinical.[2] Short-term exposure to high levels of PM and inflammation caused by that may associate with increasing the risk of plaque rupture, thrombosis and acute complications of atherosclerosis.[3]

Suspended particles include Coarse Particle in the size range of 2.5 to 10 μm ($PM_{10}$), fine Particle in the size smaller than 2.5μm ($PM_{2.5}$) and ultra-fine in the size smaller than 0.1mμ.[3] The chemical composition of suspended particles is so various. It depends on many factors including geographical and atmospheric conditions and production resources. In general suspended particles include sulfates, nitrates, ammonium, chloride, and metal particles, organic carbon, crystal materials, and biological components (bacteria, spores, etc.).[3-10]

In addition, when suspended particles combined with atmospheric pollutants such as ozone, sulfur and nitric oxide and carbon monoxide can create suspended aerosols. Mentioned pollutants are created from both normal activities and human activities.[11-15] Particles of PM10 are created from human activities including road building, agricultural dust, wood dust, construction operations, etc. Natural resources of creating $PM_{10}$ are particles caused by wind and fires.[4]

In some population studies was observed that Short-term exposure to PM can cause myocardial infarction (MI). This exposure is also associated with ischemic stroke, ST depression in ECG, increasing plasma viscosity, increasing inflammatory markers and changes in function of heart autonomic that is characterized with change in heart beat.[16-20] There is evidence on relationship between these exposures and vascular changes.

For example, exposure to PM causes arterial contraction in healthy individuals, impaired vascular reactivity and endothelial function in patients with diabetes, high blood pressure in cardiac rehabilitation patient and adult with pulmonary disease.[5, 21-26]

Khuzestan province as one of the largest provinces of Iran is located in a desert area in southwest of Iran in the vicinity of Iraq, Saudi Arabia and Kuwait which is the main sources of dust phenomena in the Middle East. In addition to dust which has been dominant phenomenon in recent years in Khuzestan province, the province is polluted in most season due to rich oil and gas resources, petrochemical industries, big metal and non-metal industries, cellulosic and electricity, and warm and humid weather conditions. The results of studies on many samples of dust in various cities of the province especially in Ahvaz and soils near the border of Iran and Iraq confirmed that amount of heavy metals such as copper, lead, zinc, nickel and chromium in the samples is higher than normal.[6]

Since now, epidemiological studies has shown the relationship between daily concentrations of dust with mortality heart disease, being admitted and worsening cardiovascular disease and preterm physiologic response in healthy individuals with risk factors.[27-30] The evidence has also shown that annual average of exposure to $PM_{2.5}$ is associated with increasing risk of mortality from dysrhythmia and heart ischemic diseases. As a result, the evidence not only has raised worsening process of cardiovascular disease, but also has shown potential role of dust in increasing susceptibility to acute coronary events.[7, 31-33]

PM harmful effects on the cardiovascular system has been demonstrated in several epidemiological study, for example study results of Pope et al., (2006), that examined ischemic heart disease events in 12865 admitted patients showed that pollution by fine particles ($PM_{2.5}$) with a higher level of 10µg/m3 increases the risk of acute ischemic coronary events such as unstable angina and myocardial infarction to an amount of 5/4% (1). The results of Rajesh et al., (2009), also showed that dust accelerates atherosclerosis.[29]

Regarding results done studies and also considering that industrially and geographically Ahvaz is exposed to severe pollution, especially dust and taking into account the high prevalence of cardiac disease in the city, studying the effect of air pollution on cardiovascular disease seems to be necessary in order to eliminate or reduce them to improve general health. Therefore, this study aimed to examine the association between presence of dust and occurrence of cardiovascular events in patients referring to Imam Khomeini Hospital in

Ahwaz during 1393. Obtaining documentary evidence is one of main functional objectives of this study in order to determine the severity of air pollution in Ahwaz to priority in hygienic macro policies, improving preventive measures to reduce cardiovascular morbidity and mortality rates, and also finding out the effect of pollution on cardiovascular events, and assistance in preventive measures.

## MATERIALS AND METHODS

### Study Design and Participants

This is an analytic epidemiological study, which has been conducted as a retrospective cross-sectional study during a 1-year period based on hospital data of patients admitted to emergency department of Imam Khomeini hospital of Ahvaz 1393. To this end, all medical records of patients with the diagnosis of cardiovascular events, including unstable pectoral angina, ST-elevation MI, Non ST elevation MI, cardiac failure, arrhythmia and new cases of arrhythmia, occurrence of acute myocardial infarction, need for cardiopulmonary resuscitation were reviewed in two groups of clear days (patients who had been admitted to hospital in days without weather pollution) and polluted days (patients who had been admitted to hospital in days with weather pollution). Patients on days with air and water pollution being referred to the hospital) were investigated. A total of 320 cases were examined, of which 210 patients admitted in polluted days and 110 patients admitted in clear days.

### Inclusion and exclusion criteria

Inclusion criteria of samples in this study includes all patients that unstable angina is registered in their record as the main diagnosis for hospitalization.

### Measuring tools

List of patients was reviewed from patient's register offices and file number was extracted. Then extracted files were examined and recorded cardiovascular events, including unstable pectoral angina, ST-elevation MI, Non ST elevation MI, cardiac failure, arrhythmia and new cases of arrhythmia, occurrence of acute myocardial infarction, need for cardiopulmonary resuscitation along with patient demographic data were registered in a related questionnaire. The questionnaire consists of three parts; First part contains 5 questions about patient demographic information, and the second part contains 15 questions about cardiac events registered in the record and history of previous disease, the third part consists of 3 questions about presence or absence of air pollution and its severity in referral time to the hospital.

Available information was set in the questionnaire according to related scientific articles (2-8) and view of advisors and supervisor. This information was provided for 10 of heart faculty members in Ahvaz Jundishapur University of Medical Sciences and their views were applied in the final version.

In this study, the reliability of check list with a correlation coefficient of 82.0 was confirmed. Days of 2014 were divided based on the concentration of pollutants with $PM_{10}$ scale. Accordingly, one day before and one day after of air pollution is calculated and prevalence of these complications is compared with the days which the amount of pollutants is allowed. Pollutants measurement and division are done based on studies conducted by Department of Environment Research Center of Ahvaz city using Greas by Anderson High Volume Sampler.

**Ethical considerations**

The Ethics Committee of Ahvaz Jundishapur University of Medical Sciences approved the study (ID number: cvrc-9415). Data were extracted all the questionnaires, in general.

**Statistical Analysis**

Absolute frequency and percentage frequency were used to describe qualitative data and mean central tendency indexes and dispersion indexes of standard deviation were used to describe quantitative data. Chi-square was used to find a significant relationship among qualitative variables of statistical test. The results were statistically analyzed using SPSS version 22 software.

**RESULTS**

The results showed that the highest water pollution and air pollution in July and the lowest was in December (Table 1 and Figure 1).

The Chi-square test results showed that there is a significant difference in terms of gender demographic characteristics, age and hyperlipidemia risk factors, hypertension, mellitus diabetes, smoking and family history of CAD between the two groups of cases and control($p>0.05$) (Table 2).

The statistical analysis of evaluated cardiac events Chi-square test showed that there is a significant difference in incidence of unstable angina only between two groups of clean and

polluted and the risk of cardiac events on polluted days is more than clean days (p< 0.046, x2=3.96). (Table 3).

**Table 1. The concentration of dust based on $PM_{10}$ in Ahvaz during 2014 in µg/m3**

| | Mean | SD | Min | Max |
|---|---|---|---|---|
| Polluted days | 283.31 | 236.002 | 76 | 1379 |
| Cleared days | 92.58 | 32.825 | 34 | 180 |
| Total | 187.94 | 192.879 | 34 | 1379 |

**Table 2 - Demographic characteristics and both infected and cleared risk factors**

| *Characteristics* | *Polluted day* | *Cleared day* | *P-value* |
|---|---|---|---|
| Number of subjects | 210 | 110 | |
| Male/female | 123/87 | 72/38 | |
| Mean age | 61.97± 13.16 | 53 | |
| *Hyperlipidemia* | 76 (67.9%) | 36 (32.1%) | 0.5 |
| *Hypertension* | 121 (66.5%) | 61 (33.5%) | 0.7 |
| *Diabetes* | 87 (65.9%) | 49 (35.5%) | 0.9 |
| *Smoking* | 84 (65.1%) | 45 (34.9%) | 0.8 |
| *Familial History of CAD* | 60 (65.9%) | 31 (34.1%) | 0.9 |

**Table3. statistical analysis of cardiovascular events in two groups of polluted and cleared days**

| *Cardiac events* | | *Polluted day* | *Cleared day* | *Total* | *χ2* | *P-value* |
|---|---|---|---|---|---|---|
| ***Unstable Angina*** | Yes | 133 (41.6%) | 57 (17.8%) | 190 (59.4%) | 3.96 | **0.046*** |
| | No | 77 (24.1%) | 53 (16.6%) | 130 (40.6%) | | |
| ***ST elevation MI*** | Yes | 59 (18.4%) | 34 (10.6%) | 93 (29.1%) | 0.277 | 0.599 |
| | No | 151 (47.2%) | 76 (23.8%) | 227 (70.9%) | | |
| ***Non ST elevation MI*** | Yes | 29 (9.1%) | 12 (3.8%) | 41 (12.8%) | 0.544 | 0.461 |
| | No | 181 (56.6%) | 98 (30.6%) | 279 (87.2) | | |
| ***Heart Failure*** | Yes | 136 (42.5%) | 67 (20.9%) | 203 (63.4%) | 0.462 | 0.497 |
| | No | 74 (23.1%) | 43 (13.4%) | 117 (36.6%) | | |
| ***Arrhythmia*** | Yes | 80 (35.0%) | 36 (11.3%) | 116 (36.3%) | 0.900 | 0.343 |
| | No | 130 (40.6%) | 74 (23.1%) | 204 (63.8%) | | |
| ***New Arrhythmia*** | Yes | 67 (20.9%) | 32 (10.0%) | 99 (30.9%) | 0.268 | 0.605 |
| | No | 143 (44.7%) | 78 (24.4%) | 221 (69.1%) | | |
| ***Worsening of symptoms*** | Yes | 134 (41.9%) | 69 (63.4%) | 203 (63.4%) | 0.036 | 0.849 |
| | No | 76 (23.8%) | 41 (12.8%) | 117 (36.6%) | | |
| ***Acute MI*** | Yes | 87 (27.2%) | 43 (13.4%) | 130 (40.6%) | 0.164 | 0.686 |
| | No | 123 (38.4%) | 67 (20.9%) | 190 (59.4%) | | |
| ***Cardiac Arrest*** | Yes | 11 (3.4%) | 4 (1.3%) | 15 (4.7%) | 0.415 | 0.520 |
| | No | 199 (62.2%) | 106 (33.1%) | 305 (95.3%) | | |
| ***CVA*** | Yes | 2 (0.6%) | 0 (0.0%) | 2 (0.6%) | 1.054 | 0.305 |
| | No | 208 (65.0%) | 110 (34.4%) | 318 (99.4%) | | |
| ***CPR*** | Yes | 16 (5.0%) | 6 (1.9%) | 22 (6.9%) | 0.528 | 0.467 |
| | No | 194 (60.6%) | 104 (32.5%) | 298 (93.1%) | | |

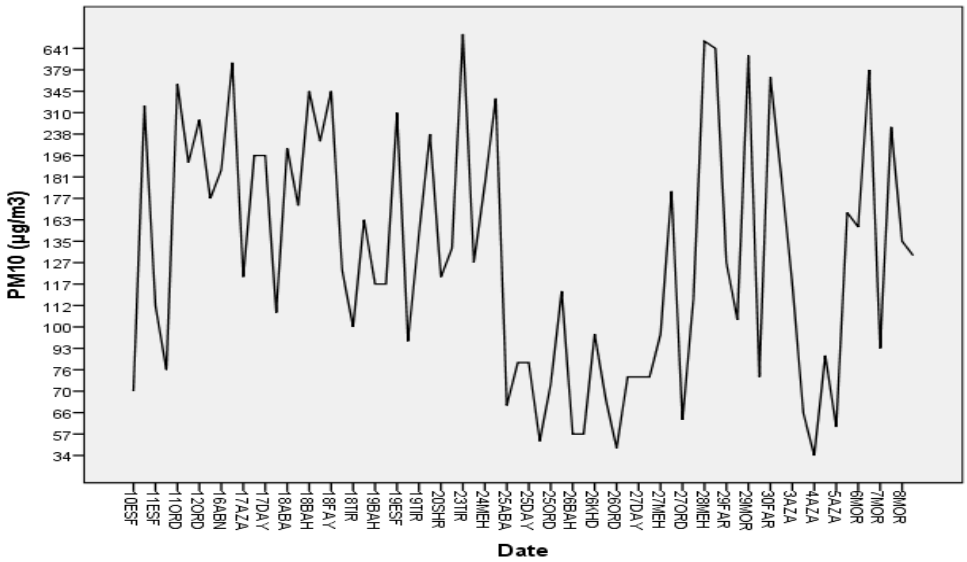


**Figure 1: The dust concentration in terms of PM10 in polluted and cleared days of Ahvaz in 2014.**

## DISCUSSION

The ambient particulate matter is associated with unstable angina. The same result has been reported in various studies with respect to PM10 and PM2.5 air pollution, for instance the study of Pope et al., that examined the Ischemic heart disease events in 12865 patients admitted at the hospital showed that infection has been associated with higher level of 10µg/$m^3$ aerosol (PM2.5) with the 5.4 percent increase in risk of ischemic acute coronary events including unstable angina and myocardial infarction (1). Examining the results of Poloniecki and colleagues' (1997) study in hospitalizations of 373 566 cardio - vascular in London ERs' in the years 1994 to 1987 also revealed that there is a direct correlation between incidence of myocardial infarction and pectoral angina with carbon black- black smoke and atmospheric gases ($SO_2$, CO, $NO_2$) there are.[34] The study results of Gold et al., (2000) also showed that the 15.5µg/$m^3$ < PM2.5 concentration was associated with a reduction in heart rate[35], while the results of POPE et al., (1999) showed that increasing g / m3µ100 <PM10 was associated with bpm 10-5 increase in heart rate.[36] These results indicate that particulate matter can cause disruption in the autonomic nervous system and the type and concentration of the particles may have different effects on heart rate.

Furthermore Ibald-Mulli et al., study results (2001) by WHO in Zbvrg (Augsburg), Germany revealed that an average increase in mmHg 37 / 2-79 / 1 at systolic pressure for each µg/$m^3$

90 creates an increase in dust. These effects were high in patients with underlying disorders including high blood viscosity and heart rate.[37]

Therefore considering these results and also a diagnosing unstable angina at the earlier stages of heart attack, it seems that most patients with this emergency cardiac event have been treated and prevented from the myocardial infarction incidence. This would reduce the frequency of MI cases at the study to a large extent that it could also involve the lack of significant differences between incidence of MI in the two case and control groups. At the lack of significant differences matter in other cardiovascular events examined in this study, it can be stated that individuals may have visited the emergency in the days after infection and the incidence of cardiovascular events statistics has increased in the cleared days and this play a role in statistical analysis between the two groups as well.

Therefore exposure to arsenic, lead, cadmium, pollutant gases, solvents and dust have been associated with increased incidence of cardiovascular diseases. These effects are attributed to changing in synthesis or nitric oxide reaction that may results from environmental oxidants or increasing the internal production of reactive oxygen radicals.[38]

The results of this study showed that dust exposure can increase the risk of cardiovascular events especially unstable angina. Scientific and practical actions in order to resolve serious problem of dust phenomenon that affected different areas of the country particularly Khuzestan province in recent years is essential. Early cardiovascular screening, diagnosis and therapeutic actions for health referrals to these health centers in the event of dust can reduce the number of death caused by these events to a large extent.

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**CONFLICT OF INTEREST**

The authors had not any financial or personal relationships with other people or organizations during the study. So there was no conflict of interests in this article.

**REFERENCES**

1. Pope CA, Muhlestein JB, May HT, Renlund DG, Anderson JL, Horne BD. Ischemic heart disease events triggered by short-term exposure to fine particulate air pollution. Circulation., 2006; 114(23): 2443-8.
2. R384 Xie W, Li G, Zhao D, Xie X, Wei Z, Wang W. Relationship between fine particulate air pollutionand ischemic heart disease morbidity and mortality. Heart (British Cardiac Society)., 2015 Feb; 101(4): 257–63.

   Lozano R, Naghavi M, Foreman K, Lim S, Shibuya K, Aboyans V. Global and regional mortalityfrom 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burdenof Disease Study 2010. Lancet., 2012 Dec 15; 380(9859): 2095–128.
3. Sun Q, Hong X, Wold LE. Cardiovascular effects of ambient particulate air pollution exposure. Circulation., 2010; 121(25): 2755-65.
4. Liu J, Liu Y, Wang L, Yin P, Liu S, You J. [The disease burden of cardiovascular and circulatorydiseases in China, 1990 and 2010]. Chi J Prev Med., 2015; 49(4): 315–20.
5. Heidari-Farsani M, Shirmardi M, Goudarzi G, Alavi-Bakhtiarivand N, Ahmadi-Ankali K, Zallaghi E, et al. The evaluation of heavy metals concentration related to PM10 in ambient air of Ahvaz city, Iran. Journal of Advances in Environmental Health Research., 2014; 1(2): 120-8.
6. Wolf K, Schneider A, Breitner S, Meisinger C, Heier M, Cyrys J. Associations between short-termexposure to particulate matter and ultrafine particles and myocardial infarction in Augsburg, Germany. Int J Hyg Environ Health., 2015 May 11; 218(6): 535–42.
7. Mustafic H, Jabre P, Caussin C, Murad MH, Escolano S, Tafflet M. Main air pollutants and myocardialinfarction: a systematic review and meta-analysis. JAMA., 2012 Feb 15; 307(7): 713–21.
8. Martinelli N, Olivieri O, Girelli D. Air particulate matter and cardiovascular disease: a narrative review. Eur J Intern Med., 2013 Jun; 24(4): 295–302.
9. Ma Z, Hu X, Sayer AM, Levy R, Zhang Q, Xue Y. Satellite-based spatiotemporal trends in PM2.5concentrations: China, 2004–2013. Environ Health Perspect., 2015 Jul 24.
10. Cao J, Xu H, Xu Q, Chen B, Kan H. Fine particulate matter constituents and cardiopulmonary mortalityin a heavily polluted Chinese city. Environ Health Perspect., 2012 Mar; 120(3): 373–8.

11. Lu F, Xu D, Cheng Y, Dong S, Guo C, Jiang X. Systematic review and meta-analysis of the adverse health effects of ambient PM2.5 and PM10 pollution in the Chinese population. Environ Res., 2015 Jan; 136: 196–204.
12. Xie J, He M, Zhu W. Acute effects of outdoor air pollution on emergency department visits due to fiveclinical subtypes of coronary heart diseases in Shanghai, China. J Epidemiol., 2014; 24(6): 452–9.
13. Vardoulakis S, Kassomenos P. Sources and factors affecting PM< sub> 10</sub> levels in two European cities: Implications for local air quality management. Atmospheric Environment., 2008; 42(17): 3949-63.
14. Strandmark R, Herlitz J, Axelsson C, Claesson A, Bremer A, Karlsson T. Determinants of pre-hospital Pharmacological intervention and its association with outcome in acute myocardial infarction. Scand J Trauma Resusc Emerg Med., 2015; 23(1): 105.
15. Wang L, Cheng Z, Gu Y, Peng D. Short-term effects of verapamil and diltiazem in the treatment of noreflow phenomenon: a meta-analysis of randomized controlled trials. Biomed Res Int., 2015; 2015: 382086.
16. Zhang H, Masoudi FA, Li J, Wang Q, Li X, Spertus JA. National assessment of early beta-blockertherapy in patients with acute myocardial infarction in China, 2001–2011: The China Patient-centered Evaluative Assessment of Cardiac Events (PEACE)-Retrospective AMI Study. Am Heart J., 2015 Sep; 170(3): 506–15 e1.
17. Wang X, Chen R, Meng X, Geng F, Wang C, Kan H. Associations between fine particle, coarse particle, black carbon and hospital visits in a Chinese city. Sci Total Environ. 2013 Apr 29; 458-460C: 1–6.
18. Milojevic A, Wilkinson P, Armstrong B, Bhaskaran K, Smeeth L, Hajat S. Short-term effects of air pollutionon a range of cardiovascular events in England and Wales: case-crossover analysis of the MINAPdatabase, hospital admissions and mortality. Heart. 2014 Jul; 100(14): 1093–8.
19. Pun VC, Yu IT, Ho KF, Qiu H, Sun Z, Tian L. Differential effects of source-specific particulate matter onemergency hospitalizations for ischemic heart disease in Hong Kong. Environ Health Perspect., 2014Apr; 122(4): 391–6.
20. Prospero JM LP. African droughts and dust transport to the Caribbean: climate change implications. Science., 2003; 302(5647): 1024-7.
21. Shahsavani A, Naddafi K, Jafarzade Haghighifard N, Mesdaghinia A, Yunesian M, Nabizadeh R, et al. The evaluation of PM< sub> 10</sub>, PM< sub> 2.5</sub> and PM< sub> 1</sub> concentrations during the Middle Eastern Dust (MED) events in

Ahvaz, Iran, from april through september 2010. Journal of Arid Environments., 2012; 77: 72-83.

22. Zarasvandi A, Carranza EJM, Moore F, Rastmanesh F. Spatio-temporal occurrences and mineralogical–geochemical characteristics of airborne dusts in Khuzestan Province (southwestern Iran). Journal of Geochemical Exploration., 2011; 111(3): 138-51.
23. Soleimani Z, Goudarzi G, Naddafi K, Sadeghinejad B, Latifi SM, Parhizgari N, et al. Determination of culturable indoor airborne fungi during normal and dust event days in Ahvaz, Iran. Aerobiologia., 1-12.
24. Møller P, Folkmann JK, Forchhammer L, Bräuner EV, Danielsen PH, Risom L, et al. Air pollution, oxidative damage to DNA, and carcinogenesis. Cancer Letters., 2008; 266(1): 84-97.
25. Kim K-H, Choi G-H, Kang C-H, Lee J-H, Kim JY, Youn YH, et al. The chemical composition of fine and coarse particles in relation with the Asian Dust events. Atmospheric Environment., 2003; 37(6): 753-65.
26. Farmer PB, Singh R, Kaur B, Sram RJ, Binkova B, Kalina I, et al. Molecular epidemiology studies of carcinogenic environmental pollutants: Effects of polycyclic aromatic hydrocarbons (PAHs) in environmental pollution on exogenous and oxidative DNA damage. Mutation Research/Reviews in Mutation Research., 2003; 544(2–3): 397-402.
27. Fang HY, Cai QG, Chen H, Li QY. Mechanism of formation of physical soil crust in desert soils treated with straw checkerboards. Soil and Tillage Research., 2007; 93(1): 222-30.
28. Rajesh D, Sunil C, Lalita R, Sushila S. Impact assessment of soils treated with refinery effluent. European Journal of Soil Biology., 2009; 45(5): 459-65.
29. Autrup H. Ambient Air Pollution and Adverse Health Effects. Procedia - Social and Behavioral Sciences., 2010; 2(5): 7333-8.
30. Karanasiou A, Moreno N, Moreno T, Viana M, de Leeuw F, Querol X. Health effects from Sahara dust episodes in Europe: Literature review and research gaps. Environment International., 2012; 47(0): 107-14.
31. Su T-C, Chen S-Y, Chan C-C. Progress of Ambient Air Pollution and Cardiovascular Disease Research in Asia. Progress in Cardiovascular Diseases., 2011; 53(5): 369-78.
32. Al-Hurban AE, Al-Ostad AN. Textural characteristics of dust fallout and potential effect on public health in Kuwait City and suburbs. Environmental Earth Sciences., 2010; 60(1): 169-81.

33. Poloniecki JD, Atkinson RW, de Leon AP, Anderson HR. Daily time series for cardiovascular hospital admissions and previous day's air pollution in London, UK. Occupational and environmental medicine., 1997; 54(8): 535-40.
34. Gold D, Litonjua A, Schwartz J, Lovett E, Larson A, Nearing B. Ambient pollution and heart rate variability Circulation., 2000; 101(11): 1267–1273. Find this article online.
35. POPE CAI, Dockery DW, Kanner RE, Villegas GM, Schwartz J. Oxygen saturation, pulse rate, and particulate air pollution: a daily time-series panel study. American Journal of Respiratory and Critical Care Medicine., 1999; 159(2): 365.72-
36. Ibald-Mulli A, Stieber J, Wichmann H-E, Koenig W, Peters A. Effects of air pollution on blood pressure: a population-based approach. American Journal of Public Health., 2001; 91(4): 571.
37. Bhatnagar A. Environmental Cardiology: Studying Mechanistic Links Between Pollution and Heart Disease. Circulation Research., 2006; 99(7): 692-705.