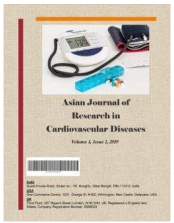

Asian Journal of Research in Cardiovascular Diseases

2(2): 1-8, 2020; Article no.AJRCD.57652

Occupational Exposure to Quarry Dust and Blood Pressure Status of Quarry Workers in Nigeria Population

Ezeja Godwin Uroko[1*] and Umahi-Ottah Grace[2]

[1]Department of Physiotherapy, Alex Ekwueme Federal University Teaching Hospital, Abakaliki, Ebonyi State, Nigeria.
[2]Department of Physiology, Ebonyi State University, Abakaliki, Ebonyi State, Nigeria.

Authors' contributions

This work was carried out in collaboration between both authors. Author EGU designed the study, conception, funding, critical review, data collection, materials and interpretation. Author UOG managed the analyses of the study, supervision, funding, administrative report and literature review. Both authors wrote the first draft of the manuscript. Both authors read and approved the final manuscript.

Article Information

Editor(s):
(1) Dr. Christopher Edet Ekpenyong, University of Uyo, Nigeria.
Reviewers:
(1) Lata Mullur, India.
(2) Shirly Paola Vargas Licona, Universidad de Córdoba, Colombia.
Complete Peer review History: http://www.sdiarticle4.com/review-history/57652

Original Research Article

Received 10 April 2020
Accepted 15 June 2020
Published 23 June 2020

ABSTRACT

Background: The relationship between cardiovascular diseases and rise in occupational dust have been known for more than a decade.
Objective: To assess the impact of quarry dust on the blood pressure parameters of quarry workers in Abakaliki metropolis.
Methods: 200 subjects participated in this study. 100 quarry workers (test group) and 100 non-quarry workers (control group). A questionnaire was issued to the participants to obtain some vital medical and workplace information. Signed consents forms were obtained from the participants. A digital sphygmomanometer was used to measure systole, diastole and pulse rate. Mean arterial pressure calculated. Dust measuring device (air sampler PCE-PCO 1) was used to analyze the quantity, quality and sizes of particulate matters present in the research area. Data were presented as Mean ±SEM, analyzed using a 2-way ANOVA and a multiple comparison test using Tukey's Post

**Corresponding author: E-mail: godexy2ke@gmail.com;*

Hoc Test. Level of significance was set at 95%. All statistical analyses were carried out using Graph Pad prism 7 software.

Results: Participants were within the age of 25 to 50 years. Quarry workers were exposed to ultrafine and coarse particulate matters ($PM_{0.5\text{-}2.5}$). The result revealed 18 mmHg increase in the diastolic blood pressure (DBP) of quarry machine operators, 10 mmHg increase in DBP of quarry stone carriers and 15 mmHg increase in DBP of quarry stone crushers when compared with the control. Also, 19 mmHg rise in systolic blood pressure (SBP) of quarry machine operators, 15 mmHg increase in SBP of quarry stone carriers and 18 mmHg rise in SBP of quarry stone crushers were recorded when compared with the control. In addition, 19 mmHg increase in the mean arterial pressure (MAP) of quarry machine operators, 12 mmHg rise in MAP of quarry stone carriers and 16 mmHg increase in MAP of quarry stone crushers were observed when compared with the control. Furthermore, 22 beats per minute (bpm) increase in the pulse rate of quarry machine operators, 18 bpm rise in pulse rate of quarry stone carriers and 17 bpm increase in pulse rate of quarry stone crushers were detected when compared with the control. Among the different groups of quarry workers, quarry machine operators recorded significant increase in their diastole, systole and mean arterial pressure when compared with other different groups of quarry workers.

Conclusion: Quarry workers have elevated systole, diastole, mean arterial pressure and pulse rate than non-quarry workers thus may have compromised cardiovascular functions. Also, the observed increase in systole, diastole and MAP of quarry machine operators when compared with other different groups of quarry workers shows that more exposure to quarry dust may cause more damage to the cardiovascular system. Quarry workers need to be motivated to embrace cardiovascular health safety approaches and also, be enlightened on quarry dusts risks.

Keywords: Occupational dust; blood pressure parameters; quarry dust.

1. INTRODUCTION

The relationship between cardiovascular diseases and rise in occupational dust have been known for more than half a century Ottah-umahi et al. [1]. Dust are small dry, solid particles projected into the air by natural forces such as wind, volcanic eruption and by mechanical or man-made processes such as crushing, grinding, milling, drilling, demolition, shoveling, conveying, screening, bagging and sweeping IUPAC [2]. Dusts, when in high concentration could harm animals, humans and vegetation Ottah-umahi et al. [1]. There are four major types of dust found in work environment namely: Mineral dust, organic and vegetable dust, metallic dust, and chemical dust. Examples of mineral dust are quartz, coal and quarry dust. Quarry dust has high concentration of crystalline silica. Crystalline silica is found in stones, rocks, sands and clays. Different types of stones contain different amounts of silica. Sand stone, gritstone and quartzite contains about 70%, concrete and mortar 25 to 70%, shale 40 to 60%, China stone 50%, slate 40%, brick 30%, granite 30%, ironstone 15%, basalt and dolerite 5%, limestone, chalk and marble contains 2% of silica Ottah-umahi et al. [1]. Crystalline silica that is fine enough to enter the lung alveoli is called respirable crystalline silica. Dust particles are usually in the size range from about 1 to 100 μm in diameter, and they settle slowly under the influence of gravity. They are generally called particulate matters. Particulate matters are classified by size of the particles into ultrafine PM< (0.1 μm), coarse (Pm 1.0-2.5 μm), fine (PM > 2.5 μm) and PM ≤10μm Brook et al. [3]. These particles are composed of solid and liquid components that originate from vehicle exhaust, road dust, forest fire, wind-blown soil and quarry dusts. Particle size, surface area and chemical composition determine the health risk posed by particulate matters. Particulate and gaseous pollutants coexist in the air and may induce adverse health effects. Whereas compelling data implicate particulate matters as a major perpetrator of various types of cardiovascular diseases, particulate matters rarely exists by itself within the ambient environment because gaseous and semi volatile compounds are constantly changing and interacting Ottah-umahi et al. [1]. Many of these vapor-phase compounds attach to the surface of particulate matters and/or by themselves form secondary aerosol particles. These particles when deposited in the alveoli, enters pulmonary circulation and presumably into the systemic circulation Peters et al. [4]. The potential mechanisms by which particulate matters may cause cardiovascular diseases include alterations in autonomic function, increase repolarization abnormalities, local and systemic inflammation, increase reactive oxygen species, coagulation and myocardial ischemia Ottah-umahi et al. [1]. Cardiovascular diseases that may be cause by air pollution include cardiac arrhythmias, myocardial ischemia, myocardial infarction, atherosclerosis and high blood pressure. Blood pressure is the pressure exerted on the walls of blood vessels by the circulating blood. Most of this pressures are due to work done by the heart as it pumps blood through the circulatory system. It's usually refers to the pressure in large arteries of the systemic circulation. Blood pressure is usually expressed as systolic pressure over diastolic pressure, and it's measured in millimeters of mercury (mmHg). Normal resting blood pressure, in an adult is approximately 120 mmHg systolic, and 80 mmHg diastolic (120/80 mmHg) Guyton and Hall [5]. Blood pressure is measured non-invasively using stethoscope and a mercury tube sphygmomanometer. Auscultation is still generally considered to be the gold standard of accuracy for non-invasive blood pressure readings in clinics. However, digital methods have become common, largely due to concerns about potential mercury toxicity, although cost, ease of use even at home have also impacted on this trend. Blood pressure is influenced by cardiac output, systemic vascular resistance and arterial stiffness. It varies depending on situation, emotional state, physical activity, and relative health/disease states. Blood pressure is control by baroreceptors which act through the cardiovascular center to control the nervous and the endocrine systems. Blood pressure that is very low (80/50 mmHg) is called hypotension, while the pressure that is very high (140/100 mmHg) is called hypertension. Both hypertension and hypotension have many causes and may be of sudden onset or of long duration. Long-term hypertension is a risk factor for many diseases, such as heart diseases, stroke and kidney failure Alpert et al. [6]. Mean Arterial Pressure (MAP): is the average pressure of blood circulating through the arteries, during cardiac cycle. The value of MAP is normally derived from the systolic and diastolic blood pressure. It is often used as an indication for blood flow to the internal organs, being considered a more accurate measurement than the systolic blood pressure. The normal value of MAP is between 70 and 110 mmHg. It can be measured through an invasive methods, but can also be calculated using the following formulas .MAP = diastolic pressure + 1/3 (systolic – diastolic pressure), MAP = 2/3 (diastolic pressure) + 1/3 (systolic pressure), MAP = diastolic pressure + 1/3 (pulse pressure). The clinical importance of MAP is that it represents the perfusion pressure of the different internal organs. MAP greater than 110mmHg may lead to stroke, cardiomegaly and heart attack while MAP less than 60mmHg may also lead to shock, cell death and organ damage. MAP can be negatively influenced by any change in cardiac output or systemic vascular resistance Zheng et al. [7]. Pulse (heart rate) is the number of times the heart beats per minutes. Normal pulse rate varies from individual to individual, but a normal range for adults is 60 to 100 beats per minute. Furthermore, pulse rate can be influenced by age, body size, heart conditions, physical activity, emotions etc. For example, getting excited or scared can increase the pulse rate. The easiest places to measure pulse rate are wrists, elbow, and side of the neck. For accurate reading, place two fingers over one of these areas and count the number of beats in 60 seconds. It can also be counted for 20 seconds and multiply by three. Pulse rate is best measured in the morning before work. A pulse rate lower than 60 doesn't necessarily mean a medical condition. Physically active individuals often have lower heart rates because their heart muscles don't need to do hard work to maintain a steady lower heart rate. For instance, athletes can have resting heart rate of 40 bpm. A pulse rate of greater than 100 beats per minute could be considered as tachycardia while a pulse rate of lower than 60 beats per minute could also be considered as bradycardia Guyton and Hall [5] .Many studies have investigated the relationship between particulate matter and blood pressure; Delfino, Sioutas and Malik [8] investigated the relationship between particulate matter ($PM_{2.5}$) and blood pressure in Boston residents and revealed that an increase from 10 to 90 μg/m^3 of particulate matters ($PM_{2.5}$) showed an increase in resting systolic (2.8mmHg) and resting diastolic (2.7 mmHg) of the participants. Furthermore, Pope et al. [9] reported a significant rise in the diastolic blood pressure (6 mmHg) among the participants after two hours exposure to particulate matter 2.5. More so, Pope and Dockery [10] observed a significant rise in the heart rate of the participants by 5 to 10 beat per minute when they were exposed to PM_{10} (10 μg/m^3). The danger of particulate matters with respect to blood pressure may not have been well documented in Nigerian. Also, no study may have attempted to assess the impact of quarry dusts on the blood pressure status of quarry workers in Ebonyi State where greater number of people are employed in dust emitting industries such as quarry, timber or rice-mill industries. Furthermore, studies carried out in other regions cannot be inferred for Ebonyians due to genetic and socio-demographic characteristics. Hence the need for this study to bridge the gap in knowledge about the impact of quarry dust on the blood pressure status of quarry workers in Abakaliki metropolis.

2. METHODS

This was a cross sectional study. The study was conducted on the quarry workers and non-quarry workers. There were three different groups of quarry workers in Abakaliki metropolis namely; quarry machine operators, quarry stone carriers, and quarry stone crushers.

The blood pressure parameters were also compared among the different groups of quarry workers.

One hundred quarry workers (test group) and one hundred non-quarry workers (control group) were purposively sampled. Quarry workers within the age of 25 to 50 years, have been in the quarry job for at least minimum of three years and are not engaged in other air pollutant Jobs participated in this study. Quarry workers that have been previously diagnosed of any cardiovascular diseases, pregnant workers, smokers and those with any underlying pathologies were excluded from this study.

Cohen [11] sample size formula was used to estimate sample size in this study.

Study area was quarry industry, located more than 20 miles away from traffic.

Dust measuring device (air sampler PCE-PCO 1) was used to analyze the quantity, quality and sizes of particulate matters present in the research area.

A digital sphygmomanometer (model: ZK – B872YA) was used to measure diastole, systole and pulse rate. The measurement was done early in the morning prior to the commencement of quarry work. Mean arterial pressures were calculated (1/3 of pulse pressure + diastolic pressure).

Participants were made comfortable, aim of the procedure explained, signed consent obtained and a questionnaire to determine participants age, sex, years in the job, exclusion and inclusion criteria obtained. Questionnaire was developed by the authors and it was interviewers – administered.

The procedure for blood pressure measurement was performed according to the American heart association guidelines. When measurement was completed, readings of systole, diastole and pulse rate were displayed on the digital panel of the sphygmomanometer and the values were recorded appropriately.

2.1 Data Analysis

Data were presented as Mean ±SEM, analyzed using a 2-way ANOVA, and a multiple comparison test using Tukey's Post Hoc Test. Level of significance was set at 95%. All statistical analyses were carried out using Graph Pad prism 7 software.

3. RESULTS

Table 1 shows the total number of participants (200), gender (36.5 percent females and 63.5 percent males), ethnicity, age groups, marital status and education of participants. It also shows the population of the participants (quarry workers and non-quarry workers). Participants that have been previously diagnosed of any cardiovascular diseases, pregnant workers, smokers and those with any underlying pathologies were excluded from the study. Furthermore, Table 1 shows job experience in years, systole, diastole, mean arterial pressure and pulse rate of the quarry workers.

Fig. 1 shows significant increase in the diastolic blood pressure of quarry machine operators (P= 0.021), quarry stone carriers (P=0.031) and quarry stone crushers (P=0.025) when compared with the control.

A significant increase in the systolic blood pressure of quarry machine operators (P=0.025), quarry stone carriers (P=0.034) and quarry stone crushers (P=0.046) were observed when compared with the control.

A significant increase in the mean arterial pressure of quarry machine operators (P=0.042), quarry stone carriers (P=0.033) and quarry stone crushers (P=0.012) were recorded when compared with the control.

Fig. 2. shows significant increase in the pulse rate of quarry machine operators (P= 0.044), quarry stone carriers (P=0.023) and quarry stone crushers (P=0.034) when compared with the control.

Table 1. Demographic characteristics of study participants

Variables	Number
Gender	
Male	127
Female	73
Ethnicity	
Igbo	200
Age group (Years)	
25 – 30	41
31 – 36	71
37 – 42	61
43 – 50	27
Marital status	
Married	152
Single	48
Population	
Quarry workers (QW)	100
Non-quarry workers (Non-QW)	100
Education	
Primary	23
Secondary	98
Tertiary	79
Job experience (Years)	
3 – 13	113
14 – 24	64
25 – 35	23
Systole (QW)	
130 - 135	31
136 - 140	69
Diastole (QW)	
90 – 95	72
96 – 100	28
Mean arterial pressure (QW)	
100 - 106	33
107 – 113	67
Pulse rate (QW)	
86 – 91	66
92 – 100	34
Total number of participants	200

Table 2 shows the Mean±SEM for quarry workers.

The result showed a significant increase in the diastolic, systolic and mean arterial pressure of quarry machine operators when compared with other different groups of quarry workers.

4. DISCUSSION

There was a significant increase in the systolic and diastolic blood pressure of quarry workers when compared with the control, an indication that quarry workers may be susceptible to hypertension. This finding agrees with the study done by Delfino, Sioutas and Malik [8] who investigated the relationship between particulate matter ($PM_{2.5}$) and blood pressure in Boston residents and revealed that an increase from 10 to 90 µg/m^3 of particulate matters ($PM_{2.5}$) showed an increase in resting systolic (2.8mmHg) and resting diastolic (2.7 mmHg) of the participants. The finding from this study also agree with the study done by Pope et al. [9] who reported a significant rise in the diastolic blood pressure (6 mmHg) among the participants after two hours exposure to particulate matter 2.5.

A significant increase in the mean arterial pressure (MAP) of quarry workers was recorded when compared with the control. This suggest that quarry workers may be prone to heart attack, cardiomegaly and stroke. This result is in line with the findings of Na Li et al. [12] who observed an increase in the mean arterial blood pressure of rural Chinese adults following long-term exposure to PM_1.

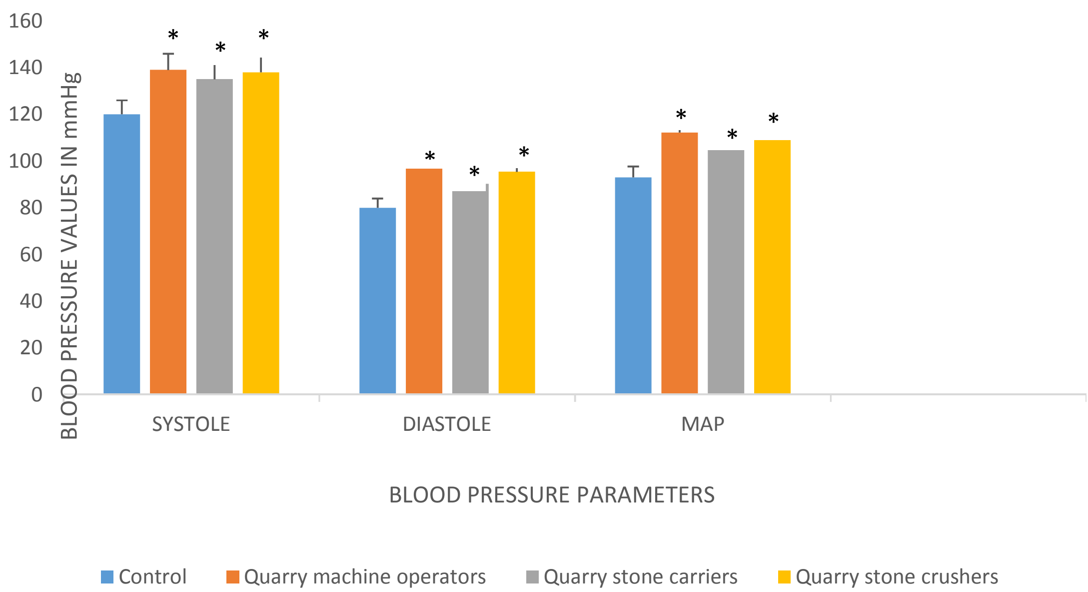

Fig. 1. Comparison of blood pressure parameters between quarry workers and control
** = Level of significance*

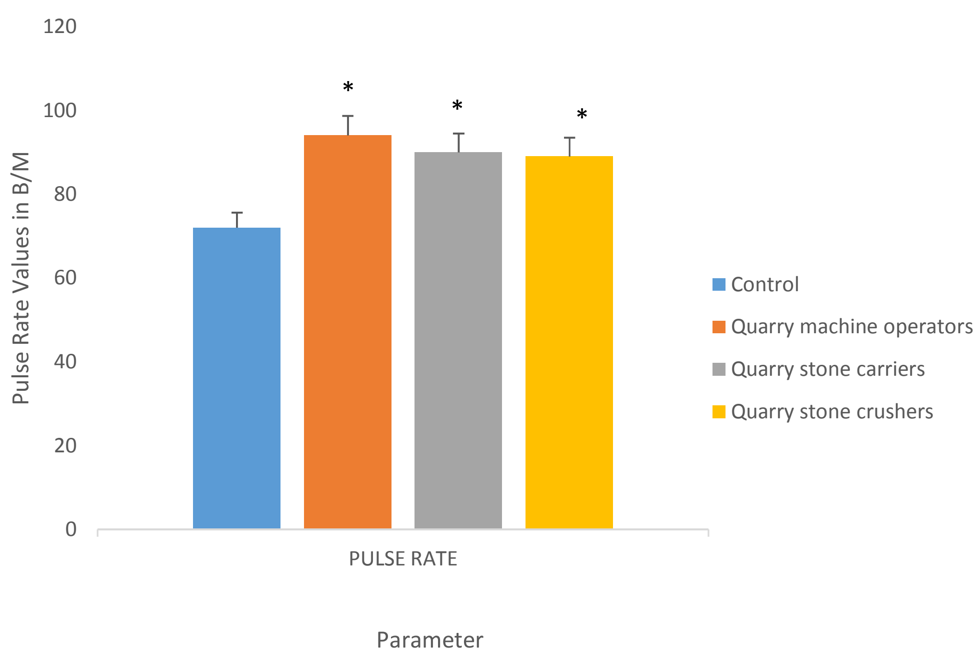

Fig. 2. Comparison of pulse rate between quarry workers and control
** = Level of significance*

Table 2. Comparison of blood pressure parameters among groups of quarry workers

Quarry workers	SYSTOLIC	DIASTOLIC	PULSE RATE	MAP
	Mean±SEM	**Mean±SEM**	**Mean±SEM**	**Mean±SEM**
Machine operator	139±3.31	98.8±1.93	94±1.33	112.2±2.1
Stone carriers	135±6.8	90.3±1.8	90±2.6	105.2±2.32
P-value	0.034*	0.023*	0.077	0.041*
Machine Operator	139±3.31	98.8±1.93	94±1.33	112.2±2.1
Stone crushers	136±3.34	95.4±2.8	89±1.7	109.6±1.4
P-value	0.033*	0.012*	0.6408	0.041*
Stone carriers	135±6.8	90.3±1.8	90±2.6	105.2±2.32
Stone crushers	138±3.34	95.4±2.8	89±1.7	109.6±1.4
P-value	0.7600	0.7411	0.7600	0.7021

Furthermore, a significant increase was observed in the pulse rate of quarry workers when compared with the control. This shows that quarry workers may be predisposed to tachycardia. This finding agrees with the study of Pope and Dockery [10] who revealed a significant increase in the heart rate of the participants by 5 to 10 beat per minute when they were exposed to PM_{10} (10 µg/m^3).

In comparison of blood pressure parameters among the different groups of quarry workers, the result showed a significant increase in the diastolic, systolic and mean arterial pressure of quarry machine operators when compared with other groups of quarry workers. This is an indication that quarry machine operators may be more prone to hypertension than other quarry workers because of their greater exposure to quarry dust than other quarry workers.

5. LIMITATION

Unwillingness of quarry workers to participate in the study which in turn limited the sample size.

6. CONCLUSION

Quarry workers have elevated systole, diastole, mean arterial pressure and pulse rate than non-quarry workers thus may have compromised cardiovascular functions. Also, the observed increase in systole, diastole and MAP of quarry machine operators when compared with other different groups of quarry workers shows that more exposure to quarry dust may cause more damage to the cardiovascular system. Quarry workers need to be motivated to embrace cardiovascular health safety approaches and also, be enlightened on quarry dusts risks.

7. RECOMMENDATIONS

The work exposure limits for quarry dusts must not exceed eight hours per day.
Dust extraction must be provided at working machines to capture and remove dust before it can spread.

Dampers should be fitted in every quarry industry to prevent spread of dusts.

Education of quarry workers by the public health workers on the danger of exposure to quarry dusts through health out reach.

A suitable face mask should be worn by every quarry worker to prevent quarry dust inhalation and subsequent absorption into the circulation.

CONSENT

Written consents have been collected and preserved by the authors.

ETHICAL APPROVAL

Ethical approval was obtained from the Ebonyi State University Ethical Committee and the Ministry of Health Ethical Committee with reference number: EBSU/TETfund/IBR/2015/26.

ACKNOWLEDGEMENT

We are very grateful to our esteemed colleagues; emeana frank and eruemulor christian for their immense support towards the success of this paper. Furthermore, we thank the quarry workers and other participants for facilitating data collection.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Ottah-Umahi G, Ezeja GU, Okorocha AE, Anwara C, Agwu UM, Onwudiwe CU, Nwodo DO, Ugwu O, Okike PO. Effects of quarry dust on the electrocardiogram of quarry workers in Abakaliki metropolis. J Cardiovasc Dis Diagn. 2020; 8:390.
2. International union of pure and applied chemistry. 1990;62(11):2167-2219. Available:www.iupac.org
3. Brook RD, Franklin B, Luis A, James S, Lucky G, Cascio W. Cardiovascular effects of air pollution. Clini Science. 2008; 115(175):187.
4. Peters A, Liu E, Verrier RL, Decramer F, Rabe B, Timbrell F. Air pollution and incidence of cardiac arrhythmia. J Epidemiol. 2000;11(11):7.
5. Guyton AC, Hall, John E. Text book of medical physiology (11th ed.) Philadephia: W.B. Saunders. 2005;116-22.
6. Alpert BS, Quinn D, Gallick D. Oscillometric blood pressure: A review for clinicians. J. Am. Soc. Hypertens. 2014; 8(12):930 - 8.
7. Zheng L, Sun Z, Li J. Pulse pressure and mean arterial pressure in relation to ischemic stroke among patients with uncontrolled hypertension in rural areas of China. Stroke. 2008;39(7):1932-7.
8. Delfino RJ, Sioutas C, Malik S. Potential role of ultrafine particles in associations between airborne particle mass and cardiovascular health. Environ. Health Perspect. 2005;113(934):946.
9. Pope CA, Burnett RT, Thurston GD, Thun MJ, Calle EE, Krewski D, Godleski JJ. Cardiovascular mortality and long-term exposure to particulate air pollution—epidemiological evidence of general pathophysiological pathways of disease. Circulation. 2004;109:71-77.
10. Pope CA, Dockery DW. Health effects of fine particulate air pollution: Lines that connect. J Air Waste Manage. 2006;56: 709-42.
11. Cohen J. Statistical power analysis for the behavioral sciences. New Jersey, Lawrence Erlbaum Associates. Second Edition. 1998;60-102.
12. Na L, Gongbo C, Feifei L, Shuyuan M, Yisi L, Yitan H, Yuanan L, Suyang L, Chongjian W, Hao X, Yuming G, Shanshan L. Association of long-term exposure to ambient PM_1 with hypertension and blood pressure in rural Chinese population: The Henan rural cohort study. Environ. Int. 2006;128:95–102.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/57652