Journal of Medical Sciences

ISSN 1682-4474

science alert

ANSInet
an open access publisher
http://ansinet.com

Research Paper

JMS (ISSN 1682-4474) is an International, peer-reviewed scientific journal that publishes original article in experimental & clinical medicine and related disciplines such as molecular biology, biochemistry, genetics, biophysics, bio-and medical technology. JMS is issued four times per year on paper and in electronic format.

For further information about this article or if you need reprints, please contact:

Dr. Azam Bakhtiarian
Department of Pharmacology,
Tehran University of Medical Sciences,
P.O. Box 13145-784 Tehran, Iran

Tel: 9821-611-2805
Fax: 9821-640-2569

ANSInet
Asian Network for Scientific Information

J. Med. Sci., 5 (1): 103-107
January-March, 2006

The Study of Blood Lead Concentration in Hypertensive and Normotensive Adults in Tehran's Hospitals

[1]Azam Bakhtiarian, [1,2]Raana Dizaji, [3]Abbas Mohaghegh, [1,4]Firoozeh Immami-Khansari and [1]Mahmoud Ghazi-Khansari

This study examined the relationship between blood lead level and hypertension prevalence in a population-based sample of hypertensive and normotensive patients in the Shariatie and Imam Khomeini hospitals in Tehran, Iran. Cross sectional samples of 160 patients (age: 40-70), who participated in a physical examination from these hospital's survey conducted from 2002-2003. The range of blood lead levels was 2.6 to 16.5 μg dL^{-1}. The mean blood lead levels of hypertensive patients (5.1±0.4 μg dL^{-1}) were higher than normotensive patients (2.6±0.3 μg dL^{-1}). There was a significant difference in the mean blood lead levels of hypertensive men (5.6±0.61 μg dL^{-1}) and normotensive men (2.2±4.3 μg dL^{-1}) in this study. The comparison of blood lead levels of hypertensive women(4.7±0.6 μg dL^{-1}) and normotensive women (2.3±0.5 μg dL^{-1}) did also show a significant difference ($p<0.001$). In this population we concluded at levels well below the exposure limit guidelines (40 μg dL^{-1}), blood lead levels are positively associated with both systolic and diastolic blood pressure and risk of both systolic and diastolic hypertension among patients aged 40 to 70 years.

Key words: Hypertension, normotensive, blood lead level

[1]Department of Pharmacology, School of Medicine, Tehran University of Medical Sciences, Tehran, Iran
[2]Zanjan University of Medical Sciences, Zanjan, Iran
[3]Department of Cardiology, School of Medicine, Tehran University of Medical Sciences, Tehran, Iran
[4]General Department of Standard and Industrial Research, Food and Agriculture, Tehran, Iran

INTRODUCTION

The destructive effects of high lead exposure on the body have been widely known[1]. Chronic lead exposure through pollution may cause various health problems in humans, including cardiovascular disorders such as hypertension[2-4]. Considering the fact that lead has an accumulative quality, lengthy exposure to small amounts of lead has also shown to have negative effects on the body. Lead in the air (due to factories and fuels containing lead), foods and drinking water enter the body and is gradually stored in the bones; and through the process of demineralization leaves the bones and enters the blood. Extensive research has been done on the effects of blood lead on the increase of blood pressure for people who had never been occupationally exposed to metals. The research has particularly been done in 1988; the most important of which, according to the population under study, is the second study of the National Health and Nutrition Examination Survey (NHANES II), consisting of 9932 participants. The results of study show that blood lead causes an increase in blood pressure, particularly in diastolic blood pressure and this effect is more prevalent in the male group than in the female group. There is also a positive relationship between blood lead and the hypertrophy of the left ventricle. In the last two decades much research has been done in many countries, including the research of Telisman *et al.*[5] on 154 men from Zagreb whose blood lead caused the increase of systolic and diastolic blood pressure. The research of Nash and Magder[6] on the effects of the blood lead of American women on the blood pressure showed that blood lead also causes an increase of blood pressure in women.

In this research, the relationship between the blood lead level and the increase of blood pressure, the blood lead level of people with high blood pressure and normotensive subjects have been compared, with respect to gender and age.

MATERIALS AND METHODS

This study was carried out in 160 residents of Tehran who had never been occupationally exposed to lead. Eighty of subjects had high blood pressure and had visited Shariati hospital and the other 80 people had normal blood pressure. People with high blood pressure had a history of blood pressure higher than 190/140 mm Hg and used anti-hypertensive drugs (the history of blood pressure drugs usage existed in the patient's record). The age group under study was within the range of 40-70 old. None of the participants had a history of kidney disease or diabetes, which can affect blood pressure. Sampling of the participant's blood was done in the winter of 2003.

Two milliliters of blood was taken from the arm vein. Blood was sampled into a Sodium Citrate (3.5%), an anti-coagulating agent, containing tube for lead analysis. Blood was kept at a temperature of 4°C for 3 days and for long term maintenances a temperature of -20°C was used. Extraction of lead from the blood samples was done according to Subramanian and Meranger[7] instructions. One tenth of a milliliter Triton X-100 (5 mL L^{-1}) and 0.1 mL Diamonium Hydrogen phosphate (5 g L^{-1}) was added to 0.2 mL blood containing an anti-coagulating drug and then by using deionized water, we brought the solution volume to 1 mL and put the sample on the vortex for 30 sec.

Analysis was done using and atomic absorption Spectrophotometer equipped with a graphite furnace and the results were statistically evaluated.

For data normalization, the logarithm of lead concentration was used. The resulting information was processed using one-way analysis of variance followed by Turkey test with $p<0.05$ considered significant.

RESULTS AND DISCUSSION

Results showed that the blood lead concentration of people with high blood pressure is significantly higher ($p<0.0001$) compared to the blood lead of people with normal blood pressure. The blood lead concentration of women with high blood pressure was significantly higher than blood lead concentration of women with normal blood pressure ($p<0.0001$). The blood lead concentration of men with high blood pressure was significantly higher than the blood lead concentration of men with normal blood pressure ($p<0.0001$) (Table 1).

There exists a relationship between the blood lead concentration and the age groups. The blood lead concentration of people 40-49 years of age who have a history of high blood pressure was significantly higher than the blood lead concentration of people of this age group with normal blood pressure ($p<0.01$) (Table 2).

Table 1: The comparison of blood lead concentration in the normotensive and hypertensive subjects with respect to gender (* $p<0.001$)

	Blood lead concentration (μg dL^{-1})	
Groups	Women	Men
Control (n = 80) normotensive	3.0±0.4	2.3±0.5
Case (n = 80) hypertensive	*4.8±0.6	*5.6±0.6

Table 2: The comparison of blood lead concentration in the normotensive and hypertensive subjects with respect to age (* p<0.01)

Age group (year)	Blood lead concentration (μg dL^{-1}) Normotensive (n = 80)	Hypertensive (n = 80)
40-49	3.1±0.05	*7.2±2.4
50-59	1.9±0.3	*4.3±2.4
60-69	4.0±1.9	5.3±2.3

Table 3: The comparison of blood lead concentration in the normotensive subjects with respect to their systolic and diastolic blood pressure

Blood lead concentration (μg dL^{-1})	Blood Pressure (mmHg) Systolic	Diastolic
0-1.18	112.4±0.8	70.7±0.7
1.19-2.22	124.55±0.8	73.1±1.2
2.23-3.5	130.0±1.8	80.2±0.4
3.51-5.76	132.1±1.2	82.0±0.5
5.77-16.48	123.1±0.8	80.3±1.6

The blood lead concentration of people 50-59 years of age who have a history of high blood pressure is significantly higher than the blood lead concentration of people of this age group with normal blood pressure (p<0.01) (Table 2).

The mean blood lead concentration of the 60-70 age group for people who have high blood pressure was not significantly higher than that of people with normal blood pressure (Table 3).

Subsequently, the blood lead concentration of five groups according to the increase of blood lead concentration and the information regarding the five blood level concentration groups and the systolic and diastolic blood pressures of each of the groups are shown in table pressures of each of the groups are shown in Table 3 which indicates that the blood pressure increase occurs in the range 1.1-5.7 μg dL^{-1}.

The existence of a strong association between blood lead and blood pressure across the entire adult age range has already been noted in the NHANES II survey and in numerous other studies[8,9]. Considering the fact that primary hypertension was highly common and is the basic cause of many illnesses, such as cardiovascular diseases and deaths among the people of society, the need to control and understanding its causes, including environmental factors and to reduce these environmental factors or to balance people's food regimen, allows us to control this occurrence.

Considering the fact that at present, the amount of lead in the air has decreased because of the elimination of tetra ethyl lead from gasoline, the source of lead in the group being studied may be the lead stored in the bones which are released from the bone and enter the blood through the process of mineralization and calcium exchange, or lead existing in air, drinking water and meat and conserved food products. The release of lead from the bone storages is different during various seasons and to eliminate this interference, the sampling occurred during only one season, that being the winter of 2003. Age and gender are important factors that control blood pressure, so the information was categorized according to them and they were also considered during statistical analysis. Extraction and measurement of the lead of the samples was done with a great accuracy and controlled daily for accuracy by analyzing three reference blood samples with certified blood lead values.

The resulting blood lead concentration of the participants (40-70 years of age) ranged between 0 to 16.5 μg dL^{-1} and its mean was 3.8 μg dL^{-1}.

None of these participants had job-related contact with lead. In people who had job-related contact with lead, a blood lead concentration of 40 μg dL^{-1} has been reported[10]. In 1996, the blood lead concentration of the people of the United States has been reported as being less than 5 μg dL^{-1}[11]. The statistical analysis of data showed that the blood lead concentration of hypertensive patients is significantly higher than that normotensive patients (p<0.0001). This significant increase shows that in our society lead probably increases the risk of getting high blood pressure.

This finding is consistent with the results of Bhardwaj *et al.*[12] on 200 patients with high blood pressure compared to a control group.

We grouped the resulting information by gender and then compared the blood lead concentration of people with high blood pressure to that of people with normal blood pressure. A comparison of the blood lead concentration of men with high blood pressure and men with normal blood pressure showed a significant difference (p<0.0001). The blood lead concentration was in the range 1.7-14.3 μg dL^{-1} with a mean of 4.3 μg dL^{-1}.

Blood lead in men had caused an increase in their blood pressure. This relationship had usually been found in studies done in different countries on people who had never been occupationally exposed to metals, including the second study of NHANES and study by Telisman *et al.*[5] and in England in 1988, in which blood lead concentration had caused an increase in the blood pressure of men[13].

In the women's group, a comparison of the blood lead concentration of women with high blood pressure and women with normal blood pressure also showed a significant difference(p<0.0001). Blood lead in women also causes an increase in their blood pressure. The study of Nash and Magder[6] showed this relationship in women who had never been occupationally exposed to lead[8]. This group consisted of 2165 women 40-59 years of age.

In this study, it was reported that the blood lead concentration ranged between 0-31.1 with a mean of 2.9 μg dL^{-1}.

Study of the information of the participants, grouped by age, showed that in the three age groups 40-49, 50-59 and 60-70 years of age, a comparison of the blood lead concentration of hypertensive and those of normotensive subjects using bidirectional statistical analysis revealed a meaningful relationship ($p<0.001$). Complimentary analysis showed that the blood lead concentration difference between the two groups under study in the age groups 40-49 and 50-59 years of age is significant. In the age groups 40-49 and 50-59 years of age, environmental factors have an important role in increasing the blood pressure of this fraction of the society. It appears that in the age group 60-70 years of age, other factors such as aging and inheritance have an important role.

After the classification of the blood lead concentrations according to the increase of lead concentration in the five groups and considering the systolic and diastolic blood pressure in each of the groups, it was found that an increase of systolic and diastolic blood pressure is seen in blood lead concentrations less that 10 μg dL^{-1}. An increase of systolic and diastolic blood pressure is seen more with small and medium amounts of blood lead than with large amounts of blood lead. This result has also been shown in the study of Telisman *et al.*[5]. In this study, they have also showed, that blood pressure increased more with small amounts of blood lead.

These findings show that an increase of blood pressure due to small amounts of lead occurs during a long period of time whereas large amounts of lead in blood cause a temporary increase and is incapable of increasing blood pressure.

Researchers have suggested many mechanisms in order to explain the increases of blood pressure caused by lead. The mechanisms attained are the result of *in vivo*, *in vitro* experiments on animals[14]. Lead causes an increase of intercellular calcium either by changing the calcium distribution or by causing changes in calcium exchange[15]. Other factors that show the effects of lead on the increase of blood pressure include controlling of the Na^{+}-K^{+} ATPase pump by lead[16], activating the protein Kinase C[17] increasing vessel contracting factors such as Endothelin[18], causing changes in factors dependent on endothelium[19] and decreasing the responsiveness of the vascular smooth vessel to the beta adrenoreceptor agonists[20].

In our studied society, especially in people with normal blood pressure, a range of 1.1-5.8 μg dL^{-1} has caused an increase in blood pressure is seen in the range 3.5-5.7 μg dL^{-1}. In all of the studied society (160 people), the sensitivity of the society to small amounts of lead was greater.

The study results indicate a significant lead related increase in systolic and diastolic blood pressure. This should be considered relevant in terms of public health implications. Further studies in this respect would be valuable, including possible interaction of lead and selenium on blood pressure in general population.

REFERENCES

1. Beevers, D.G., E. Erskine and M. Robertson, 1976. Blood lead and hypertension. Lancet, 2: 1-3.
2. Goyer, R.A., 2001. Toxic Effect of Metals. In: Cassaret and Dule's Toxicology The Basic Science of Poisons. 6th Edn., New York: McGraw-Hill Co, pp: 999-1001.
3. Harlan, W.R., J.R. Landis, R.L. Schmouder, N.G. Goldstein and I.C., Harlan, 1985. Blood lead and blood pressure relationship in the adolescent and adult US population. JAMA., 253: 530-534.
4. Neri, L.C., D. Hewitt and B. Orser, 1988. Blood lead and blood pressure: Analysis of cross sectional and longitudinal data from Canada. Environ. Health Perspect., 78: 123-126.
5. Telisman, S., P.A. Jurasovic and P. Cvitkovic, 2001. Blood pressure in relation to biomarkers of lead, cadmium, copper, zinc and selenium in men without occupational exposure to metals. Environ. Res. Section A, 87: 57-68.
6. Nash, D. and L. Magder, 2003. Blood lead, blood pressure and hypertension in prermenopausal and postmenopausal women. JAMA., 289: 1523-1532.
7. Subramanian, K.S. and J.C. Meranger, 1981. A rapid electrothermal atomic absorption spectrophotometric method for cadmium and lead in human whole blood. Clin. Chem., 27: 1866-1871.
8. Pirkle, J.L., J. Schwartz, J.R. Landis and W.R. Harlan, 1985. The relationship between blood lead and blood pressure and its cardiovascular risk implications. Am. J. Epidemiol., 121: 246-258.
9. Schwartz, J., 1988. The relationship between blood lead and blood pressure in the NHANES II survey. Environ. Health Perspect., 78: 15-22.
10. Wu, T.N., C.N. Shen, K.N. Ko, C.F. Guu, H.J. Gau, J.S. Lai, C.J. Chen and P.Y. Chang, 1996. Occupational lead exposure and blood pressure. Intl. J. Epidemiol., 25: 791-796.
11. Hu, H., A. Antonio, M. Payton, S. Korrick, D. Sparrow, S.T. Weiss and A. Rotnitzky, 1996. The relationship of bone and blood lead: the normative aging study. J. Am. Med. Assoc., 275: 1171-1176.

12. Bhardwaj, S., O. Chandra and A.S. Khan, 1991. Serum and urinary lead levels in hypertension. Ind. J. Pharmacol., 823: 69-74.
13. Schwartz, J., 1991. Lead, blood pressure and cardiovascular disease in men and women. Environ Health Perspect., 91: 71-75.
14. Lal, B., R.C. Murthy and M. Anand, 1991. Cardiotoxicity and hypertension in rat artery oral lead exposure. Drug Chem. Toxicol., 14: 305-318.
15. Piccinini, F. and L. Favalli, 1997. Experimental investigations on the contraction induce by lead in arterial smooth muscle. Toxicology, 8: 43-51.
16. Weiler, E. and F. Khalil-Manesh, 1990. Effects of lead and a low-molecular-weight endogenous plasma inhibitor on the kinetics of sodium-potassium-activated adenosine triphaosphatase and potassium-activated p-nitro phenyl phosphatase. Clin. Sci., 79: 185-192.
17. Watts, S.W. and S. Chai, 1995. Lead acetate-induced contraction in rabbit mesenteric artery interaction with calcium and protein kinase C. Toxicology, 99: 55-65.
18. Gonick, H.C. and Y. Ding, 1997. Lead-Induced hypertension. Hypertension, 30: 1487-92.
19. Vaziri, N.D. and K. Liang, 1999. Increased nitric oxide inactivation by reactive oxygen species in lead-induced hypertension. Kidney Intl., 56: 1492-1498.
20. Tsao, D.A. and H.S. Yu, 2000. The change of B-Adrenergic system in lead-induced hypertension. Toxicol. Applied Pharmacol., 164: 127-133.