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Determination of Blood Levels of Lead in Pregnant Women in Nnewi, Anambra State, South Eastern Nigeria

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Abstract: Lead is a well known environmental and reproductive toxicant. This study was designed to evaluate the blood lead levels in pregnant women in Nnewi, Anambra State, South Eastern Nigeria. A total of 100 apparently healthy subjects comprising of 75 pregnant women and 25 non-pregnant women (control) aged between 18 and 45 years were recruited for the study. Thereafter, 2mls of blood sample was collected into EDTA container for the estimation of lead concentration using atomic absorption spectrophotometric method. A structured questionnaire was used in obtaining relevant data for age, dietary and lifestyle patterns of subjects. The result showed a significantly higher lead level in pregnant women compared with control group ($p=0.000$). Also, the mean blood lead level differed significantly between the first and second trimester as well as between first and third trimesters of pregnancy ($p<0.05$), but values obtained were similar between second and third trimesters of gestation ($p>0.05$) respectively. This study further revealed significantly higher blood levels in pregnant women that consume caffeine, animals killed by ammunition, and food items as well as in pregnant women that smokes ($p<0.05$). Also, blood lead level was significantly elevated in pregnant women that used well and piped water respectively ($p<0.05$). Therefore, there is need to avoid avenues of lead exposures in pregnancy in order to sustain the low blood level recorded in this study and hence, limit the potential adverse implications of lead exposures.

Keywords: Lead, pregnancy, Atomic absorption spectrophotometric method, Nnewi.

INTRODUCTION

Lead (Pb) is a stable, silver-gray, ubiquitous heavy metal detectable in all phases of inert environment such as air, water and soil as well as in most biological systems as a result of mining and industrialization and has no known physiological function in human body and is toxic [1]. It is one of the most extensively studied reproductive toxicants and a well known industrial and environmental toxin with a broad range of acute and chronic toxic effects [2]. Lead poisoning remains an urgent public health problem especially in developing countries like Nigeria [3] and is considered to be one of the most difficult health issues during pregnancy.

Lead exposure has been associated with a number of adverse health effects in persons of all ages and there is no known safe level of exposure to lead [4]. It may be absorbed by the body through inhalation, ingestion or dermal contact (skin) and can be transferred to the fetus through the placenta [5]. Chronic low levels of lead exposure may result in lead accumulation in the renal tubule, lungs, hepatocyte and calcified tissues. It is well known that lead accumulates mostly in the bones of the body [6]. Lead exposure remains a risk factor in female reproductive health, even at low levels of lead in blood [7]. Following lead absorption from the gastrointestinal or the respiratory system, it is transported bound to erythrocytes and accumulates in bone [8]. During pregnancy, calcium demands increase [9], resulting to increased bone turnover, subsequently leading to the release of lead from bone and increasing blood lead levels [10, 11]. Thus, lead can cross the placenta, and contributes to fetal lead exposure since there is no protective barrier to the transplacental transport of lead [12, 13] and this can alter the embryonic development in the fetus [14, 15]. Previous studies have recorded negative outcomes of lead exposure in pregnancy including pregnancy hypertension or preeclampsia [16, 17], premature delivery [7], miscarriage [18, 19] and low birth weight [20, 21]. Also, previously higher levels of lead have been reported in pregnant women than in control subjects [22, 23]. Therefore, this study investigated the blood lead levels in pregnant women in Nnewi, Anambra State, Southeastern Nigeria.

MATERIALS AND METHODS

Study design and sample collection

This is a cross sectional study designed to determine the blood lead levels in pregnant women in Nnewi, Anambra State, Southeastern Nigeria. A total of 100 apparently healthy subjects comprising of 75 pregnant women and 25 non-pregnant women (control) aged between 18 and 45 years were recruited for the study. Subsequently, they were grouped into different trimesters of gestation and 25 pregnant women were recruited in each of the trimester respectively. Thereafter, 2mls of blood sample was collected into EDTA container for the estimation of lead concentration. A structured questionnaire was used in obtaining relevant data for age, dietary and lifestyle patterns of subjects.

Inclusion Criteria and Exclusion Criteria

Apparently healthy pregnant and non-pregnant women aged between the age of 18 and 45 years were included in the study while those younger than 18 and older than 45 years, those that take alcohol or smoke cigarette as well as hypertensive subjects were excluded from the study.

Estimation of blood lead level

Blood lead (Pb) level was estimated using Varian AA240 Atomic absorption spectrophotometer (AAS) using the method described by Hessel [24].

Ethical Consideration

This was sought and obtained from Faculty of Health Sciences and Technology Ethical Committee, Nnewi. Informed consent was obtained from participants prior the commencement of the study.

Statistical analysis

Data obtained were tabulated and analyzed using SPSS version 20.0 (SPSS Inc. Chicago, IL, USA). Student's t-test and ANOVA was employed in comparing means and results expressed as Mean±SD. P<0.05 was considered statistically significant.

RESULTS

The mean blood levels of lead were found to be significantly higher in pregnant women when compared with the control group (0.87±0.17 Vs 0.11±0.07; p=0.000), See table-1.

Table 1: Comparison of blood lead level in pregnant women and control group ($\mu g/dl$)

Variables	Number of subjects	Blood lead (µg/dl)
Pregnant women	75	0.87±0.17
Control group	25	0.11±0.07
t-value		5.122
p-value		0.000*

*Statistically significant at P<0.05; MEAN±STD.

Table-2 shows significant difference in the mean blood levels of lead among the different trimesters of gestation, with the first trimester having the lowest mean value of 0.16±0.12 $\mu g/dl$, followed by third trimester (1.09±0.45) and with the highest mean value observed in the second trimester (1.37±0.28), (p<0.05). However, there was no significant difference observed in blood lead levels between second trimester and third trimester (p>0.05) See table-2.

Table-2: Comparison of blood lead levels in pregnant women among the different trimesters of gestation

Variables	Number of subjects	Blood lead ($\mu g/dl$)	F-value	P-value
First trimester (A)	25	0.16±0.12		
Second trimester (B)	25	1.37±0.28	7.226	0.001*
Third trimester (C)	25	1.09±0.45		
A Vs B				0.001*
A Vs C				0.007*
B Vs C				0.403

*Statistically significant at P<0.05; MEAN±STD.

Furthermore, the levels of lead were found to increase significantly in pregnant women that are involved in caffeine intake, consumption of animal killed by ammunition, consumption of non-food items and passive smoking, when compared with women that are not involved in this lifestyle (p<0.05), See table-3.

Table-3: Comparison of lifestyle characteristics of pregnant women and their blood levels ($\mu g/dl$)

Variables	Reponses	Number of subjects	Blood lead ($\mu g/dl$)	t-value	p-value
Caffeine intake	YES NO	11 64	2.78±1.85 0.54±0.79	3.943	0.002
Consumption of animals killed by ammunition	YES NO	7 68	3.52±1.56 0.60±0.87	7.710	0.000
Stay with smokers	YES NO	10 65	2.71±1.68 0.60±0.94	3.881	0.003
Consumption of non-food items	YES NO	21 64	1.84±1.71 0.50±0.82	3.433	0.002

*Statistically significant at P<0.05; MEAN±STD.

Table-4 also compared source of drinking water of the pregnant women and their blood lead levels. The mean levels of lead were found to increase significantly (p<0.05) in pregnant women that uses well, piped water and others, as their source of drinking water. The mean blood levels of lead among the different sources of drinking water, with those that drink well water having the highest mean value (2.24±1.05) $\mu g/dl$ followed by those that drink pipe water (1.46±0.76) and the least mean value was seen in those that uses other sources of water like bottle water (0.48±0.13). there was a significant increase (p<0.05) in the mean blood lead levels between women that drink well water and other sources of drinking water and women that uses piped water and other sources of drinking water but there was no significant difference (p>0.05) in the mean lead levels between women that uses well and piped water as their source of drinking water.

Table-4: Comparison of source of drinking water of pregnant women and their blood levels ($\mu g/dl$)

Variables	Number of subjects	Blood lead($\mu g/dl$)	f-value	p-value
Well water (A)	9	2.24±1.05		
Piped water (B)	14	1.46±0.76	11.801	0.000
Others (C)	52	0.48±0.13		
A Vs B A Vs C B Vs C				0.107 0.000 0.005

*Statistically significant at P<0.05; MEAN±STD.

DISCUSSION

Lead is one of the most extensively studied reproductive toxicants and is considered as a major health issue during pregnancy, with a number of adverse outcomes. Pregnancy is a powerful stimulus for bone re-sorption [25] and hence, the blood lead levels of women with high bone lead content may be elevated because of pregnancy.

In the present study, blood lead levels were measured and compared between pregnant women and the control subjects. A significant increase was observed in the mean levels of lead in pregnant women than in control group (p=0.000). during pregnancy, lead from prior exposures can be mobilized from bones because of the increase in bone re-sorption to accommodate the mineral needs of the fetus for ossification and growth and this may result in transient increases in the mean endogenous blood lead levels, especially if dietary calcium is low [9, 26]. This is in consonance with previous studies which reported higher blood lead levels [27, 23, 28].

Similarly, a significant increase was observed in the mean blood levels of lead between first and second trimester and between first and third trimesters of gestation (p=0.001, 0.007) respectively, but there was no significant difference in the mean blood lead levels observed between second and third trimester of pregnancy (p>0.05). A decline in blood lead level during the first trimester was observed, followed subsequently by a rise in blood lead level. This initial decline is perhaps due to pregnancy-induced plasma volume expansion [29], whereas the subsequent rise in blood level could be attributed to either an increased absorption or mobilization through osteoclastic re-sorption of lead stored in bone or both. This is in keeping with the previous findings of Rothenberg *et al*., [29].

In this study, blood lead concentrations ranged from 0.05 to 5µg/dl, with a mean of 0.87µg/dl. This suggests low lead exposure among the pregnant women in the studied population. This is similar to the finding of Tellez-Rojo *et al*., [11].

Furthermore, higher caffeine consumption was also predictive of increased blood lead levels. This is because coffee is known to contain high levels of lead [30]. Also, caffeine may lead to a small negative calcium balance through a weak interference with calcium absorption, leading to an increase in bone re-sorption, although this effect is important only in those with low calcium intake [31]. Women that use pipe and well water as their source of drinking water were observed to have higher blood lead level when compared with other women that utilizes other sources of water. This increase of lead in well water may be attributed to high lead content of Nigeria's gasoline.

CONCLUSION

This study revealed a significantly higher lead level in pregnant women compared with control group. Also, the mean blood lead level differed significantly between the first and second trimester as well as between first and third trimesters of pregnancy but values obtained were similar between second and third trimesters of gestation respectively. This study further found significantly higher blood levels in pregnant women that consume caffeine, animals killed by ammunition and food items as well as in pregnant women that smokes. Also, blood lead level was elevated in pregnant women that used well and piped water respectively. Therefore, there is need to avoid avenues of lead exposure in order to sustain the low blood level recorded in this study.

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