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# Assessment of Some Heavy Metals in Blood Samples of Pregnant and Non-Pregnant Women in Damaturu, Yobe State

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***Abstract*****—***The investigation involved structured interview with the 65 healthy non pregnant women randomly selected from the various wards and 75 pregnant women that were attending antenatal clinics at 4 Health care centers in Damatru, followed by collection of blood samples for heavy metals analysis. The blood samples were acid-digested and the metals were analyzed by Atomic Absorption Spectrophotometry (using AAS -Buck scientific model 210GP). This study aimed at determining the status of toxic elements (heavy metals) in pregnant women of different age groups as well as non-pregnant women in Damaturu, Yobe State and to compare the results obtained with cited literature values of heavy metals in blood in order to assess the exposures of women to the heavy metals and possible health risks as designated by Health regulatory agencies such as WHO. The results obtained indicated higher concentrations of As, Cr, Ni, Mn, in the blood samples of Pregnant women, with Pb, Zn, Co, Hg, Al having higher concentrations in the non-pregnant blood samples. Among the metals analysed Zn was found to have the highest mean concentration of 0.0151, sem 0.0034 mg l-1 of blood, followed by As with mean concentration of 0.0076 with sem of 0.0370, whilst Cd was below detection limit in all the blood samples. The concentrations of the heavy metals in the blood of pregnant and non-pregnant women in Damaturu were found to within the WHO and US EPA permissible limits, and less than those analysed in China, Iran and US. Environmental factors such as heavy metals exposure can have interference with women reproductive health, usually Lead (Pb) being frequently distributed in the environment are recognized as toxic to human reproductive system. Exposure to large concentration of trace elements such as As, Cd, Mg, and Zn can lead to accumulation in human follicular fluid and may diminish fecundity (reproduction capacity). Naturally, heavy metals get into human body through ingestion, inhalation and absorption in small extent as trace elements, essential to maintain the metabolism of human body. Trace amount of metals maybe essentially used in metabolic activities, but high exposures are dangerous to humans because of their tendency to bioaccumulation and bio-magnification, which lead to an increase in the concentration of the metals in biological organisms or targeted organs over a time unit and becomes hazardous to health*.

***Keywords*****—** *Heavy metals, Blood, pregnant women, Exposure*.

## I. INTRODUCTION

Pregnancy period is an important course of women's life. It is considered as a period during which there is a high sensitivity toward toxic substances. This period also comes with pregnancy complications and reproductive health issues which may involve either mother's health, the child's, or both. The host of environmental factors that may influence negatively on human reproductive system include poor maternal diet and toxic metals among others. A reported study on animals revealed that increased uptake of heavy metals such as Lead (Pb), Arsenic (As), Cadmium (Cd), Chromium (Cr), Mercury (Hg) and other toxic metal elements interfered with the normal pregnancy which may result in abortion among other physiological dysfunctions**.** Another route of exposure that is endogenous demands for a great concern, as many toxic metals may be mobilized from accumulated organs like bones, to the blood stream during pregnancy after period of exposure (Semczuk et al, 2001), those metals have the tendency to cross the fetal membrane which potentially harm the fetus, and no level has been proven for safety during pregnancy for many metals (Ajajiy et al., 2012).

Heavy metal elements such as Lead (Pb), Mercury (Hg) Cadmium (Cd) and Arsenic (AS) are the potential essential toxic elements known for their ability to bio-accumulate in the human body and result in multi-organ disruption (Ray SA, et al, 2009). The mechanism of heavy metal toxicity can best be explained by their ability to interact with nuclear proteins and DNA, resulting in oxidative deterioration of biological macromolecules (Leonard et al, 2004). Environmental factors such as heavy metals exposure can have interference with women reproductive health, usually Lead (Pb) been frequently distributed in the environment are recognized as toxic to human reproductive system. Exposure to large concentration of trace elements such as AS, Cd, Mg, and Zn can lead to accumulation in human follicular fluid and may diminish fecundity (reproduction capacity) (Blooma, 2011). Environmental exposure to toxic heavy metals are assessed by using self-administered questionnaires, by measuring the ambient environment, by conducting numerical modelling and, in particular, by collecting and analysing biological samples such as blood, urine, hair and breast milk (Michinkawa et al., 2018).

Naturally, heavy metals get into human body through ingestion, inhalation and absorption in small extent as trace elements, essential to maintain the metabolism of human body. Thus, trace amount of toxic metals maybe essentially used in metabolic activities, but some are dangerous to humans because of their tendency to bioaccumulation and bio-magnification, which lead to an increase in the concentration of the metals in biological organisms or targeted organs over a time unit and becomes hazardous to health (Meta et al, 2008). This can result in deficiency of some certain nutrient as well can lead to Parkinson's disease, cancers, skin disorders, respiratory abnormalities, abnormal pains and internal



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problems; central nervous system damage blood disorder and reproductive failure (U N E P, 2007). An acute exposure to high concentration of heavy metal can lead to nausea, anorexia, vomiting, gastrointestinal abnormality, and dermatitis. According to a review paper, Pb, Cd, As, and Hg can cause preterm delivery, oxidative stress in the trophoblastic placental tissue, and the production of reactive oxygen species (Singh et al.2020). Additionally, a case-control study revealed that preeclampsia is excessively associated with pregnant women exposed to chromium (Cr) and As (Wang et al. 2020c).

Due to potential health effects, it's critical to lower women's exposure to metals, notably Cd and Pb, during pregnancy (Osorio-Yanez et al. 2021). Pb exposure is harmful to the reproductive system in male and female; it can cause female infertility, abortion, premature birth, gestational hypertension, and inhibit embryonic growth and development (ATSDR 2012).

*Aims and Objectives of Study:*

This study aimed at determining the status of toxic elements (heavy metals) in pregnant women of different age groups as well as non-pregnant women in Damaturu, Yobe State and to compare the results obtained with cited literature values of heavy metals in blood in order to assess the exposures of women to the heavy metals and possible health risks as designated by Health regulatory agencies such as WHO, USEPA.

## II. Materials and Methods

*Study Area*: Damaturu town is the capital of Yobe state, Nigeria. it is located on coordinates of 11o 44'40"n and 11o 57'40"e in the north-eastern part of Nigeria with an area of 2,366km$^2$ and a population of 88,014 according to the 2006 census. Damaturu is an urban settlement with its inhabitants coming from all works of life. Yobe state has a population of 2,321,591 according to the record of the national head count of 2006. the state has 17 local government areas, and with 14 emirate councils. (Ningi, et al., 2015).

*Questionnaire design and administration of structured questionnaire*

Information about the participants such as age, affiliation, status, health status was obtained by via a structured interview questionnaire.

*Study Population:* A total of 140 blood samples were be collected. 75 samples were collected from healthy non pregnant women of childbearing ages (20 to 50 years old) from healthy donors randomnly in 4 wards within Damaturu town. I.e. Gwange/Sabon pegi, Maisandari, Waziri Ibrahim Estate/Poly quarters, and Malari wards. 65 samples were collected from pregnant women attending maternity hospitals (16 each at Specialist hospital, Gwange primary health care centre, Fedpodam clinic and 17 from Family support hospital), all within Damaturu metropolis.

*Sample Collection:* 5ml venous blood was collected from each of the subjects using sterile disposable syringe into EDTA containers and then stored in a refrigerator at 8 $^oC$ for the analysis of toxic metals. Since the study involved human subjected, ethical clearance was obtained from Ethical committee at Specialist Hospital

*Sample pre-treatment (Microwave Acid digestion) and AAS Analysis:*

Prior to the analysis of toxic metals, about 2.0 ml each of whole blood samples were placed into a thoroughly clean microwave tubes. To the samples, 6 ml of 65% nitric ($HNO_3$**)** acid followed by 2ml of hydrogen peroxide ($H_2O_2$) was added and allowed to stand for few minutes. The tubes were covered and placed on microwave digester and then digested at a temperature of 95$^0$C for 15 minutes. The digested samples then diluted with deionized water to a total volume of 25ml. Analysis of Heavy Metals in Blood Using AAS (Buck Scientific, Model 210VGP, USA).

*Determination of metal contents of the blood samples:*

Concentration of the various metal ions present in the samples were determined by reading their absorbance using AAS (Buck scientific model 210GP) and comparing it on the respective standard calibration curve. The metals determined by absorption/concentration mode and the instrument readout were recorded for each solution manually. Blanks were used simultaneously in each batch of the analysis to authenticate the analytical quality.

Data for the concentrations of the various heavy metals in the samples were analyzed using SPSS v.24 statistical software and expressed in term of descriptive statistics while the figures were presented with Mean values as (Mean ± SEM).

## III. Results and Discussions

The results were analysed and interpreted, then compared with the results obtained from other studies across the globe. The 140 women randomly selected were between the ages of 18 to 55 with the highest number of participants between the ages of 25 to 35 (childbearing age). The average age of the women was 28.84±7.432 as shown in Figure 1.

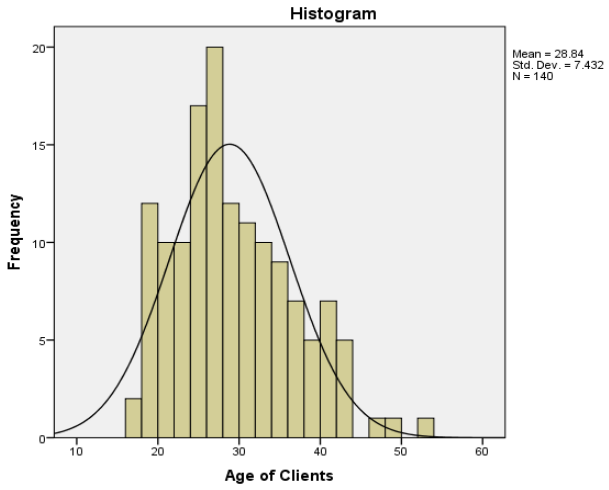


Fig. 1. Normal distribution of Age variable among the women whose blood samples were collected

*Affiliations and status of the Women participants:*

Among the women, 18 were civil servants (12.9 %), 50.7 % that is 71 were full time house wives, and 36.4% of the



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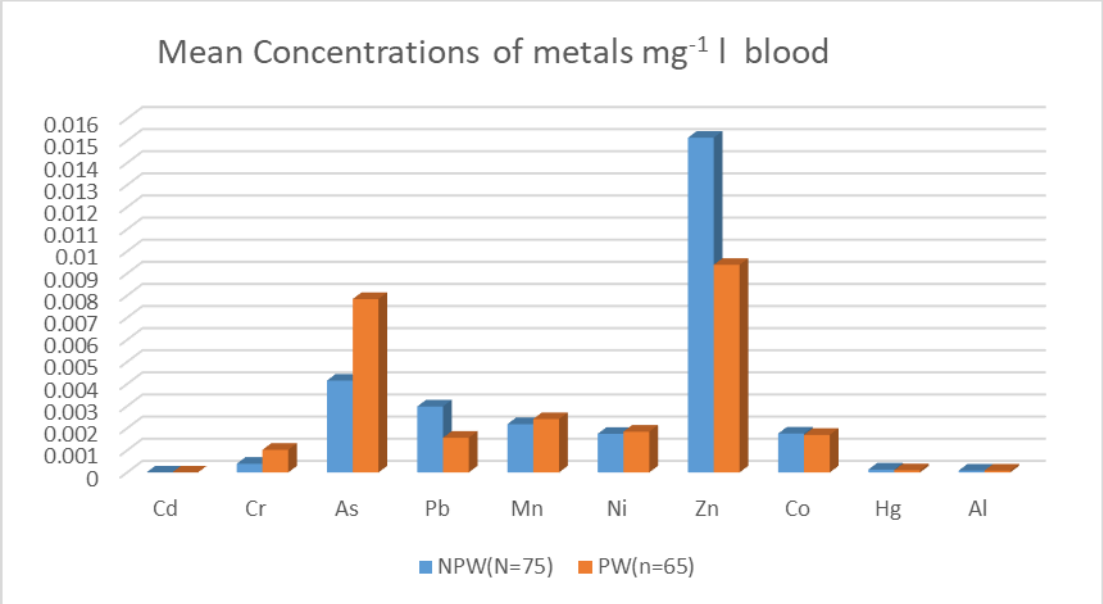
women representing 51 were students at tertiary institutions (Table 1). 75 women which is 53.6 percent were non pregnant, while 65 of them (46.4 %) were at various stages of pregnancies.

TABLE 1. Summary information of women that participated

| Affiliations | Frequency | Percent(%) | Status | Frequency | Percent(%) |
|---|---|---|---|---|---|
| Civil servant | 18 | 12.9 | Non Pregnant | 75 | 53.6 |
| House wife | 71 | 50.7 | | | |
| Student | 51 | 36.4 | Pregnant | 65 | 46.4 |
| **Total** | 140 | 100 | | 140 | 100 |

*Concentrations of metals in Blood samples*

The results obtained indicated that the concentrations of As, Cr, Ni, Mn, are higher in the blood samples of Pregnant women, with Pb, Zn, Co, Hg, Al having higher concentrations in the non-pregnant blood samples. Among all the metals analysed Zn was found to have the highest mean concentration of 0.0151, sem 0.0034 mg $l^{-1}$ of blood, followed by As with mean concentration of 0.0076 with sem of 0.0370, whilst Cd was below detection limit in all the blood samples analysed as shown in Fig.2.




Key: NPW= Non pregnant women PW= Pregnant women

Fig. 2. Mean Metals Concentration Mg L -1 Blood Of Non-Pregnant And Pregnant Women

TABLE 2. Mean metals concentration mg l -1 blood from different studies

| Mean metal concentration mg- l-I blood from different studies | | | | | Permissible limits | |
|---|---|---|---|---|---|---|
| **Metal** | **NPW(N=75) (This study)** | **PW (n= 65) (This study)** | **N=80 (Rajabi et al.,2021)** | **N=330(Zhang et al.,2015)** | **WHO** | **US EPA** |
| **Cd** | 0.000000 | 0.000000 | 0.014 | 0.0069 | 0.0005 | 0.0005 |
| **Cr** | 0.000393 | 0.001023 | | | 0.005 | 0.005 |
| **As** | 0.004154 | 0.007843 | **0.221** | | 0.005 | 0.001 |
| **Pb** | 0.002983 | 0.001568 | 0.173 | 0.0043 | 0.005 | 0.0015 |
| **Mn** | 0.002187 | 0.002414 | | 0.0011 | 0.002 | |
| **Ni** | 0.001746 | 0.001846 | | | | |
| **Zn** | **0.015139** | 0.009390 | | 0.0005 | 0.05 | 0.05 |
| **Co** | 0.001760 | 0.001700 | | | 0.001 | - |
| **Hg** | 0.000134 | 0.000101 | | | 0.0001 | 0.0002 |
| **Al** | 0.000085 | 0.000064 | | | | |

Among metals of health concern, manganese (Mn), copper (Cu) and zinc (Zn) are nutritionally important, and yet their deficiency or overload is detrimental to human health. cadmium Cd, Cr, Pb, Hg and Al on the other hand, are toxic metals commonly present in environment, working places and cooking utensils, as well as cosmetics such as perfumes, face powder, eyeliners etc., with no beneficial health effects.

*Comparison of results:*

The concentrations of the heavy metals in the blood of pregnant and non-pregnant women in Damaturu were found to within the WHO and US EPA permissible limits, and less than those analysed in China, Iran and US (Table 2).

Environmental factors such as heavy metals exposure can have interference with women reproductive health, usually Lead (Pb) being frequently distributed in the environment are recognized as toxic to human reproductive system. Exposure to large concentration of trace elements such as As, Cd, Mg, and Zn can lead to accumulation in human follicular fluid and



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may diminish fecundity (reproduction capacity). Naturally, heavy metals get into human body through ingestion, inhalation and absorption in small extent as trace elements, essential to maintain the metabolism of human body. Trace amount of metals maybe essentially used in metabolic activities, but high exposures are dangerous to humans because of their tendency to bioaccumulation and bio-magnification, which lead to an increase in the concentration of the metals in biological organisms or targeted organs over a time unit and becomes hazardous to health.

## IV. Conclusion and Recommendations

The results of the metal analysis indicated the presence of heavy metals in all the blood samples collected from non-pregnant as well as the pregnant women. Though the concentrations of the metals were found to be within the WHO as well as US EPA permissible units, it signifies exposures to the various toxic metals among the women.

There is therefore the need to conduct a major baseline assessment of the heavy metals to determine the levels of the exposure and possible health risks.

There is a need also to determine the factors that lead to exposures for mitigation and regulation.

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