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Effect of occupational exposure to heavy metals on the liver functions in persons working in cable manufacturing factory in Nnewi

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ABSTRACT

Occupational exposure to hazardous metals or heavy metals has remained an issue of public health importance owing to the grave implications it has on human health. This study evaluated the effect of occupational exposure to heavy metals on the liver functions in persons working in a cable manufacturing factory in Nnewi. A total of 79 apparently healthy individuals comprising of 39 persons working in cable producing factory (test group) and 40 control participants aged between 18 and 56 years were recruited for the study. Five millilitres (5mls) of venous blood sample was collected from each individual into plain container for the evaluation of biochemical parameters. Serum total protein (TP), albumin (ALB), direct bilirubin (DB), total bilirubin (TB), aspartate aminotransferase (AST), alanine aminotransferase (ALT) and alkaline phosphatase (ALP) activities were assayed for using standard laboratory methods. Results showed significant increases in the AST (27.55±2.08 Vs 9.15±0.13) and ALP (238.37±24.40 Vs 20.70±0.48) activities and in levels of TP (7.82±0.27 Vs7.10±0.04) and DB (4.14±0.30 Vs 2.67±0.07) in cable factory workers when compared with the control subjects ($p<0.05$) respectively, although levels of TB and ALB as well as ALT activity were comparatively similar in both groups ($P>0.05$). Furthermore, gender differences were observed in the values of DB, AST, and ALP compared with control. Results also showed no significant effects of age and length of service (LOS) on the liver function status of factory workers studied. Thus, this study revealed no liver impairment among the cable factory workers studied as a result of occupational exposure. This could be attributable to the short term duration of exposure of the factory workers.

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1. Introduction

The liver is a vital and largest gland in the human body and is involved in detoxification and excretion of metabolites; in glycogenesis and production of albumin and coagulation factors.[1] It is sometimes referred to as a metabolic factory. The human liver is located in the right upper quadrant of the abdominal cavity immediately beneath the diaphragm with a smaller extension to the left upper quadrant and weighs about 1.5 kilogram. The functionality of the liver is affected by some factors such as biological and non-biological factors. Biological factors include infections caused by various infective agents like viruses; non-biological factors affecting the functions of the liver include toxins, chemicals, radiations, heavy metals among others. Notably, heavy metal exposures have become an issue of grave health importance especially in the work

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place. Individuals working in various factories including cable factory, lead acid battery factory, forging, plastics, paints etc. tend to be exposed to varying types of heavy metals and these may have negative consequences on their health. Heavy metals such as copper, lead, arsenic etc. areused in cable making and factory workers are prone tobeing exposed to such heavy metal toxicity overtime. Heavy metalsare generally referred to as those metals which possessa specific density of more than 5 g/cm and adverselyaffect the environment and living organisms.[2] Heavy metals are toxic and have adverse effects on human health depending on the intensity and duration of exposure[3] and tend to be toxic even at low dose.[4] Notable heavy metals found in the workplace which are of principal health consequences are Lead, Mercury, Cadmium, Arsenic, Chromium, Nickeland Zinc. Elevated levels of Lead, Arsenic, Nickel, Mercury, Cadmium, Chromium, have been documented by various authorities among factory workers in the work place.[3,5–7] Occupational exposures to these heavy metals have been associated with varying degrees of* organ damage or abnormal functions in humans,[8] although some recent studies recorded no significant alterations in the parameters of hepatic functions among some factory workers in Nnewi.[9] Hepatic enzymes such as alanine amino transferase (ALT), aspartate amino transferase (AST) and alkaline phosphatase (ALP), as well as total protein, albumin, and bilirubins are commonly known Liver function tests which help to assess the status of the liver. In this study, our aim was to assess whether exposure to heavy metals in cable manufacturing factory affects liver function status.

2. Materials and Methods

2.1. Study design and subjects

This study is a cross-sectional study designed for the determination of the effect of occupational exposure to heavy metals on the liver functions in persons working in cable manufacturing factory in Nnewi. A total of 39 apparently healthy individuals working in cable producing factory aged between 19 and 56 years were recruited for the study as exposed group. The control groups were made up of forty (40) staff and undergraduate students of Nnamdi Azikiwe University, that resides about 5-10 km away from the factory sites aged between 18 and 44 years. Five millilitres (5mls) of venous blood sample was collected from each individual into plain container for the evaluation of biochemical indices.

2.2. Inclusion criteria

Cable manufacturing factory workers without any known disease condition aged between 19 and 56 years and control individual (non-exposed groups) were included in this study.

2.3. Exclusion criteria

Individuals who are alcoholics and smokers as well as pregnant women were excluded from the study.

2.4. Ethical approval

Ethical approval for the research was obtained from Ethical Committee of Nnamdi Azikiwe University Teaching Hospital, Nnewi, Anambra State, Nigeria (NAUTH/CS/66/Vol.2/149).

2.5. Methods

2.5.1. Reagents

The reagents for these assays were obtained from Randox Lab. UK; purchased from manufacturer's representative in Nigeria and they were in the ready-to-use form

2.6. Determination of total protein

2.6.1. Principle

The total protein concentration was determined according to the method of Gornall et al.[10] Proteins in alkaline medium react with cupric ions to produce an intensive violet-blue color complex (Biuret reaction). The intensity of the reaction is a measure of the quantity of total protein present in the sample and is read at 545nm wavelength.

2.6.2. Protocol

1. Two test tubes labeled test and standard were added 0.1ml of serum and 0.1ml of standard protein, respectively. To each of the test tubes was added 5.0ml of biuret reagent. For the blank, only 5.0ml of distilled water was added to a third test tube.
2. All the tubes were mixed and stood at room temperature for 20 minutes
3. The optical density (OD) of the test and standard were read at 545 nm in RA-50 spectrophotometer after adjusting the instrument with the blank to zero reading.

2.6.3. Calculation

$$Concentration\ of\ total\ protein\ (g/dL) = \frac{OD\ of\ unknown}{OD\ of\ Standard}\ x\ conc.\ of\ standard\ (6.0g/dL)$$

2.7. Determination of albumin

2.7.1. Principle

The albumin concentration in the plasma was determined using the method of Doumas and Watson.[11] Bromocresol green (BCG) is an indicator which is yellow between pH 3.5 and 4.2. When BCG binds to albumin, the color of the indicator changes from yellow to green. The absorbance of the color is measured in a spectrophotometer at 630nm.

2.7.2. Protocol

1. Three* test tubes marked blank, test and standard were each administered 3.0ml of B.C.G reagent. To the test and standard test tubes were added 20μl of serum and 20μl of standard solutions, respectively.
2. All tubes were allowed to stand at room temperature for 10 minutes
3. The absorbance of the color developed was read at 630nm wavelength in RA-50 spectrophotometer (Ames/Technicon) after adjusting instrument to zero with blank.

2.7.3. Calculation

The concentration of albumin in serum was calculated from the formula as shown:

Abs. of test sample /Abs. of standard x 4.58g/dL.

2.8. Determination of serum bilirubin

2.8.1. Principle

The colorimetric method of Jendrassik and Grof[12] was used to determine the concentration of direct bilirubin in plasma. In this method, direct (conjugated) bilirubin (DB) reacts with diazotized sulphanilic acid in alkaline medium to form a blue colored complex. Total bilirubin is determined in the presence of caffeine which releases albumin bound bilirubin by the reaction with diazotized sulphanilic acid.

2.8.2. Equation of reaction

$$Bilirubin + diazotized\ sulphanilicacid + H^{+} \rightarrow azobilirubin\ (Blue\ color)$$

(a). Total bilirubin (TB determination

To 2 test tubes marked blank and test were added 0.20ml of Diazo reagent each. To the "test" test tube was added 0.05ml sodium nitrite solution. To both test tubes were added 1.0ml caffeine-sodium benzoate reagent followed by 0.20ml of plasma sample.

The tubes above were mixed and allowed to stand for 10 minutes at 25^0C followed by 1.00ml of tartrate-sodium hydroxide reagent. The tubes are allowed to stand for 5-30 minutes at 25^0C and then the OD read against their blanks at 578nm wavelength and recorded.

The concentration of the total bilirubin was calculated using the following formula:

T. B. (μmol/L) = 185 x A_{TB} (μmol/L)

Where A_{TB} represents the absorbance i.e. the OD.

(b). Direct bilirubin (DB determination

2.8.3. Procedure

Two test tubes marked Blank and Test were added 0.20ml of daizo reagent each. To the Test test tube was added 0.05ml of 2.5mM sodium nitrite solution. To both tubes were added 2.00ml each of sodium chloride solution followed by 0.20ml of test sample, mixed and allowed to stand for exactly 5 minutes at 25^0C. The absorbances were read at 546nm wavelength and the concentration of the direct bilirubin was calculated with the following formula:

D.B. (μmol/L) = 246 x A_{DB}

Where A_{DB} represents the absorbance

2.9. Determination of L-Aspartate aminotransferase (AST) activity

2.9.1. Principle

Aspartate aminotransferase (AST) (EC.2.6.1.1.) was estimated according to the method of Reitman and Frankel.[13] The assay is based on the following reactions of the enzyme:

2.9.2. Equations of Reaction

$$Aspartate + \alpha - KG \rightarrow Oxaloacetate + L - Glutamate$$

$$Oxaloacetate + DNPH \rightarrow Oxaloacetate - DNP - Hydrazone\ (b$$

The method measures spectrophotometrically the intensity of the blue-colored hydrazone formed from the reaction of oxaloacetate with 2,4-dinitrophenyl hydrazine at 546nm. The activity of the enzyme is proportional to the amount of oxaloacetate formed.

2.9.3. Procedure

To two test tubes marked test and blank were administered 0.1ml of plasma and 0.1ml of distilled water, respectively, pre-incubated at 37^0C for 5 minutes,followed by 0.5ml of R1 (AST substrate) each. Contents of each test tube were mixed and the test tubes returned to water bath for 60 minutes after which 0.5ml of DNPH was added, mixed and allowed to stand for 20 minutes. Five milliliters (5ml) of 0.4mol/L sodium hydroxide solution was then added to the two test tubes. The contents of the two test tubes were mixed thoroughly and the absorbance of the test read at 546 nm against a reagent blank after 5 minutes. Activity of the enzyme is expressed in U/L was then determined from the calibration curve.

2.9.4. Calculation

Enzyme activity was then read from calibration curve for AST.

2.10. Determination of L-Alanine aminotransferase (ALT) activity

2.10.1. Principle

Alanine aminotransferase (ALT) (EC.2.6.1.2.) was estimated according to the method of Reitman and Frankel[13]. The assay is based on the following reactions of the enzyme:

2.10.2. Equations of reaction

$$Alanine + \alpha - KG \rightarrow Pyruvate + L - Glutamate$$

$$Oxaloacetate + DNPH \rightarrow Pyruvate - DNP - Hydrazone\ (red -$$

The method measures spectrophotometrically the intensity of the red-colored hydrazone formed from the reaction of pyruvate with 2,4-dinitrophenyl hydrazine at 546nm The activity of the enzyme is proportional to the amount of pyruvate formed.

2.10.3. Procedure

To two test tubes marked test and blank were administered 0.1ml of plasma and 0.1ml of distilled water, respectively, pre-incubated at 37^0C for 5 minutes, followed by 0.5ml of R1 (ALT substrate) each. Contents of each test tube were mixed and the test tubes returned to water bath for 60 minutes after which 0.5ml of DNPH was added, mixed and allowed to stand for 20 minutes. Five milliliters (5ml) of 0.4mol/L sodium hydroxide solution was then added to the two test tubes. The contents of each of the two test tubes were shaken to mix thoroughly and the absorbance of the test read at 546 nm against a reagent blank after 5 minutes. Activity of the enzyme is expressed in U/L was then determined from the calibration curve.

2.10.4. Calculation

Enzyme activity was then read from calibration curve for ALT.

2.11. Determination of alkaline phosphatase (ALP) activity

2.11.1. Principle

Alkaline phosphatase activity was assayed according to the method described by Bessey et al.[14] The enzyme (ALP) catalyzes the hydrolysis of p-nitrophenyl phosphate in the presence of magnesium ions to liberate p-nitrophenol and inorganic phosphorus. The rate of formation of p-nitrophenol which is measured at 405nm is proportional to the alkaline phosphatase activity present in the sample.

2.11.2. Protocol

1. To three test tubes marked 'blank', 'test' and 'standard', were each added 0.5ml of test substrate and pre-incubated for 5 minutes at 37^oC. This was followed by 0.5ml of plasma to the 'test' and 0.05ml of standard to the 'standard' test tube.
2. Tubes were mixed and incubated for 20 minutes at 37^0C and 20mmol/L sodium hydroxide was added to each of the test tubes
3. The absorbances (A) of test (sample) and standard were measured at 405 nm in RA-50 spectrophotometer (Ames/Technicon), after adjusting the instrument with blank to zero reading.

2.11.3. Calculation

In the procedure described, p-nitrophenol (1mmol/L) standard corresponds to an alkaline phosphatase catalytic activity of 50IU/L (Bessey et al., 1946). Therefore, the activity of alkaline phosphatase in the samples was determined thus:

Abs. of unknown/Abs. of standard x 50 IU/L.

2.12. Statistical Analysis

The data obtained were analyzed for both control and test group by Students t-test and Pearson's bivariate correlation coefficient using Statistical package for social sciences (SPSS) (Version 16) software and statistical significance was pecked at $P<0.05$.

3. Results

The total protein (TP) values ofcable factory workers (X)was significantly elevated compared with the control (7.82±0.27Vs7.10±0.04; $p<0.05$) while the albumin (Alb) values (4.64±0.20Vs 3.90±0.01) were non-significantly elevated ($p>0.05$).

Total bilirubin (TB) was non-significantly decreased in the factory subjects when compared with the control (9.83±0.53 Vs10.06± 0.18; $p<0.05$) whereas, DB values were significantly elevated in the cable factory workers compared with control subjects (4.14±0.30 Vs 2.67±0.07; $p<0.05$).

There were significant increases in the AST (27.55±2.08 Vs 9.15±0.13)and ALP (238.37±24.40 Vs 20.70±0.48) values in cable factory workers when compared with the control subjects ($p<0.05$). There was no significant difference ($p>0.05$) between the ALT levels of control subjects and cable factory workers (8.55±0.18 Vs 7.09±0.49); $p>0.05$). See Table 1.

There was no significant statistical difference ($p>0.05$) between the TP, Alb, TB, DB, AST, ALP and ALT levels of the control males and females ($p>0.05$) when compared. DB levels of female factory X workers were significantly ($p<0.05$) reduced when compared with the control. AST levels in males of factory workers were significantly increased ($p<0.05$) when compared with the control. The AST levels in the females followed the same trend in the males. There was no significant difference between the ALT levels of the males and female factory workers ($p>0.05$) when compared with the control while there were significant increase ($p<0.05$) in ALP levels in the male and female factory X workers. See Table 2.

4. Effect of age and LOS on liver function status of cable factory workers (X)

Table 3 presents the analyses of the classification of liver function status of factory X workers according to age while Table 4 presents the effect by LOS. Regression of the liver function status with age is presented in Figure 1 while regression with LOS is in Figure 2. In order to determine the degree of relationship between the

Table 1: Liver function status of thecable factory workers

Factory	TP (g/dL)	Alb (g/dL)	TB (μmol/L)	DB (μmmol/L)	AST (U/L)	ALT (U/L)	ALP (U/L)
Contrl E (n=40)	7.10± 0.04^{a}	3.90±0.01^{a}	10.05± 0.17^{b}	2.67± 0.07a	9.15 ± 0.13^{a}	8.55± 0.18a	20.70±0.48^{a}
X (n=39)	7.82±0.27^{b}	4.64±0.20^{a}	10.21±0.84^{b}	4.14±0.30^{b}	27.55±2.08^{b}	7.09±0.49^{a}	238.37±24.35^{c}

Values are in mean±SEM; within the column, mean with different superscript letters are statistically significant (p<0.05).
Key: ContrlE: Control subjects from Elele; **X**: Factory workers from cable manufacturing factory; **TP**: Total Protein; **Alb**: Albumin; **TB**: Total Bilirubin; **DB**: Direct bilirubin; **AST**: Aspartate aminotransferase; **ALT**: Alanine aminotransferase; **ALP**: Alkaline phosphatase.

Table 2: Effect of gender on liver function status of cable factory workers.

Factor	Sex	TP (g/dL)	ALB (g/dL)	TB (μmol/L)	DB (μmol/L)	AST (U/L)	ALT (U/L)	ALP (U/L)
N(n=29)	M	7.88±0.06^{b}	4.38±0.08^{Abcd}	18.14±0.91^{c}	7.62±0.62^{b}	11.66±1.08^{a}	8.24±0.95^{a}	78.03±1.74^{a}
N(n=10)	F	7.10±0.06^{b}	4.16±0.15^{abc}	18.70±2.80^{c}	7.86±0.98^{b}	11.50±1.76^{a}	7.00±1.74^{a}	75.60±3.20^{a}
X(n=31)	M	7.70±0.32^{b}	4.63±0.25^{bcd}	10.82±0.93^{ab}	4.50±0.34^{a}	26.20±2.42^{b}	6.94±1.53^{a}	230.12±29.00^{bc}
X(n=8)	F	8.28±0.44^{b}	4.68±0.24^{bcd}	7.96±0.74^{a}	2.80±0.21^{a}	32.08±3.90^{b}	7.70±0.94^{a}	270.35±39.33^{c}

Within column, means with different superscript letter alphabets are statistically significant (p<0.05)
Key: Contr N: Control subjects from Nnewi, **X**: Factory workers from cable factory; **ALB**: Albumin; **TB:** Total bilirubin; **DB**: Direct bilirubin; **AST**: Aspartate Aminotransferase; **ALT**: Alanine aminotransferase; **ALP**: Alkaline phosphatase; **M**:male; F:female

liver function status of factory X workers and age and LOS, correlation analyses was performed. There was no significant correlation (p>0.05) between any of the liver function parameters with age and LOS, however, TP, ALB, DB, AST and ALP were positively correlated while TB and ALT were negatively correlated with age. Except for TP, ALB, TB and DB which were negatively correlated, AST, ALT and ALP were positively correlated with LOS. Further analyses of the liver function parameters to determine the effect of age (Table 3) showed no significant effect (p>0.05). Similar analyses with LOS (Table 4) also revealed no significant effect (p>0.05) indicting that both age and LOS had no effect on the liver function parameters of factory X workers in this study.

5. Discussion

Heavy metals are persistent environmental pollutants and humans are exposed to them through water, air, food, or industrial activities.[15] Occupational exposure to hazardous metals or heavy metals has remained an issue of public health importance owing to the grave implications it renders on human health. Toxic metals are known to impact negatively on the health and functionality of the liver. This study evaluated the liver function status among the cable manufacturing factory workers in Nnewi, Nigeria.

In this study, the mean serum total protein value of cable factory workers was significantly elevated compared with the control (7.82±0.27 Vs7.10±0.04; p<0.05), although the albumin value (4.64±0.20 Vs 3.90±0.01) were non-significantly elevated (p>0.05). In any event, the TP value of the cable factory workers was within the normal serum total protein concentration of 6.4-8.3g/dl. The same pattern was followed in the serum albumin levels of the factory

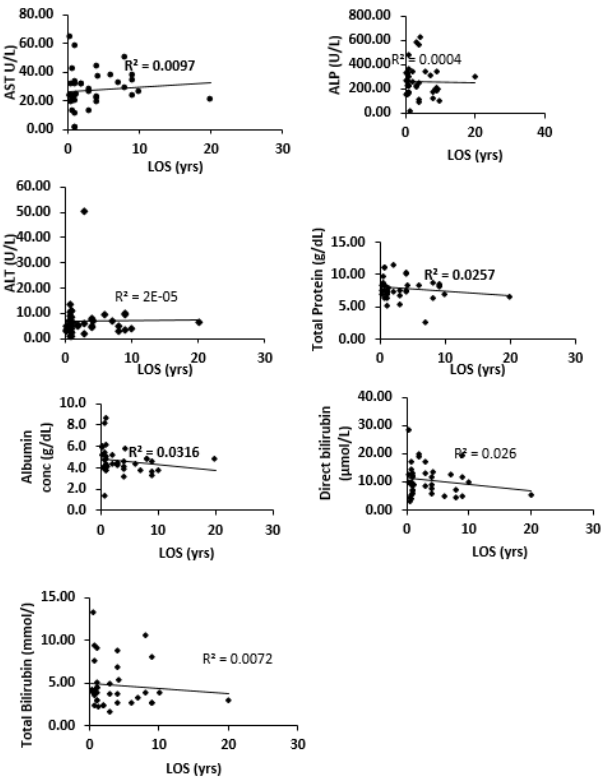

Fig. 1: Regression of liver function status of factory X workers with age.

Table 3: Effect of age on liver function status of cable factory (X) workers.

Age Range	TP (g/dL)	ALB (g/dL)	TB (μmol/L)	DB (μmol/L)	AST (U/L)	ALT (U/L)	ALP (U/L)
Contrl N (n=39)	7.82±0.06^{a}	4.32±0.07^{a}	18.28±0.96^{b}	7.68±0.52^{b}	11.61±0.91^{a}	7.92±0.83^{a}	77.41±1.52^{a}
18-30yrs (n=25)	7.60±0.38^{a}	4.63±0.33^{a}	10.50±1.17^{a}	3.89±0.31^{a}	26.30±3.26^{b}	7.77±2.14^{a}	237.89±31.97^{b}
31-40yr (n=11)	8.10±0.44^{a}	4.74±0.26^{a}	10.53±0.86^{a}	4.76±0.69^{ab}	27.11±2.52^{b}	5.63±0.84^{a}	236.69±57.05^{b}
41-50yrs (n=4)	8.49±1.08^{a}	4.63±0.33^{a}	6.47±1.17^{a}	2.95±0.27^{a}	28.18±4.09^{b}	7.12±0.82^{a}	274.71±55.30^{b}
51-60yrs (n=2)	7.44±1.09^{a}	4.10±0.80^{a}	13.21±6.19^{ab}	6.04±2.10^{ab}	42.58±8.18^{c}	7.68±2.40^{a}	180.25±1.34^{ab}

Values are represented in mean±SEM
Within column, means with different superscript letter alphabets are statistically significant (p<0.05)
TP = Total Protein; **ALB=**Albumin; **TB=**Total Bilirubin; **DB=**Direct Bilirubin; **AST=**Aspartate aminotransferase; **ALT=**Alanine aminotransferase; **ALP=**Alkaline phosphatase**.**

Table 4: Effect of LOS on liver function status of factory X workers.

Range	TP (g/dL)	ALB (g/dL)	TB (μmol/L)	DB (μmol/L)	AST (U/L)	ALT (U/L)	ALP (U/L)
Contrl N (n=39)	7.82±0.06^{b}	4.32±0.07^{a}	18.28±0.96^{a}	7.68±0.52^{a}	11.61±0.91^{a}	7.92±0.83^{a}	77.41±1.52^{b}
0-5yrs (n=30)	8.01±0.29^{a}	4.76±0.25^{a}	10.43±0.89^{a}	4.24±0.34^{a}	26.06±2.51^{a}	7.31±1.58^{a}	243.88±29.90^{a}
6-10yrs (n=7)	7.04±0.15^{a}	4.00±0.27^{a}	11.47±2.36^{a}	4.48±0.96^{a}	31.94±2.09^{a}	6.59±1.41^{a}	192.77±59.31^{a}
11-15yrs (n=2)	8.24±1.00^{a}	4.15±0.55^{a}	8.22±3.42^{a}	2.71±0.00^{a}	30.80±7.35^{a}	6.34±2.94^{a}	269.67±72.09^{a}
16-20yrs (n=2)	6.53±1.18^{a}	4.86±0.05^{a}	6.28±0.74^{a}	3.45±0.50^{a}	35.7015.05^{a}	5.84±0.56^{a}	238.37±24.35^{a}

Values are mean±SEM; within column, mean with different alphabet letters are statistically significant (p<0.05)
Key: **LOS**: Length of service; **TP=**Total Protein; **ALB=**Albumin; **TB=**Total Bilirubin; **DB=**Direct Bilirubin; **AST=**Aspartate aminotransferase; **ALT=**Alanine aminotransferase; **ALP=**Alkaline Phosphatase.

workers. The elevation in serum protein among the cable factory workers may have resulted from loss of protein-free fluid otherwise called dehydration or excessive stasis during venipuncture.[16] On the other hand, estimation of serum albumin is an important and cheap means of ascertaining the synthetic capacity of the liver.[16] The present result indicates that the synthetic capacity of the liver has not been impaired by the harmful effect of occupational exposure to heavy metal contamination. Similar findings have been documented in literature.[17]

The present study revealed no significant difference in the mean total bilirubin level in cable factory workers than in control subjects (p>0.05). However, the direct bilirubin level was significantly increased in workers compared with control subjects (p<0.05). This may imply that the ability of the liver to conjugate serum bilirubin is intact. This is because despite its elevated level in the factory workers than in control subjects, it is still within the normal range. The current report is in contrast with the previous work of Okpogba et al. on the assessment of liver functions in occupationally exposed subjects working in lead acid battery factory in Nnewi which documented a decline in total bilirubin level with no significant alteration in conjugated bilirubin level in lead acid factory workers compared with the control subjects.[9]

In this study,there were significant increases in the ALP (238.37±24.40 Vs 20.70±0.48) values in cable factory workers when compared with the control subjects (p<0.05). Alkaline phosphatase (ALP) catalyzes the hydrolysis of various phosphomonoesters at an alkaline pH. The highest concentrations of ALP are found in bone, liver, spleen, intestine, placenta, and kidneys. ALP contains a number of isoenzymes, with bone, liver, and placenta types being the most extensively studied.[18] Elevated level of ALP is a sensitive marker of biliary cholestasis as increased synthesis of ALP in the affected ducts increases the activity of this enzyme in the plasma. This confirms the findings of some previous similar studies.[19]

There was a significant increase in the AST (27.55±2.08 Vs 9.15±0.13) activity in cable factory workers when compared with the control subjects (p<0.05). However, there was no significant difference (p>0.05) between the

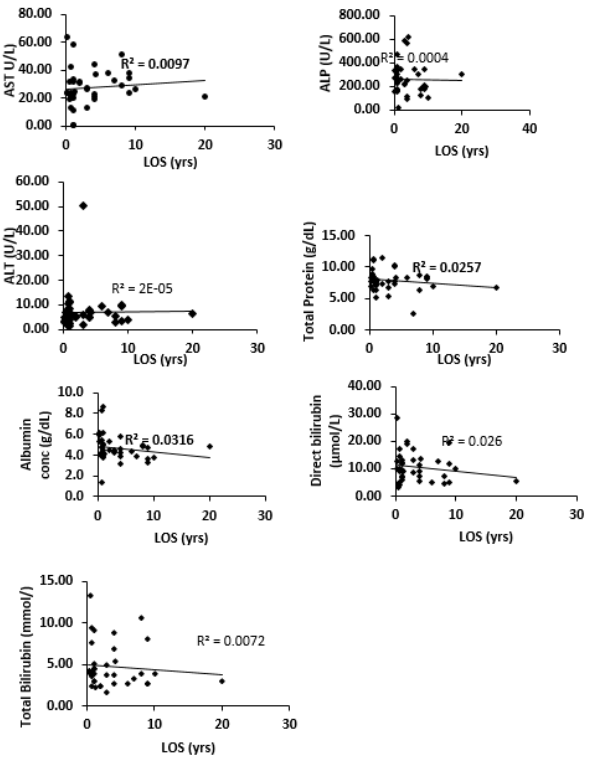

Fig. 2: Regression liver function status of factory X workers with LOS.

ALT levels of control subjects and cable factory workers (8.55±0.18 Vs 7.09±0.49); p>0.05).

Liver cell damage is characterized by the release of enzymes (AST and ALT) from damaged hepatocytes. Aminotransferases such as AST and ALT are present in highconcentrations in the liver. AST is also found diffusely represented in the heart; skeletal muscle, kidneys, brain and red blood cells, and ALT have low concentrations in skeletal muscle and kidney. A rise in plasma aminotransferase activities is a sensitive indicator of damage to cytoplasmic and/ or mitochondrial membranes. Plasma enzyme activities rise when the membranes of only very few cells are damaged. Liver cells contain more AST than ALT, but ALT is confined to the cytoplasm, in which its concentration is higher than that of AST. An increase in ALT serum levels is, therefore, more specific for liver damage.[16] The mild rise in AST documented in the present work may have resulted from other sources other than the liver and since there was no significant alteration in ALT concentration, it may be inferred that the short term occupational exposure of the cable factory workers was not enough to induce or cause liver impairment or damage in the subjects studied. This is in line with similar work of Adejumo et al.[19] that recorded no significant differences in ALT activity in automobile workers in Benin City, Edostate Nigeria but remains in contrast with the study of Kahtan et al. which revealed elevated activity of ALT among workers.[1] Furthermore, gender differences were observed in the values of DB, AST, and ALP compared with control. Results also showed no significant effects of age and length of service (LOS) on the liver function status of factory workers studied.

6. Conclusion

There were significant statistical increases in the serum total protein and direct bilirubin levels, aspartate aminotransferase and alkaline phosphatase activities with no significant alterations in the levels of serum albumin and total bilirubin as well as alanine aminotransferase activity among the cable factory workers. Thus, this study revealed no liver impairment among the cable factory workers studied as a result of occupational exposure. This could be attributable to the short term duration of exposure of the factory workers.

7. Conflicts of Interest

All contributing authors declare no conflicts of interest.

8. Source of Funding

None.

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