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Occupational Health and the Impact of Long-Term Formaldehyde Exposure on Health Professionals in Calabar, Nigeria

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Abstract

This research was carried out among persons occupationally exposed to formaldehyde in Calabar metropolis with a view to evaluating occupational health and by extension safety. Eighty eight male and female subjects comprising anatomists, medical laboratory attendants, medical laboratory scientists and morticians occupationally exposed to formaldehyde in this locality were enrolled in the study. Another group of eighty eight age and sex-matched individuals without formaldehyde exposure served as control subjects. Participants were between 24-52 years of age with job duration ranging up to 18 years. Informed consent was obtained from all enrolled subjects. A structured questionnaire was utilized to capture the bio-data and other pertinent information on work place exposure including allergic reactions experienced during work. Alpha-Fetoprotein (AFP), Total Protein (TP), Albumin and White blood cell (WBC) count were estimated. The measurement of AFP was by enzyme-linked immunosorbent assay, TP and Albumin were assayed by colourimetric methods, while WBC count was performed by automation. Itching, watery eyes and sneezing were part of the allergic reactions experienced by exposed persons. While AFP (2.66±1.76 ng/L) was significantly increased ($p<0.05$), TP (64.30±8.00 g/L), Albumin (30.80±5.50 g/L) and WBC ($4.71±1.03\times10^9$/L) were significantly reduced ($p<0.05$) in persons occupationally exposed to formaldehyde compared to control subjects (1.58±0.84ng/L, 68.30±7.70g/L, 35.10±4.60g/L and $6.23±1.56\times10^9$/L respectively). Participants in this study with occupational exposure to formaldehyde were further grouped into three on the basis of duration on their jobs; 0-5 years, 6-10 years and above 10 years. The measured parameters varied with duration of exposure. Findings from this study point towards possible formaldehyde toxicity among exposed persons, particularly those with long term exposure.

Keywords: Formaldehyde, toxicity

1. Introduction

Occupational safety and health has been a subject of global concern since later half of the past century and risk assessment of identified hazards has been advocated for specific labour environments (Abrams, 2001). Industrial use of formaldehyde is widespread and covers such sectors as manufacturing, education and health. For the later two, it is often incorporated into preservatives because of its satisfactory fixative properties. Unfortunately, such routine use may constitute unhealthy exposure to the workers (Albertini, Mainardi, Mazzeo & Triassi, 2012; Loomis, Guha & Straif, 2014).

Employers of labour are expected to bear the burden of periodic monitoring to ensure occupational safety and health (Adams *et al.,* 2011), however, it appear not to be the case for most developing countries. The reality in these regions is that of ineffective implementation of Occupational Safety and Health guidelines due to inadequate funding. Unfortunately, this trend culminates into enormous economic losses notably through occupationally induced ill health and sometimes welfare settlements (Swuste & Eijkemans, 2002). Moreover, in frantic search for a means of livelihood, the labour force in these regions becomes vulnerable in the face of unregulated labour environment.

In recent times, concerns have been raised on the standard of practice at mortuaries as it relates to occupational safety and health in developing countries including Nigeria (Okoth-Okelloh et al., 2013; Ogunnowo et al., 2010). Incidentally, this facility also makes use of formaldehyde in embalming. In addition to facing general inherent risks from compromised safety standards, impaired liver function has been reported among such exposed professionals in South-western (*Olooto, 2010*). Against this backdrop, the present study assessed some screening parameters as well as the possible influence of prolonged exposure among exposed health professionals in Calabar.

2. Methods

The present research study was conducted in Calabar, Cross River State of Nigeria. Case-control experimental study design was employed in this research. Exposed Subjects comprised eighty eight male and female workers, while, another eighty eight age and sex-matched civil servants and self-employed adults who had no history of

formaldehyde exposure as at the time of the study served as control subjects. Bio-data and occupation-related information was obtained using questionnaire. Five milliliters of venous blood was collected aseptically from each subject; from which 2mL transferred into an anti-coagulated (ethylene di-amine tetra acetic acid) sample bottle at a concentration of 2mg/ml of blood for total white cell count within 2hrs of collection. The remaining 3mL was collected into plain sample bottle, spun after blood clotting and separated. Serum samples obtained for measurement of biochemical parameters were stored at -80ºC until the time of analysis.

Quantitative determination of Alpha Feto-Protein (AFP) was carried out by sandwich enzyme immunoassay technique using ELISA Kit purchased from Pishtaz Teb Diagnostics, Germany (reference range of 0.2 – 8.5 ng/mL). Total Protein was measured by the Biuret Method (reference range of 66 – 83 g/L), Albumin by Dye-binding Method (reference range of 35 – 55 g/L). The last two parameters were analyzed using colorimetric Giesse Diagnostics Kits from Italy. Additionally, total white blood cell count (WBC) was carried out by automated method using Sysmex Kx2IN from Sysmex Corporation, Japan. SPSS 19.0 was used for the statistical analyses of data. Pearson's correlation coefficient (r) was used to express relationship between two variables. A two tailed P-value of <0.05 was considered indicative of a statistically significant difference.

3. Results

This research was carried out to assess possible health impact of long-term exposure of health professionals to formaldehyde in Calabar. A total of 176 male and female subjects between the ages of 24-52 years were enrolled in the study. Out of this total figure, 88 were test subjects and included medical laboratory scientists, laboratory attendants, anatomists and mortician. Their duration on the job ranged from 1-18 years (Figure 1). During the period of exposure to formaldehyde, the subjects had experienced some allergic reactions including itching, watery eyes sneezing and airways-related symptoms (Figure 2).

The mean values of Alpha-Fetoprotein (AFP), Total Protein (TP), Albumin and total white blood cell count (WBC) of exposed subjects were compared to those of unexposed subjects. AFP, was significantly increased ($p<0.05$), TP, Albumin and WBC were significantly reduced ($p<0.05$) in persons occupationally exposed to formaldehyde compared to the control subjects (Table 1).

All exposed subjects were further grouped into three on the basis of duration of exposure on their jobs; ≤ 5 years, 6-10 years and above 10 years. The analysis of variance on the obtained data revealed that AFP was significantly higher ($p<0.05$) among subjects with 6-10 years as well as above 10 years, while TP, Albumin and WBC were significantly lower ($p<0.05$) in these groups compared to those with 1-5 years of exposure (Table 2). Correlation analyses revealed a moderate negative correlation between alpha fetoprotein and total protein ($r = -0.476$), albumin ($r = -0.602$) and total white blood cell count ($r = -0.586$).

4. Discussion

Persons occupationally-exposed to formaldehyde in Calabar who were enrolled in this study comprised different health professionals with job duration ranging up to 18 years. These respondents admitted to experiencing some allergic reactions to the chemical during work including; sneezing /airways-related symptoms, itching and watery eyes. These effects are attributable to the high solubility of formaldehyde; such that even though it gains entry to the body as a gas, it easily solubilizes to liquid within the mucous membranes of the nasopharyngeal tract as well as the eyes resulting in irritation at these sites. Unregulated exposure may with time trigger neoplastic development within the naso-pharyngeal compartment, dermatitis and sight deterioration among these exposed workers.

Findings of the present study also reveal relatively-increased values of AFP among persons occupationally-exposed to formaldehyde compared to unexposed subjects. However, values recorded for the unexposed subjects (controls; 1.58±0.84 ng/mL) in the present study are quite low compared to that (3.04 ± 1.90 ng/mL) reported among normal adult blood donors in USA (Ball et al., 1992). The possible implication of this observation is a low predisposition to malignancy among Blacks compared to Caucasians. Inversely, TP and Albumin levels as well as WBC count were reduced among this same group. Alpha fetoprotein also had moderate negative correlations with the later three parameters. Possibly chronic exposure to formaldehyde induces systemic toxicity which in turn interferes with health. Previous reports had also documented haematologic and biochemical changes in man and experimental animal models (Kuo et al., 1997; Yilmaz et al., 2004). In the midst of diverse theories, increased systemic generation of free radicals has been proposed as a possible mechanism for toxicity-induced impairment. In any case, the effects of such derangement appear to worsen with increased duration at exposure (Skrzydlewska and Farbiszewski, 1997; Viegas, 2010).

Indeed the developmental stage of any nation in terms of economic growth and stability is a function of many individual yet overlapping factors. As with many other sectors, labour environment is yet to operate at an acceptable standard let alone its optimum among the developing regions of the globe; notably South America

and African countries including Nigeria. Serious concerns have been expressed by international bodies including World Health Organization and the International Labour Organization over labour environments in developing nations and the economic implications (Swuste & Eijkemans, 2002). Deleterious effects from formaldehyde exposure in Nigeria probably echoes ventilation challenges in our locality. Added to this constraint is the burden of congestion that regrettably overstretches existing facilities; a situation where a mortuary facility originally built to accommodate fewer numbers are now seen to be overstretched with much higher numbers (Ogunnowo et al., 2010). Obviously, Mortuaries and Laboratories with formaldehyde exposure represent an unregulated labour environment in our setting. Although formaldehyde remains an effective preservative, the impact and health burden of long-term exposure on the end users call for great concerns. This is particularly an issue in the tropics where increased temperature enhances formaldehyde volatility. Consequently, adequate ventilation should always be considered in setting up laboratory/ mortuary facilities. The Government of this country should ensure stability in the power sector in order in improve the working environment of these professionals. Again, occupational safety should be ensured in our labour environments particularly within the health sector. Finally, efficient fume extractors and portable gas detectors should be installed in our work places, while enlightenment campaigns should be mounted and sustained by stakeholders in this field.

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Table1. Screening parameters of persons occupationally-exposed to formaldehyde in Calabar versus those of control subjects

Parameter	Test Subjects n=88	Control Subjects n=88	p-Value
AFP (ng/mL)	2.66±1.76	1.58±0.84	p=0.000
Total Protein (g/L)	64.30±8.00	68.30±7.70	p=0.000
Albumin (g/L)	30.80±5.50	35.10±4.60	p=0.000
WBC (10^9/L)	4.71±1.03	6.23±1.56	p=0.000

Table2.Screening parameters of persons occupationally-exposed to formaldehyde in Calabar based on duration of exposure

Parameter	1-5yrs n=35	6-10yrs n=45	Above 10yrs n=8	p-Value
AFP (ng/mL)	1.52±1.14	3.23±1.70	4.38±1.44	p=0.000
Total Protein (g/L)	68.00±8.00	62.00±7.60	61.60±4.50	p=0.002
Albumin (g/L)	33.70±5.30	29.20±4.60	27.10±5.80	p=0.000
WBC (10^9/L)	5.20±0.92	4.42±1.02	4.25±0.67	p=0.001

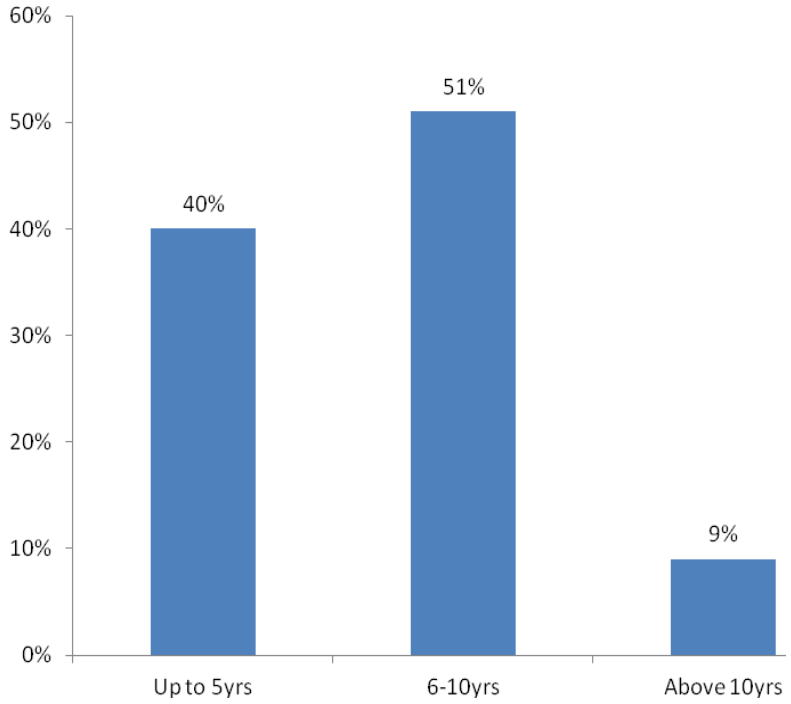

Figure1. Distribution of formaldehyde-exposed persons based on duration of exposure

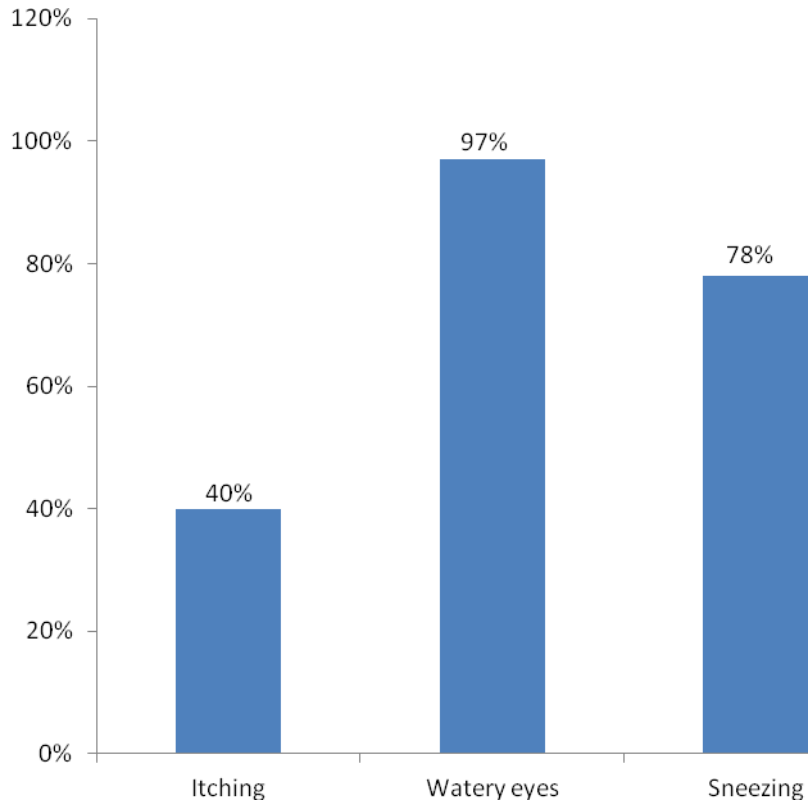

Figure2. Noticeable reactions to formaldehyde among exposed persons

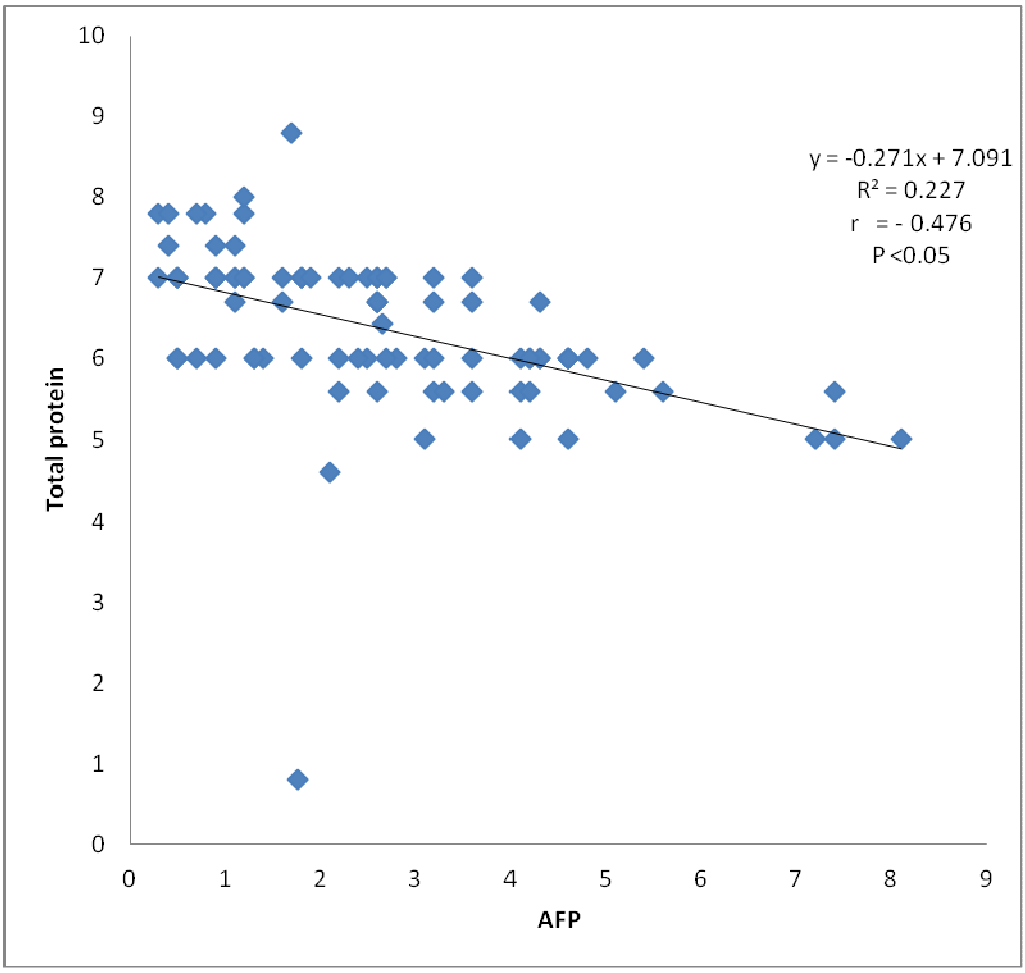

Figure3. Correlation between Alpha Fetoprotein and Total Protein of Exposed subjects

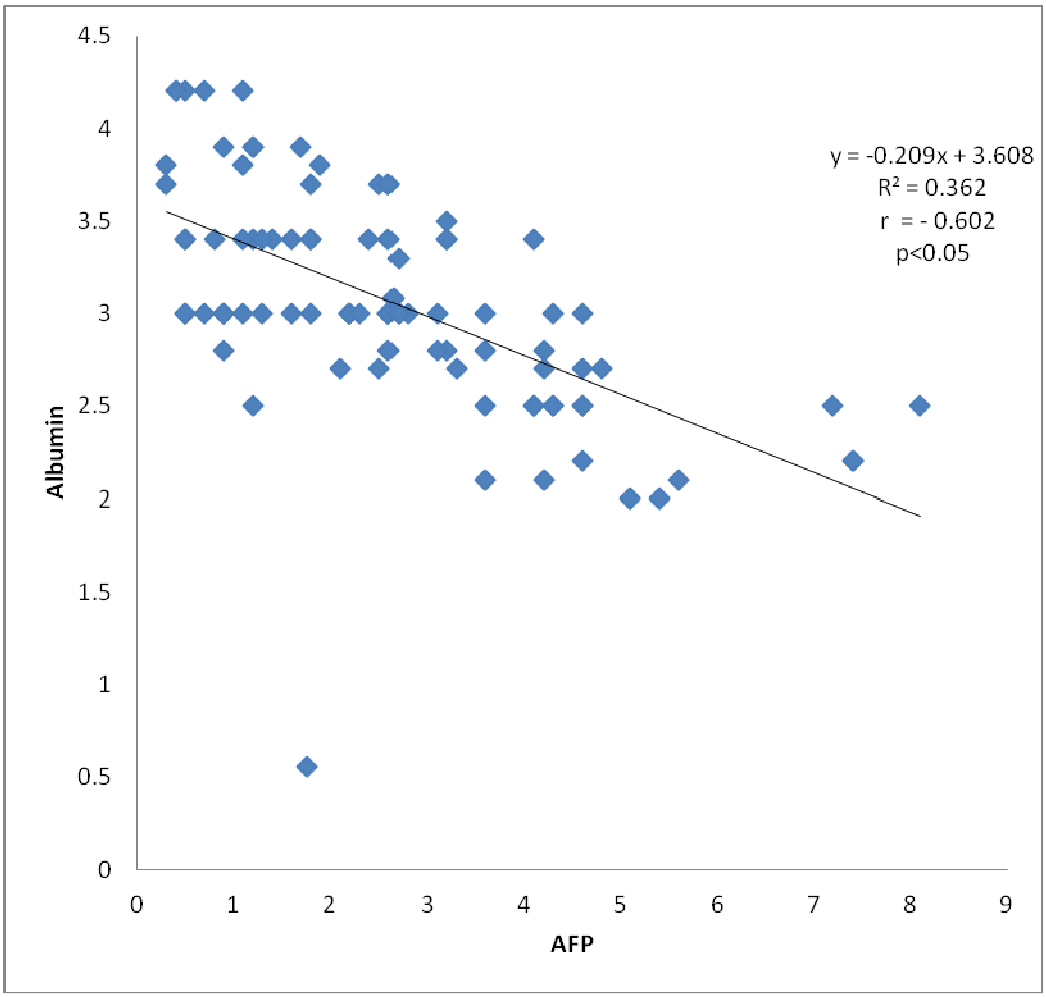

Figure4. Correlation between Alpha Fetoprotein and Albumin of Exposed subjects

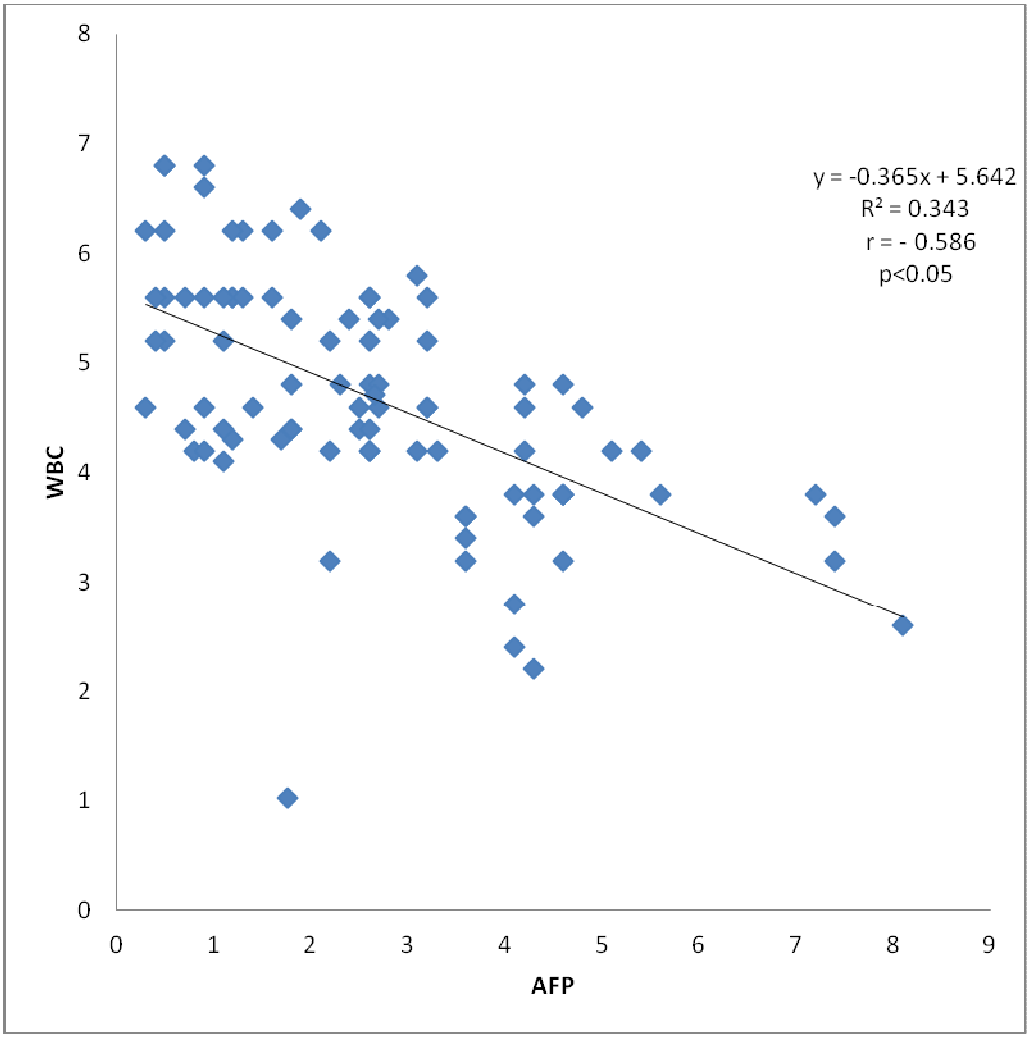

Figure5. Correlation between Alpha Fetoprotein and Total White Blood Cell Count of Exposed subjects