

## Evaluation of the Occupational Health Hazards among Workers in Quarry Industry in Abakaliki Using Biochemical Markers

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### Abstract

*Serum transaminases are highly diagnostic of hepatobiliary, cardiac, muscular, and other organ damages, while bicarbonates are useful index in assessment of pulmonary and respiratory problems. Reviews on the usefulness of these tools in evaluation of occupational health risks in quarry workers are hitherto limited. 57 and 22 workers of Abakaliki quarry industry and ministry of health respectively, who have worked for more than 10 years, were involved in the study. Alanine transaminases (ALT) and aspartate transaminase (AST) were analysed by enzymatic methods while measurement of bicarbonates ( $\text{HCO}_3^-$ ) and chloride ( $\text{Cl}^-$ ) was done by titrimetry. In males, AST, ALT, and  $\text{HCO}_3^-$  was significantly higher ( $P < 0.05$ ) in quarry workers ( $18.28 \pm 3.05$  U/L,  $19.22 \pm 5.54$  U/L, and  $39.28 \pm 1.8$  mmol/L;  $6.60 \pm 2.63$  U/L,  $9.94 \pm 1.85$  U/L, and  $24.0 \pm 3.8$  mmol/L). In females, the values were higher ( $P < 0.05$ ) in quarry workers than in those working in the ministry of health ( $24.33 \pm 6.5$  U/L,  $22.78 \pm 3.28$  U/L,  $42.13 \pm 2.95$  mmol/L and  $9.33 \pm 2.33$  U/L,  $10.44 \pm 2.59$  U/L,  $25.0 \pm 2.61$  mmol/L) respectively, for the same duration in years. There was no significant change ( $P > 0.05$ ) in the serum chloride concentration between the quarry male workers and males working in the ministry ( $98 \pm 4.23$  mmol/L and  $99 \pm 3.20$  mmol/L respectively), while the chloride level was higher in females quarry workers than the control ( $113 \pm 3.16$  and  $99 \pm 2.65$  mmol/L respectively). A sex-adjusted comparison revealed that all the studied parameters were higher in the quarry females than their male counterpart. An elevated value of bicarbonate suggests respiratory and pulmonary diseases while high level of ALT and AST suggests organ-system perturbation in the quarry workers. This study informs the need for proper routine assessment of level of risk exposure of the workers.*

**Keywords:** Alanine transaminase, Aspartate transaminase, Bicarbonate, Chloride, Quarry industry, Hazard, Occupation

### Introduction

Increased economic and industrial growths are often accompanied by increased environmental pollution and contamination. Egboka *et al.* (1989) defined pollution as introduction of certain substances in such high dosages or concentrations that render the environment hazardous or highly deleterious to biota. Volumes of these pollutants are produced yearly through natural and anthropogenic sources. Important natural sources include volcanic activity, continental weathering and forest fire (Zoller, 1980). Anthropogenic sources are industrial activities and agricultural practices (FAO, 1994).

The abundant occurrence of granite in Ebonyi State has made granite quarry industry one of the greatest employer of labour in Ebonyi State, South - Eastern Nigeria. A sizeable of the population of young men and women are engaged as causal labourers in these industries. Crushing of granites and use of its products are usually associated with the generation of much dust (Ezeonu *et al.*, 2005). The health hazards associated with this industry are great and they include; respiratory and pulmonary problems and lung diseases (Theodore, 1980; Abron *et al.*, 1988; Saric, 1992); irritation and contact dermatitis (Lachapelle, 1986), organ-system perturbations,

particularly of lungs and liver (Ezeonu and Ezejifor, 1999); wheezing cough, phlegm, tightness of the chest, lacrimation (Ezeonu, 2004), physical injuries, headache, fatigue, muscular and skeletal disorders.

The use of biochemical indicators to assess susceptibilities of organ system of people working in the quarry industries in this part of the globe is grossly inadequate. The purpose of this research is to employ routine diagnostic tests for some organ - system functions as biochemical indices for establishing disturbances and early pathological manifestations associated with working in the quarry industry. The result of the study would inform routine assessment of health risk exposures in quarry workers.

### Materials and Methods

**Study population:** A total of fifty seven (57) volunteers quarry workers consisting of thirty (30) females and twenty seven (27) males were collected and used for this study. All the subjects were within the age bracket of 16 – 45 years and have worked in either of the quarry industries or the ministry of health for more than 10 years. Twenty two (22) apparently healthy subjects properly matched for their age and their working duration, involving twelve (12) healthy females and ten (10)

males working in the ministry of health were used as control subjects. All members of the study population are resident in Abakaliki, the capital of Ebonyi State of Nigeria.

Ethical consent was sort and obtained from the directors of the quarry industries from were the subjects where recruited, as well as the ministry of health. Also, the approval of the individual subjects was obtained. Exclusion criteria were previous history of conditions that are associated with organ-system perturbation or pulmonary disease all of which include but not limited to hepatitis, cirrhosis, asthma, alcohol binge, and pregnancy.

**Sample collection and storage:** About 5ml of blood was collected from each of the subjects (the workers from both the quarry industries and the ministry of health) and allowed on the bench for approximately 30 minutes to ensure complete clotting and retraction. This was subsequently centrifuged and the serum used for the analysis for samples that were worked on the same day. Samples that were not analysed the same day for any reason were stored frozen till a later date. The biochemical parameters that were assayed for includes alanine transaminase, aspartate transaminase, serum bicarbonate, and serum chloride.

**Laboratory analysis:** All samples analysed were allowed to thaw at room temperature. The transaminases were estimated using the methodology provided in Randox kit for the respective enzymes. The principle of the tests involves the formation of oxaloacetate hydrazone and pyruvate hydrazone by the reaction of oxaloacetate and pyruvate (products of transamination reactions catalysed by aspartate transaminase and alanine transaminase respectively) with 2, 4-dinitrophenylhydrazine respectively. The absorbance of the colour developed in each of the reaction mixture was read at a wavelength of 550nm.

The titrimetric method according to Slyke (1922) was adopted for serum bicarbonate estimation. The serum chloride was estimated by titrating specimen samples with mercuric nitrate in the presence of diphenyl carbazone indicator (Schales and Schales, 1941). All values were analysed statistically with Student t-test using SPSS v15 software. Values are reported as mean  $\pm$  standard deviation and statistically considered significant at 95% confidence interval ( $P < 0.05$ ).

## Results

The results of ALT, AST, bicarbonate and chloride levels in both the workers in the quarry industry and control subjects are presented in the Tables below. The results indicated higher levels of alanine transaminase (ALT), aspartate transaminase (AST) and bicarbonate ( $\text{HCO}_3^-$ ) in both the males and female workers in the quarry industry than in the control subjects. On the other hand, there was no significant change ( $P > 0.05$ ) in the serum chloride concentration between the quarry male workers and

males working in the ministry ( $98 \pm 4.23$  mmol/L and  $99 \pm 3.20$  mmol/L respectively), while the chloride level was higher in females quarry workers than the control ( $113 \pm 3.16$  and  $99 \pm 2.65$  mmol/L respectively).

**Table 1: Comparison of the biochemical parameters between male quarry workers and the apparently healthy control subjects from the ministry of health**

Parameters	Quarry workers n=27	*Control n=10	$\beta$ P- value
Alanine transaminases (U/L)	18.24 $\pm$ 3.05	6.60 $\pm$ 2.63	P<0.05
Aspartate transaminases (U/L)	19.22 $\pm$ 5.54	9.94 $\pm$ 1.85	P<0.05
Bicarbonate (mmol/L)	39.28 $\pm$ 1.80	24.00 $\pm$ 3.80	P<0.05
Chloride (mmol/L)	98.0 $\pm$ 4.23	99.0 $\pm$ 3.20	NS

\*Workers in the ministry of health; P<0.05=Significant; SD=Standard Deviation, NS=Not Significant

**Table 2: Comparison of the biochemical parameters between female quarry workers and the apparently healthy control subjects from the ministry of health**

Parameters	Quarry workers n=30	*Control n=12	$\beta$ P- value
Alanine transaminases (U/L)	24.33 $\pm$ 6.50	9.33 $\pm$ 2.33	P<0.05
Aspartate transaminases (U/L)	22.78 $\pm$ 3.28	10.44 $\pm$ 2.59	P<0.05
Bicarbonate (mmol/L)	42.13 $\pm$ 2.95	25.0 $\pm$ 2.61	P<0.05
Chloride (mmol/L)	113.0 $\pm$ 3.16	99.0 $\pm$ 2.65	P<0.05

\*Workers in the ministry of health; P<0.05=Significant; SD=Standard Deviation

**Table 3: Sex-adjusted comparison of the biochemical parameters in quarry workers**

Parameters	Males n=27	Females n=30	$\beta$ P- value
Alanine transaminases (U/L)	18.24 $\pm$ 3.05	24.33 $\pm$ 6.50	P<0.05
Aspartate transaminases (U/L)	19.22 $\pm$ 5.54	22.78 $\pm$ 3.28	P<0.05
Bicarbonate (mmol/L)	39.28 $\pm$ 1.80	42.13 $\pm$ 2.95	P<0.05
Chloride (mmol/L)	98.0 $\pm$ 4.23	113.0 $\pm$ 3.16	P<0.05

SD=Standard Deviation; P<0.05=Significant

## Discussion

The usefulness of aminotransferases in assessment of activities in the liver, heart and other organs have been exclusively reported (Tygstrup, 1990; Sturgill and Lambert, 1997; Ezeonu and Ezejiofor, 1999; Dufour *et al.*, 2000; Kim *et al.*, 2004) while bicarbonate and chloride are involved in fluid and acid-base balance (Heusel *et al.*, 2001). The values

of ALT and AST reported in this study exceeded  $14.57 \pm 6.24$  U/L and  $22.4 \pm 13.53$  U/L recorded by Ezeonu and Ezejiofor (1999) among people working in Nkalagu cement industry located in the same South-Eastern Nigeria. The activities of the liver enzymes such as AST and ALT represent the functional states of the liver. The increase or decrease of enzyme activities was related to the intensity of cellular damage (Manna *et al.*, 2004). Kim *et al.* (2004) opined that serum aminotransferase concentration is associated with mortality from liver disease, even within the current normal range. High levels of ALT and AST in both the female and male workers in the quarry industry have serious health implications. Such increase is often an indication of liver damage and heart diseases (Gray and Howork, 1982). This makes the liver and the heart to be the most susceptible organs as this is the usual pattern in cases of hepatotoxicity caused by toxic agents (Ezeonu and Ezejifor, 1999). Dufour *et al.* (2000) asserted that alanine aminotransferase is the most important test for recognition of acute and chronic hepatic injury. The enzyme had also been attributed to future development of type 2 diabetes (Adams *et al.*, 2005) and cardiovascular events (Targher, 2007) independent of other known risk factors, thus, implying that quarry workers are at a higher risk of suffering the diseases at any time later in life.

Many authors (Theodore, 1980; Akahara, 1994; Gray and Howork, 1982) have reported high levels of bicarbonate among workers in quarry industries. These authors attributed the increase to high contents of calcium oxide (62-66%), silicon oxide (19 – 22%) and aluminium oxide (4 – 8%). Changes in chloride concentration have little significance but implicate an underlying disturbance in fluid and acid-base homeostasis (Heusel *et al.*, 2001).

Although, these workers are apparently healthy at the time of this study, the high levels of the biochemical markers among the quarry workers suggest a serious health risk exposure.

**Conclusion:** There is a possibility that a gradual and progressive organ-system damage and repairs that may have distorted cellular activities in the involved quarry workers. An elevated value of bicarbonate suggests respiratory and pulmonary diseases while high level of ALT and AST suggests organ-system perturbation in the quarry workers. This study informs the need for proper routine assessment of level of risk exposure of the workers. Government or municipal councils in charge of areas where quarrying is done should come up with enforceable legislation that will protect her citizenry from the hazards associated with quarry occupation.

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