Original Research Article

VARIATIONS IN SERUM LEVELS OF URIC ACID, UREA, CREATININE, POTASSIUM AND SODIUM IN EXPOSED MALE PAINT WORKERS IN OWERRI, NIGERIA.

ABSTRACT

Background: Paint is a blend of standardized constituents specifically binder, additives, pigment and heavy metals, which on application to an exterior as a thin coating is transformed to a solidified film. Increasingly eruption of newly painted buildings is a phenomenon in fast developing Owerri, Nigeria. Despite the toxic nature of some paint constituents, paint worker seems to be ignorant of possible consequence of its occupational exposure on their health, thus blood chemistry and renal function.

Objective: The study was carried out to appraise the serum levels of uric acid, urea, creatinine, potassium and sodium in male paint workers in Owerri, Nigeria.

Methods: A total of 80 male subjects aged between 20 to 40 years participated in the study. This consists of 40 male paint workers and 40 male controls. Venous blood samples were collected in plain containers, allowed to clot and retract. It was then centrifuged and the serum separated into plain containers and was used for biochemical analysis. Serum Uric acid, Urea and Creatinine were determined spectrophotometrically, while Potassium and Sodium were determined by flame photometric method. SPSS version 21 was employed in the statistical analysis of the obtained data.

Results: There were significantly higher serum levels of uric acid (4.29±1.30mg/dl versus 3.59±0.80mg/dl, p=0.030), urea (29.10±4.95mg/dl versus 25.40±3.34mg/dl, p=0.003) and creatinine (0.79±0.11mg/dl versus 0.69±0.07mg/dl, p=0.006) in paint workers compared with the controls. There was a significantly lower serum level of sodium (129.50±4.77mEq/L versus 135.80±2.37mEq/L, p=0.000) in male paint workers compared with male controls. While there was no statistical difference in the serum level of potassium (3.43±0.15mEq/L versus 3.44±0.10mEq/L, p=0.832) in male paint workers compared with male controls.

Conclusion: This study shows that uric acid, **urea and creatinine** are raised while serum sodium is reduced in male paint workers. This may be an indication of the toxic effect of paint constituents on the renal function of exposed male paint workers.

Key Words: Creatinine, Nigeria, Paint workers, Potassium, Sodium, Urea, Uric acid.

INTRODUCTION

Paint is a homogeneous blend of coloring substance/pigment, binder, volatile solvent and additives that convey distinct features. **[1]**. On application of paint to exterior surfaces, the volatile constituents disperse as the film dehydrates, whereas the binder stick to the coloring substance/pigment in the dry film, thus, facilitating its adherence to the exterior surface. **[1]**.

Alterations in serum levels of some biochemical parameters may serve as an indication for renal dysfunction affecting the ultrafiltration, selective reabsorption, dilution and concentration of urine by the nephrons **[2]**. Such parameters include serum potassium, sodium, urea, creatinine and uric acid which are assessed routinely to appraise renal function/dysfunction **[3]**. Knowledge of the serum levels of these biochemical parameters is very essential for precise diagnosis, risk assessment and selection of medication/therapy to ameliorate clinical disorders.

Uric acid is a derivative from purine metabolism in human beings. It is dissimilar to allantoin produced in other mammals by the enzymatic action of uricase. The rate of ingestion of purine and renal balance impacts on the serum levels of uric acid **[4]**. Apart from being waste and inactive produce from metabolism of purine, uric acid is speculated to play vital role in several biological functions **[5]**.

Urea is produced and distributed by the liver to both extracellular and intracellular fluid consequential to breakdown of protein and amino acid. It is a main nitrogenous constituent of glomerular filtrate, but is partially reabsorbed with water in the renal tubules. Therefore, its serum concentration is a reflection of the renal function/dysfunction **[6]**, thus justifies it Laboratory evaluation in appraisal of renal function/dysfunction.

Creatinine; the human muscle contains creatine phosphate which depending on the muscle mass is catabolized at fairly continuous rate to yield creatinine, whose serum concentration is employed in assessment of renal function/dysfunction **[7]**

Electrolytes consist of serum ***potassium***, ***sodium***, bicarbonate and chloride, which are crucial in the assessment of acid-base balance/imbalance associated disorders as well as renal dysfunction in the humans **[2, 8]**.

Progressively construction of new buildings is a marvel in fast evolving Owerri, Nigeria., thus has attracted numerous paint workers to reside and work in Owerri. Despite the harmful effect of some paint constituents, paint worker appears to be unaware of likely significance of its occupational exposure on their well-being, and consequently renal physiology. Therefore, this study is designed to appraise the serum values of uric acid, urea, creatinine, potassium and sodium, as a reflection of renal physiology in male paint workers in Owerri, Nigeria.

METHODOLOGY

Area of Study

This research was performed in Imo State University and its environs in Owerri, the capital of Imo State, Nigeria.

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Study Population and Size

A total of eighty (80) male subjects were selected for the study in Owerri. The study population consists of 40 male paint workers between the age range of 20-35 years who were working in new building sites in Imo State University and its neighborhoods in Owerri. The study group was age-matched with the Control group which consist of 40 apparently healthy male students of Imo state University, who are none paint workers.

Selection Criteria

Other matching bias which might interfere in the statistical analysis of kidney function test were eliminated in the selection criteria. Though all subjects were not pure vegans. But because of the high cost of living, especially animal food source in Nigeria and particularly Owerri, all subjects seldom take animal protein food, but more of plant food and protein source like beans.

Inclusion criteria

i. Male Subjects that have been Paint worker for up to 3years
ii. Paint workers without any chronic disease.
iii. Paint workers without addiction history of smoking
iv. Paint workers without addiction history of alcoholism,
v. Subjects that gave informed consent.

Exclusion criteria

i. Subjects who did not give their consent were excluded from the study.

ii. Female subjects were excluded.

iii. Subjects with chronic diseases.

iv. Subjects with addiction history of smoking

v. Subjects with addiction history of alcoholism,

Sample Collection and Processing

Using a sterile needle and syringe, 5mls of venous blood was collected aseptically from the median cubital or antecubital vein and was dispensed into a labelled plain container. The sample was allowed to clot after which the serum was separated with the aid of a Pasteur pipette. The serum was then introduced into another specimen container (plain container), and stored at -20^{0}C prior to use. Samples were analyzed within 2 days of collection.

Analytical Methods and Procedures

Serum uric acid level was determined by Spectrophotometric method as described by Caraway **[9]**. This uses the reducing property of uric acid in alkaline phosphotungstic acid to form tungsten blue whose colour is valued spectrophotometrically at 700nm wavelength.

Serum urea was estimated Spectrophotometrically using Diacetyl Monoxime method as described by Natelson, **[10]**. Proteins in whole blood, plasma or serum are precipitated with trichloroacetic acid. The urea in the supernatant reacts with diacetyl monoxime in the presence of thiosemicarbazide and cadmium ions under acid conditions. The absorbance of the red rose-purple solution is measured at 530nm.

Serum Creatinine (anhydride of creatine) was determined by Jaffes Reaction method as described by Bonsnes and Toussky, **[11]** spectrophotometrically.

In an alkaline picrate solution, creatinine reacts with picric acid to give a red colour (jaffes reaction) which absorbs at 510nm.

Flame Photometric method was employed in the determination of serum potassium and sodium **[12]**. Potassium and sodium solution under standardized conditions, a actual fine spray of the solution is supplied to the flame photometer burner. The solution evaporates and the salt dissociates to give neutral atoms. Some of these moves into a high energy state. When these excited atoms fall back to the ground state, the characteristic wavelength is 770nm and 590nm respectively for potassium and sodium. The light passes through a suitable galvanometer onto a photosensitive element and the amount of current produced is measured.

Statistical Analysis

Statistical analysis was carried out with the aid of IBM SPSS version 21 software and all values were expressed as mean ± standard deviation. The results were analyzed for statistical significance using the student T-test. The values with ($P<0.05$) were considered statistically significant. Pearson's correlation was also performed to evaluate relationship between the variables.

RESULTS

Serum Uric Acid, Urea, Creatinine, Sodium and Potassium in male Paint Workers versus Controls.

There were significantly higher levels of serum uric acid (p = 0.030), serum urea (p = 0.003) and serum creatinine (p = 0.006) in male paint workers compared to male controls. There was a significantly lower level of serum sodium (p = 0.000) in male paint workers compared to male control. While there was no significant difference in serum potassium (p = 0.832) in male paint workers compared to male controls.

Pearson Correlation of Uric Acid, Urea, Creatinine, Sodium and Potassium in male Paint Workers.

There was significant negative correlation of uric acid with sodium (r = -0.448, p= 0.048) in male paint workers. There was significant positive correlation of urea with sodium (r= 0.764, p=0.000) in male paint workers. There was no significant correlation of creatinine with uric acid (r = 0.290, p = 0.214), urea (r = 0.257, p = 0.274), sodium (r = 0.104, p = 0.662) and potassium (r = 0.244, p = 0.300) in male paint workers. There was no significant correlation of potassium with uric acid (r = 0.199, p = 0.399), urea (r = 0.210, p = 0.375), creatinine (r = 0.244, p = 0.300) and sodium (r = -0.145, p = 0.541) in male paint workers.

Table 1: Serum Uric Acid, Urea, Creatinine, Sodium and Potassium in male Paint Workers versus Controls

Variables (mean ± SD)	male **paint workers** (n = 40)	male **control** (n = 40)	***t*-value**	***p*-value**
Uric acid (mg/dl)	4.29±1.30	3.59±0.80	2.351	0.030
Lower 95% C.I	3.68	3.21		
Upper 95% C.I	4.89	3.96		
Urea (mg/dl)	29.10±4.95	25.40±3.34	3.377	0.003
Lower 95% C.I	26.78	23.83		
Upper 95% C.I	31.41	26.96		
Creatinine (mg/dl)	0.79±0.11	0.69±0.07	3.110	0.006
Lower 95% C.I	0.73	0.65		
Upper 95% C.I	0.84	0.73		
Sodium (mEq/l)	129.50±4.77	135.80±2.37	-5.581	0.000
Lower 95% C.I	127.26	134.68		
Upper 95% C.I	131.73	136.91		
Potassium (mEq/l)	3.43±0.15	3.44±0.10	-0.216	0.832
Lower 95% C.I	3.35	3.39		
Upper 95% C.I	3.50	3.48		

Table 2: The Pearson Correlation of Uric Acid, Urea, Creatinine, Sodium and Potassium in male Paint Workers

		Uric acid	urea	creatinine	sodium	potassium
Uric acid	*r*-value	1	-0.134	0.290	-0.448*	0.199
	p-value		0.574	0.214	0.048	0.399
	N	40	40	40	40	40
Urea	*r*-value	-0.134	1	0.257	0.764**	0.210
	p-value	0.574		0.274	0.000	0.375
	N	40	40	40	40	40
Creatinine	*r*-value	0.290	0.257	1	0.104	0.244
	p-value	0.214	0.274		0.662	0.300
	N	40	40	40	40	40
Sodium	*r*-value	-0.448*	0.764**	0.104	1	-0.145
	p-value	0.048	0.000	0.662		0.541
	N	40	40	40	40	40
Potassium	*r*-value	0.199	0.210	0.244	-0.145	1
	p-value	0.399	0.375	0.300	0.541	
	N	40	40	40	40	40

DISCUSSION

Heavy metals are contained in the organic and inorganic chemical composition of paint, and have been linked to various disorders in humans including, kidney dysfunction, brain disturbances, high blood pressure [13].

In this present study, there were significantly higher levels of serum uric acid, urea and creatinine ($p < 0.005$) in paint workers compared with controls. There was a significantly lower level of serum sodium ($p=0.000$) in paint workers compared with controls. While there no significant difference in serum potassium ($p > 0.05$) in paint workers compared with controls.

Paint workers are occupationally exposed to solvents, pigments and fillers during paint application, mechanical removal and manual preparation of the paint through inhalation and penetration by skin contact **[14]**. Numerous noxious ingredients of paint viz solvents; toluene, xylene, benzene **[15]** heavy metals pigments; chromium, arsenic lead cadmium**[16]** and additive nanoparticles; silver, titanium dioxide **[17]** poses source of occupational exposure to paint workers **[16]**. Thus, high blood levels of paint chemical constituents and their metabolites has been reported in paint workers **[15]**.

Previous reports shows that these paint constituents have toxic effects on several body systems; respiratory functions, renal system, neurobehavior, blood circulatory system, cardiovascular system , spleen and liver **[18,19,20].** Heavy metals particularly lead and cadmium exposure has been associated with development of pre-eclampsia **[21]** heart failure, fatigue **[22]**, and acne vulgaris **[23]**. It is likely that these constituents of paint may have caused some toxic effects on the renal function of the exposed paint worker in this present study, thus the observed raised values of uric acid, urea and creatinine in the paint workers.

The kidney/renal system regulates the removal of 70% of the uric acid produced daily. Decreases in glomerular filtration rate (GFR) has been associated with uric acid retention. Raised serum uric acid has been implicated in the pathophysiology of kidney stones and gout. High serum uric acid was proposed to be in association with other ailments plus diabetes mellitus, hypertension and chronic kidney disease [24]. This is consistent with the present study since there is significant increase in serum uric acid. Kanbay *et al*., [25] described how uric acid has been resurrected as a potential mediator of acute kidney injury.

The regulation of uric acid entails sequence of complex factors viz diet, renal urate transporters, uricase inactivation by its gene; all leading to 10 times higher uric acid in human compared to other mammals [4]. Despite that uric acid is very potent antioxidant, it still functions as a pro-oxidant, thus contributing to free radical production, endothelial vascular damage, inflammation, altered nitric oxide generation and cardiac arrest. Medically, the damaging pro-oxidant actions of uric acid overweigh its positive antioxidant effects excluding the central nervous system, where the positive antioxidant deed appears to triumph. Besides, uric acid plays significant role in the immune system and the progression of some inflammatory courses with substantial likely effects in several health and disease conditions [5].

Although blood urea is employed in assessment of renal dysfunction, it may not be dependable because it is easily influenced by other factors that are distinct from glomerular filtration rate [26]. Nevertheless, blood urea is valuable in differentiating acute renal failure from pre-renal disorders causing elevated blood urea nitrogen-creatinine ratio [6].

Urea clearance is an inadequate pointer of glomerular filtration rate, since its excessive production rate is influenced by numerous non-renal aspects, viz enzymes acting on urea cycle and diet. Elevated blood urea nitrogen is linked to renal disorders, urinary tract blockage by kidney stone, bleeding in the gastrointestinal tract, dehydration, congestive heart failure, fever and shock [6].

Serum creatinine helps in assessment of renal dysfunction. The tubular secretion of creatinine upsurges in chronic kidney disease consequential to erratic overrating of glomerular filtration rate [27]. The creatinine clearance test is employed in monitoring the advancement of renal disease. Elevation of serum creatinine above the upper reference limit is an indication for renal failure [7]. In chronic renal failure and uremia, a subsequent drop in elimination of creatinine by glomeruli and tubules ensues, and thus consequential to reduced creatinine clearance values as observed with polycystic kidney disease, glomerulonephritis, acute tubular necrosis, dehydration, shock and congestive heart failure, [7]. The main function of the kidney is acid-base balance and electrolyte regulation. Imbalance in the acid-base and electrolytes unavoidable occur with increasing loss of kidney function. Instability in serum potassium level is a common phenomenon in kidney disease patients mainly in patients with renal tubular disarrays and reduced glomerular filtration rate. Serum potassium level is employed as the utmost undoubted electrolyte indicator of renal failure [2]. The blend of reduced filtration and diminished secretion of potassium in distal tubule thru renal failure leads to elevated plasma potassium. Hyperkalemia is the most weighty and life-threatening complication of renal failure.

Serum sodium, potassium, chloride, and bicarbonate are useful indicators for glomerular and tubular function, they functions as indicator for biological process, pathophysiologic process and therapeutic response [8].

The kidney regulates sodium concentration via tubular reabsorption and urinary excretion of excess [28]. Hereditary essential hypertension, renal disease, primary hyperaldosteronism and obesity may predispose kidney weakening in sodium excretion[29]

CONCLUSSION

The results of this study indicates that serum levels of uric acid, urea, and creatinine are raised in paint workers. Serum level of sodium is significantly lower in paint workers, while the serum level of potassium in paint workers is indifferent. Thus, occupational exposure to harmful chemicals present in paint products may be consequential to elevation in serum level of uric acid and some markers of renal function.

RECOMMENDATION

It is recommended that paint workers wear personal protective equipment during work which can substantially reduce uptake of chemicals found in paint product. It is also recommended that they should have regular medical monitoring to assess their kidney and any other related organs that could be affected due to exposure to some paint components.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

ETHICAL APPROVAL AND CONSENT

The study protocol was approved by the Department of Medical Laboratory Science, Imo state University, Owerri, Nigeria, Research Ethics Committee with reference number

MLS/IMSU/REC/2021/011. Written informed consent was obtained from all study participants prior to their enrolment and collection of blood samples in accordance with the "1964 Helsinki declaration" and its later amendments in 2000.

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