*Original Research Article*

Assessing the Relationship Between Hair and Blood Levels of Urea, Creatinine, and Uric Acid: A Cross-Sectional Study

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ABSTRACT

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| **Aim:** To assess the correlation between blood and hair in Urea, Creatinine and Uric Acid.**Study design:** Cross-sectional study.**Place and Duration of Study:** Otuoke community in Ogbia Local Government Area and Eni-yimini Laboratories LTD, Yenezue-gene, Yenagoa, Bayelsa State, between June and October 2023.**Methodology:** A total number of fifty (50) samples were used in this research. The samples were divided into twenty-five different human hairs and twenty-five human blood samples (Araoye method). Blood samples were collected with 5ml syringe into plain tubes, the blood samples coagulated, and each of the blood samples were spun in a centrifuge at 4000rpm and the supernatant separated from the red blood cells for further analysis. Data were analyzed using one-way Anova with statistical significance considered as P < 0.05**Results:** The results showed no significant correlation between urea, creatinine and uric acid concentrations. However, there was a significant difference in creatinine and uric concentration (p<0.001), when compared using ANOVA. The study suggests that hair analysis can help identify nutritional deficiencies in the body, potentially causing health problems. Although hair analysis is not as accurate as blood analysis, it can be a helpful tool for identifying problems and monitoring treatment results.**Conclusion:** With more research, hair analysis may rank among the best for clinical analysis in the absence of hair. |

*Keywords: Correlation, Hair, Blood, Urea, Creatinine, Uric Acid*

1. INTRODUCTION

“A protein filament known as hair develops from dermal follicles. One of the distinguishing features of animals is their hair. The human body is covered in follicles that generate thick terminal and fine vellus hair, except for patches of glabrous skin. The most popular areas of interest in hair include hair types, hair growth, and hair care, but hair is also an important biomaterial that is mostly made of proteins, particularly alpha keratin. Attitudes towards different forms of hair, such as hairstyles and hair removal, vary widely across different cultures and historical periods, but they are often used to indicate a person's personal beliefs or social position, such as their age, sex, or religion” [1]. “The high interspecific variability of the size, color, and microstructure of hair often enables the identification of species based on single hair filaments” [2].

“A fluid that delivers oxygen and nutrients to the cells and removes wastes like carbon dioxide from the body is known as blood. Blood is, technically speaking, a transport liquid that the heart (or a comparable structure) pumps to all areas of the body before returning to the heart to begin the cycle again. Both a fluid and a tissue, blood is Because it is made up of a group of similar, specialized cells that perform a certain purpose, it is a tissue. These cells are suspended in a liquid matrix (plasma), which makes the blood fluid. If blood flow ceases, death will occur within minutes because of the effects of an unfavorable environment on highly susceptible cells” [3].

“According to the International Journal of Creative Research and Thought (IJCRT), blood is one of the most important biological traces that are often found at crime scenes. It is regarded as a very useful clinical tool because of the valuable information it carries. Bloodstain analysis can help shed light on the context in which some violent crimes have been perpetrated. Such important details can steer criminal investigations in the appropriate direction and aid in the crime's resolution. In some circumstances, it can also aid in the legal adjudication of a criminal offense, which can result in a more accurate and suitable penalty for the offender. Knowing the sequence of events that led up to a bloody, violent crime is crucial information. Blood genotyping is a factor in investigations, and blood grouping is used to categorize cases.As markers of renal function, creatinine, urea, and uric acid are for routine analysis, whereas several studies have confirmed and consolidated the usefulness of markers such as cystatin C and trace protein. Creatinine is a breakdown product of creatine phosphate in muscle and is usually produced at a constant rate by the body, depending on muscle mass” [4]. “Creatinine is a commonly used measure of kidney function. The normal creatinine clearance test valve is 110–150 ml/min in males, and in females it is 100–130 ml/min” [5]. The National Kidney Disease Education Program recommends calculating the glomerular filtration rate from serum creatinine concentration [6]. However, findings have not been shown to utilize renal markers such as urea, creatinine, and uric acid in correlation between hair and blood. There are clinical situations where blood cannot be accessed, such as a collapsed vein or a patient in a coma, so a substitute is required. Blood as a clinical parameter has the additional flaw of reflecting only recent changes, necessitating a retrospective sample.

Hair represents a long-term metabolic blueprint that can span many years, whereas urine and blood tests only reveal the recent and current state of the body. A severe traumatic brain injury, a stroke, or a lack of oxygen to the brain can all result in a protracted deep state of unconsciousness known as a coma. Blood cannot be drawn from the veins in coma patients who are in critical condition because of the body's oxygen levels [7]. Collapsed veins happens when the vein's outer walls become inflamed and swollen, causing clotting to form within the vein's walls. Blood flow to the area has stopped, which is a surefire sign that a vein has collapsed. If there is a court proceeding, shoot it up. Parameters such as urea, creatinine and uric acid help in correlation. There are clinical situations where blood cannot be accessed, such as a collapsed vein or a patient in a coma, so a substitute is required. Blood as a clinical parameter has the additional flaw of reflecting only recent changes, necessitating a retrospective sample. This study aims to utilize the following renal markers such as urea, creatinine and uric acid to correlated hair and blood in clinical investigation and analytical processes.

2. materialS and methods

**2.1 Location Area**

The study was conducted at Otuoke in Ogbia local government area, in Bayelsa state. The blood sample was springed at Federal Medical Centre Otuoke, the biochemical investigation was carried out at Eni-Yimini Laboratory (eL) Limited at Yenezue Gene Epie, Yenegoa Bayelsa State.

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 **Fig. 1:** **Map showing location (Otuoke) [8]**

**2.2 Research Design**

The research design employed a quantitative experimental design, which is a scientific method to establish the cause-and-effect relationship among the various groups (hair and blood) that make up the study.

**2.3 Population Size**

A sample size was calculated using a formula proposed for studies where the population is less than 10,000 [9]. The formula is stated and the components defined below:

n / (1 + n / N);

 Where:

 n = Is the total number of samples in the study (where the study took place),

N = population of sample (the surrounding area), that is 50/(1+50/50) = 25.

The first group was the hair which where process to get the filtrate and was extracted from all the groups for biochemical analysis.

The second group was the blood, and it was in two categories, one was the red cap container which where centrifuge to get the serum extracted from all the groups for biochemical analysis. And the other was the blood which was in yellow cap container was extracted from all the groups for biochemical analysis. There are some selected sample sizes for this study since biomarkers are numerous. The list of the one for this study are (Total protein, albumin and globulin). Electrolyte markers are present as elementary compounds or mineral deposits in nature, from which they are extracted and processed for different purposes. The samples were collected from one location.

**2.4 Selection Criteria**

The Hair and Blood were obtained from the students in the Biochemistry Department, Faculty of Sciences, University of Otuoke, for this study. The hair and blood used were apparently healthy and active, as confirmed and approved by a veterinary doctor. Hair and blood showing signs and symptoms of illness were excluded from the research. Also excluded were samples with any form of disorder. The age range was between twenty and twenty-eight years old. The weight brackets were 1.5–2 kg.

**2.6 Sample Collection**

The hair and blood sample were collected from 10 students from the department of Biochemistry, Faculty of Science, Federal University Otuoke, Bayelsa State at random. Prior to the collection of these samples. The blood Samples collected into plain tubes were spun in a centrifuge and the supernatant separated for determination of urea, creatinine and uric acid, the supernatant was stored in a fridge. The samples were employed for the determination of the relationship between hair and blood using renal markers urea, creatinine and uric acid as parameters.

**2.7 Laboratory Methods and Procedures**

**2.7.1: Hair Processing Procedures**

The hair samples were sorted out, each sample was washed twice with ordinary water and detergent and then rinsed with distilled water. The hair samples were placed in different crucibles and were placed inside an oven to dry for 30mins at 500C. The samples were brought out from the oven after 30mins, 10ml of 1N sodium hydroxide (NAOH) was added to each of the sample in the crucible. The samples submerged into 10ml of 1N NAOH were placed back into the oven at 1000C for 1hr (the NAOH is expected to reduce and form a paste like mixture). The samples were brought out again from the oven after 1hr, then the expected result was obtained from each of the samples. Finally, 10mls of distilled water were added to each of the samples in the crucible, they were filtered using filter paper.

**2.7.2 Blood Processing Procedure**

5mls of 10 different blood samples were collected, 3mls of the samples were added into a sterile container and 2mls in fluoride oxide container. The samples in the plain container were spun with a centrifuge at 400RPM and the supernatant were separated into a different plain container.

**2.7.3 Determination of Correlation Urea Concentration**[10]

Hair and serum urea were estimated by the diacetyl monoxime method. The diacetyl monoxime salts are stable at room temperature and could adapt to harsh environments [11].

 *2.7.3.1 Principle*

Urea reacts with diacetyl monoxime at 100oC to produce a pink color that is measured calorimetrically. The intensity of the color produced is directly proportional to the concentration of urea.

**2.7.4 Determination of correlation in creatinine concentration** [10]

The method of choice for this was Jaffe's method. It was chosen because of its stability and consistency [11].

*2.7.4.1 Principle*

In an alkaline medium, creatinine reacts with picric acid to produce a pink color, which is directly proportional to the concentration of creatinine in the sample.

**2.7.5 Determination of Correlation: Uric Acid Concentration**

The correlation of serum uric acid concentration was estimated quantitatively by the Uricase Method using the Agappe kit as specified by Agappe Diagnostics (Switzerland) (Agappe Kit Leaflet).

*2.7.5.1 Principle*

Uricase transforms uric acid into allantoin with the formation of hydrogen peroxide in the presence of peroxidase (POD). The allantoin then reacts with ethylsulphopropyl tuluidine (ESTP) and 4- aminophenazone to produce a colored complex whose intensity is directly proportional to the uric acid concentration in the sample.

**2.8 Statistical Analysis**

Data were analyzed with the Statistical Package for Social Sciences (SPSS) program (SPSS Inc., Chicago, IL, USA; Version 18–21) and Microsoft Excel. A one-way ANOVA (Post Hoc) was used in comparing the means of the various biochemical parameters of the various correlation of the study. Tables and charts were used for the presentation of various biochemical findings.

3. results and discussion

**Table 1: Multiple Comparison Between Various Groups of Samples**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameters** | **Blood**  | **Hair**  | **NaoH** | **F-Value** | **P-Value** |
| Urea (mmol/L) | 3.05 ± 1.22 | 1.76 ± 2.66 | 0.84 ± 0.00 | 2.94 | 0.07 |
| Creatinine (µmol/L)  | 77.99 ± 12.73 | 39.36 ± 15.67 | 12.97 ± 0.00 | 53.61 | 0.00 |
| Uric acid (mmol/L)  | 2.41 ± 30.44 | 25.30 ± 12.49 | 48.83 ± 6.65 | 158.09 | 0.00 |

**Table 2: Correlation between Blood and Hair**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Parameters | Blood  | Hair  | R- value | P-value | Comments |
| Urea (mmol/L) | 3.05 ± 1.22 | 1.76 ± 2.66 | -0.03 | 0.54 | Non-correlation  |
| Creatinine (mmol/L)  | 77.99 ± 12.73 | 39.36 ± 15.67 | -0.02 | -0.79 | Non-Correlation  |
| Uric acid (mmol/L)  | 2.41 ± 30.44 | 25.30 ± 12.49 | -0.40 | 0.56 | Non-correlation  |

**Table 3: Correlation Between Blood and NaoH**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Parameters | Blood  | NaoH | R- value | P-value | Comments |
| Urea (mmol/L) | 3.05 ± 1.22 | 0.84 ± 0.00 | 1 | 0.30 | Non-Correlation  |
| Creatinine (mmol/L)  | 77.99 ± 12.73 | 12.97 ± 0.00 | 1 | 0.06 | Non-Correlation  |
| Uric acid (mmol/L)  | 2.41 ± 30.44 | 48.83 ± 6.65 | 1 | -0.68 | Non-Correlation  |

**Table 4: Correlation Between Hair and NaoH**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Parameters | Hair  | NaoH | R- value | P-value | Comments |
| Urea (mmol/L) | 1.76 ± 2.66 | 0.84 ± 0.00 | 0.30 | 1 | Non correlation  |
| Creatinine (mmol/L)  | 39.36 ± 15.67 | 12.97 ± 0.00 | 0.06 | 1 | Non correlation  |
| Uric acid (mmol/L)  | 25.30 ± 12.49 | 48.83 ± 6.65 | -0.68 | 1 | Non correlation  |

The aim of this study was to assess the levels of the following renal markers; urea, creatinine and uric acid, in two different specimens: hair and blood. The results (Table 1) showed that there were no significant (p=0.07) differences in the levels of urea in blood, hair and NaOH. However, significant differences in creatinine (p<0.001) and uric acid (p<0.001) were observed.

The study revealed that there was no significant correlation in the levels of blood, hair, or NaOH, a significant increase in blood concentration correlation and stability of uric acid concentration correlation were seen and increased in uric acid blood on (Table 1). Increase in correlation in blood. Urea and creatinine are nitrogenous end products of metabolism [12]. There is minimal extrarenal disposal or demonstrable metabolism [13]. Uric acid is a product in the metabolic processes of purine nucleotides in the human body. The lead content of hair in workers occupationally exposed was correlated with the blood lead concentration. Determinations of lead in blood and hair were performed by electrothermal atomic absorption spectrophotometry in two exposed groups and a control group [14]. trace elements in hair and blood of clinically healthy companion dogs to decide whether hair and blood element concentrations correlate with each other, and to assess the effect of age, sex, hair color, and diet on these elements [15].

 In similar vein, the correlation analysis revealed a non-significant correlation between table 2 to 4). This study exhibited no correlation in hair and blood, therefore, parameters such as urea, creatinine and uric acid, no indexed in correlation.

4. Conclusion

In conclusion, this study found no correlation in the levels of urea, creatinine and uric acid in blood and hair. By assessing the amount of these nutrients in the hair, it is possible to spot nutritional deficiencies that might cause health problems. It is possible to keep in mind that hair analysis is not as accurate as blood analysis and should only ever be used as a gentle method of identifying nutrient deficiencies. However, it can be a helpful tool for identifying problems and monitoring treatment results. With more study, it's possible that hair analysis will rank among the best because it can be used for clinical analysis to obtain results in absence of hair.

Consent

All authors declare that written informed consent was obtained from the patient (or other approved parties) for publication of this case report and accompanying images.

**Ethical Approval**

The ethical approval was granted by the Directorate Quality of Research Assurance, Federal University Otuoke, Bayelsa State, Department of Biochemistry, as attached in the appendix. A trichologist is a specialist who focuses on trichology, the study of diseases or problems related to hair, and a hemologist is a specialist who focuses on hemology, the study of blood.

Disclaimer (Artificial intelligence)

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Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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Details of the AI usage are given below:

1.

2.

3.

References

1. Sherrow, V. [*Encyclopedia of Hair: A Cultural History*](https://archive.org/details/encyclopediaofha0000sher). Westport, CT: Greenwood, 2006.
2. Toth, M. [*Hair and fur atlas of Central European mammals*](http://www.hairatlas.hu/). Pars Ltd. p. 307. Transporter influencing serum urate concentration, urate excretion and gout". *Nature Genetics,* 2017; 40 (4): 437–42.
3. Schwartz, Robert S. and Conley, C. L. Blood. Encyclopedia Britannica, 2023.
4. Yuegang, Z., & Chengjun, W. Simultaneous Determination of Creatinine and Uric Acid. Lan. 2008; 34:25-9.
5. Corbett, J. V., & Banks, A. Laboratory tests and diagnostic procedures with nursing diagnoses (9th ed.). Upper Saddle River, NJ: Pearson hair strand cross-section: Advanced analysis using LA-ICP-MS in dentistry. Talanta, 124909, 2018.
6. Miller, R., Liu, K., & Ball, A. F. Critical counter-narrative as transformative methodology for educational equity. Review of Research in Education, 2020; 44(1): 269-300.
7. Zhong, W., Ji, Z. & Sun, C. A Review of Monitoring Methods for Cerebral Blood Oxygen Saturation. Healthcare (Basel). 2021 Aug 26;9(9):1104
8. Uzakah**,** R. & Epidi, T. Survey of Termites along Yenagoa-Imiringi-Otuoke Axis of Bayelsa State, Southern Nigeria**.** *African Scientist*, 2023; 24, 4-9.
9. Araoye, M.O. Sample Size Determination in Research Methodology with Statistics for Health and Social Sciences. Nathadex Publishers, Ilorin, 2004; 115-21.
10. Francis, P.S., Lewis, S.W. & Lim, K.F. Analytical methodology for the determination of Urea: Current practice and future trends.[*Trends in Analytical Chemistry*](https://www.researchgate.net/journal/TrAC-Trends-in-Analytical-Chemistry-0165-9936?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6Il9kaXJlY3QiLCJwYWdlIjoicHVibGljYXRpb24iLCJwb3NpdGlvbiI6InBhZ2VIZWFkZXIifX0), 2002; 21(5): 389-400.
11. Langenfeld, N.J., Payne, L.E. & Bugbee, B. Colorimetric determination of urea using diacetyl monoxime with strong acids. *PLoS* One,16(11),0259760.
12. Zhu, J., Pan, J., Li, Y., Yang, J., & Ye, B. Enzyme-nanozyme cascade colorimetric sensor platform: A sensitive method for detecting human serum creatinine. Analytical and Bioanalytical Chemistry, 2022; 414(20): 6271-80.
13. Bauer, J. H., Brooks, C. S., & Burch, R. N. Renal function studies in man with advanced renal insufficiency. American Journal of Kidney Diseases, 1982; 2(1): 30-5.
14. Niculescu, T., Dumitru, R., Botha, V., Alexandrescu, R., & Manolescu, N. Relationship between the lead concentration in hair and occupational exposure. Occupational and Environmental Medicine, 1983; 40(1): 67-0.
15. Jutha, N., Jardine, C., Schwantje, H., Mosbacher, J., Kinniburgh, D., & Kutz, S. Evaluating the use of hair as a non-invasive indicator of trace mineral status in woodland caribou (Rangifer tarandus caribou). Plos one, 2022; 17(6): e0269441.