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# Calculated Haematocrit Gave a Better Prediction of Anaemia than Observed Haematocrit in Patients with Haemorrhage and under Aged Children in Central Nigeria

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***Authors' contributions***

*This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.*

***Original Research Article***

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## ABSTRACT

**Background:** In the north central Nigeria, observed haemoglobin concentration is often used to determine the packed cell volume of patients, especially by many laboratories that cannot afford the cost of micro-haematocrit centrifuge.
**Aim:** The study was carried out to determine the accuracy of 3-fold haemoglobin conversion to haematocrit level in anaemic conditions.
**Materials and Methods:** The study was conducted on 580 symptomatic (febrile) patients and 810 subclinically anaemic subjects attending some selected private medical laboratories, hospitals and clinics in Kuje Area Council of Federal Capital Territory (FCT), Abuja, Nigeria. Calculated haemotocrit was obtained by multiplying observed haemoglobin concentration by three while the observed haemoglobin was determined by colorimetric technique using Drabkin solution. Observed haematocrit was determined by using microhaematocrit technique. Mean observed and mean calculated haematocrit were statistically analyzed by students' T-Test and findings compared.

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**Results:** Findings revealed a significant bias for higher degree of anaemia when 3-fold haemoglobin (calculated haematocrit) was employed than when observed haematocrit was used to determine anaemia in children within 1-10 years of age ($T=2.1630$, $P<0.05$). Also, this study showed a significant difference between mean calculated haematocrit and mean observed haematocrit in post-haemorrhagic conditions ($T=3.0151$, $P<0.05$).
**Conclusion:** Use of direct haemoglobin estimation and derived haematocrit is advocated to diagnose anaemia in children and post-haemorrhagic conditions. Side laboratories are advised to enroll into proficiency testing programmes to monitor accuracy of their assay results.

*Keywords: Calculated haematocrit; anaemia; haemoglobin; diagnosis.*

## 1. INTRODUCTION

Haemoglobin concentration and Haematocrit values are vital parameters often used for assessment of blood haemoglobin level and red cells mass respectively. These parameters are therefore useful in the diagnosis of qualitative and quantitative anaemia. Haemoglobin is the main constituent of red blood cells, with the normal healthy adult red blood cells containing about 600g of the substance [1]. Routinely, Haemoglobin level in the blood can be assayed by oxyhaemoglobin, alkaline haematin, cyanomethaemoglobin and Haemacue techniques [2] while haematocrit value can be determined routinely either by Wintrobe or microhaematocrit centrifugation but the later is often preferable owing to its simplicity and reproducibility [3]. Interconversion between haemoglobin and Haematocrit had earlier been reported [4,5]. However such conversion may not be valid in every condition and all cases of anaemia as a result of environmental variations, technical factors, age and gender; among others [6].

In apparently healthy males, a reference range of 42-53% PCV had been reported while 37-47% was reported for their female counterparts [7]. Values significantly higher than these ranges are considered elevated in adults and they are characteristic of polycythemia, whereas values below the lower limits are said to be in anaemic conditions. Anaemia nowadays is being used as predictors of many infections and non infectious diseases [8,9] and it can also be used for monitoring and evaluation of response to therapy [10]. In malaria endemic areas, interconversion between haemoglobin and haematcrit had been employed for determining anaemia due to malaria [9,11].

In view of the increasing request for haematocrit value by clinicians, coupled with high cost of quality micro-haematocrit machine, many private clinics, hospitals and private medical laboratories have resorted to the alternatives. Use of locally fabricated machines is now very common, albeit without validation, while the use of haemoglobin conversion is fast gaining ground in Nigeria.

This study therefore attempted to assess the reliability of three-fold conversion of haemoglobin concentration (in g/dL) to haematocrit value as an alternative method for determining Packed Cell Volume (PCV) in anaemic conditions.

## 2. MATERIALS AND METHODS

### 2.1 Sample Collection

After swabbing the site of collection with methylated spirit, 2 millilitres of venous blood was collected from each of the patients into di-potassium EDTA vacutainer. A total of 1390 samples were collected comprising of those from 580 patients with malaria parasitaemia and another from 810 clinically anaemic patients with no malaria infection. All the patients were randomly selected from Kuje Biomedical Laboratory, Sure Foundation Medical Laboratory Gwagwalada, Agape Biomedical Clinics Kuje, Capital Clinic and Maternity Kuje, Kuje Area Council Health Center and General Hospital, Kuje.

Before the commencement of the sample collection, approval from Research and Ethics Committee of Kuje Area Council Kuje, Abuja was obtained in accordance with the Helsinki Declaration guidelines. The study also received written consent of the subjects prior to their inclusion in the study. Study populations in this study comprise males and females within age of 3 months and 64 years.

### 2.2 Laboratory Procedure

Determination of observed haemoglobin concentration was done by colorimetric technique using Drabkin solution as described by Baker and Silverton [2], whereas observed heamatocrit value was obtained by microhaematocrit centrifugation using microhaematocrit centrifuge (Hawksley Ltd, Sussex UK) at 12,0000 revolutions per minute for 5 minutes. Plain capillary tubes were used throughout and they were sealed at one end with plastercine before spinning.

### 2.3 Data Analysis

Calculated haemotocrit was obtained by multiplying the observed haemoglobin (in g/dl) by three. Data on mean observed and mean calculated haematocrit were statistically analyzed and compared using students' T-test.

## 3. RESULTS

Variations in the mean observed and mean calculated haematocrit among anaemic populations by age and gender is as shown in Table 1. Statistical analysis by student's T-test showed a significant difference between observed and calculated haematocrit within age 1-10 years ($T=2.1630$, $P<0.05$), whereas no significant difference in the values among the remaining age groups ($P>0.05$). Similarly by gender, statistical analysis showed no significant difference between the observed and calculated haematocrit ($P>0.05$).

Table 2 shows the mean observed haematocrit and calculated haematocrit among subjects in different anaemic conditions. In blood loss anaemia, the observed haematocrit was significantly different from the calculated value ( $T=2.1630$, $P<0.05$), while in anaemia due to sickle cell disease, nutritional deficiency and malaria parasitaemia, no significant difference was recorded between the mean observed and mean calculated haemotocrit ($P>0.05$). All subjects were clinically diagnosed, as categorized and the clinical diagnosis were indicated in the laboratory request forms sent by the clinicians.

**Table 1. Mean haematocrit values of anaemic subjects by age and gender**

| Age group (year) | Observed PCV (%) Mean±S.D | Calculated PCV (%) Mean±S.D | $T_{Cal}$ | $T_{tab}$ | Level of significance |
|---|---|---|---|---|---|
| <1 | 21.0±0.18 | 19.3±0.81 | 0.9542 | 0.9969 | P>0.05 |
| 1-10 | 20.3±0.92 | 14.1±0.2 | 2.163 | 0.9969 | P<0.05 |
| 11-20 | 27.8±0. 8 | 29.6±0.24 | 0.7380 | 0.9969 | P>0.05 |
| 21-30 | 31.9±0.04 | 30.5±0.07 | 0.9413 | 0.9969 | P>0.05 |
| 31-40 | 26.1±0.08 | 24.8±0.91 | 0.8412 | 0.9969 | P>0.05 |
| >40 | 27.4±0.03 | 28.9±0.10 | 0.9142 | 0.9969 | P>0.05 |
| Sex | | | | | |
| Male | 30.9±0.91 | 32.3±0.69 | 0.9210 | 0.9969 | P>0.05 |
| Female | 24.6±1.03 | 26.6±0.87 | 0.8996 | 0.9969 | P>0.05 |

*n=1390*

**Table 2. Mean Haematocrit values in clinically anaemic conditions**

| Anaemic conditions | Mean observed Hct±SD (%) | Mean calculated Hct±SD | $T_{cal}$ | $T_{tab}$ | Level of significance |
|---|---|---|---|---|---|
| Sickle cell | 21.3± 0.3 | 19.2±0.1 | 0.7455 | 0.9969 | P>0.05 |
| Blood loss disorders | 23.9±1.4 | 14.3±0.7 | 3.015 | 0.9969 | P<0.05 |
| Nutritional deficiency | 21.4±0.8 | 20.6±0.08 | 0.9101 | 0.9969 | P>0.05 |
| Malaria | 28.1±1.02 | 27.4±0.52 | 0.8790 | 0.9969 | P>0.05 |

*n=1390*

## 4. DISCUSSION

Findings in this study revealed a significant bias for higher degree of anaemia when 3-fold haemoglobin (calculated haematocrit) was employed than when observed haematocrit was used to determine anaemia in children within 1-10 years of age (T=2.1630, P<0.05). Also, the study showed a significant difference between mean calculated haematocrit and mean observed haematocrit with respect to blood loss anaemia (T=3.0151, P<0.05). In other age groups and the remaining cases of anaemia, there was no significant difference between the observed and calculated haematocrit values (P>0.05).

These results are in agreement with previous studies [6,12-15] in which observed hemoglobin value was adjudged the better indicator of anaemia than observed haematocrit. However the present findings disagree with the result of Brittin et al. [16] in which observed heamotocrit revealed a higher degree of anaemia with coulter-counter device.

The variation between our findings and the Brittin et al result could probably be due to the difference with method of blood sample analysis. While we employed direct haemoglobin estimation and PCV determination methods, the later made use of coulter analyser wherein the PCV is a derived parameter. False raised haemotocrit could also be as a result of plasma being trapped between the packed red cells as was previously documented [15,16] in a study.

As a way of increasing the accuracy of observed haemotocrit values, routine monitoring of haemotocrit centrifuge speed with tachometer and connection of the machine to back-up

current stabilizer is suggested to maintain the efficiency of the machine. Lastly, the relationship between observed and calculated haemotocrit by region and epidemiological settings needs further studies since these factors can affect the relationship. Also, further studies on the efficacy of locally fabricated microhaemotocrit centrifuge often employed in Nigeria is recommended while inter-laboratory quality control on haematocrit values is strongly advocated by way of external proficiency testing.

## 5. CONCLUSION

In conclusion, based on our findings, we deduced that observed haematocrit is capable of under estimating the degree of anaemia in cases of blood loss anaemia and among anaemic children within 1-10 years of age. We therefore recommend the use of direct haemoglobin estimation and calculated haematocrit as a preferred alternative for the assessment of anaemia in such cases.

## CONSENT

Before the commencement of the sample collection and after the approval from Research and Ethics Committee of Kuje Area Council Kuje, Abuja was obtained; the study also received written consent of the subjects prior to their inclusion in the study.

## ETHICAL APPROVAL

Authors may use the following wordings for this section: “All authors hereby declare that all experiments have been examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.”

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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