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Evaluation Of The Packed Cell Volume (PCV) As A Potential Screening Tool For Iron Deficiency Anaemia Among Under-5 Children In A Resource Limited Setting

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ABSTRACT

In resource-limited settings as seen in developing countries, most clinicians use cheap and readily available tests to diagnose and treat iron-deficiency anaemia. Some of these tests have no proven statistical correlation with iron deficiencies, which is usually diagnosed with iron studies, represented by the serum Ferritin level. This study aims to correlate the Packed Cell Volume (PCV), a widely used parameter in these settings, to the Serum Ferritin (SF), so as to evaluate its usefulness as an alternative parameter in diagnosing iron deficiency. The study was a cross sectional and analytical survey of 356 children aged 2-59 months. Their PCVs and SF were obtained and correlated using *IBM-SPSS Version 22*. The result obtained using the Pearson Correlation Coefficient, revealed a statistically insignificant, very weak, negative association between PCV and SF in both groups. The coefficients were -0.089 (p-value 0.237) and -0.101 (p-value 0.182) respectively for the anaemic and non-anaemic groups. We conclude that there is no correlation between PCV and serum Ferritin, and therefore recommends that the PCV should not be used as a screening tool for iron-deficiency.

Key words: Packed Cell Volume, Serum Ferritin, Correlation, ESUTH,

INTRODUCTION

Iron deficiency anaemia is the type of anaemia resulting from lack of sufficient iron for the synthesis of haemoglobin (Bertil, 2004). Studies have described it as the commonest cause of anaemia in infancy and childhood (Bertil, 2004, Kasili, 1990), and a leading cause of infant morbidity and mortality worldwide. Behavioural abnormality, cognitive dysfunction and poor school performance associated with iron deficiency could become irreversible (Graitham and Ani 2001; Politt, 1993).Different iron parameters used singly or in combination for evaluation of iron status have been illustrated in various studies (Akinkugbe et al, 1999; Tympa-Psirropoulous et al 2005),but availability and affordability have posed a serious limitation to their use in resource-limited settings. For instance, serum Ferritin test which has been described as the single best blood test for diagnosis of iron deficiency (Choi et al, 2005; Mansour et al, 1985) is largely unavailable in most centers. On this premise, clinicians managing anaemic babies in most developing countries either resort to giving iron formulas routinely or employ other indirect laboratory parameters to diagnose iron deficiency. While the former option may appear conservative, it could however, predispose to iron toxicity. Indirect parameters used in diagnosis of iron deficiency state include, haemoglobin (Hb) estimation, reticulocyte haemoglobin concentration, reticulocyte size, percentage hypochromic cells, Mean Corpuscular Volume (MCV) and therapeutic trial with elemental iron.

A study in particular found a significant positive correlation between Hb and Log of Serum Ferritin level, Log of serum iron levels and transferrin saturation in under-fives (Jeremiah et al, 2007). None to the authors' knowledge has correlated PCV with SF particularly in under-5 children. Though there is a standard mathematical relationship between Hband PCV values; PCV= Hb multiplied by a factor 3 (Carneiro et al, 2007), andPCV has been widely used as an alternative to haemoglobin(Shiff et al, 1996; Chandramohan et al, 2005, Curtis et al, 1998), but PCV estimation is simpler, faster and more cost effective than that of Hb, hence suitable for a

Therefore it becomes imperative to correlate this tool with serum Ferritin level which is a confirmatory and most accurate tool for iron status (Salvioli et al, 1991; Bogen et al, 2000; Kapoor et al, 2001), and evaluate its usefulness as a potential screening tool for iron deficiency anaemia especially in a resource-limited setting.

MATERIALS AND METHOD

This was a cross sectional and analytical study carried out at the Enugu State University Teaching Hospital, (ESUTH), a tertiary health facility in Enugu, South-East Nigeria. Children aged 2-59months presenting in the Children's Emergency Room (CHER) and Children Outpatient (CHOP) unit of the Department of Paediatrics between December 2009 to June 2010 were consecutively selected for the study. Their haematocrit was done using capillary tubes, micro-haematocrits centrifuge (model SJ8038HA2 Suntronics by Surgifriends medicals, England) and haematocrit reader. Study subjects were classified as anaemic (PCV<30%) and non anaemic (PCV>=30%). Serum Ferritin level was done using Human Ferritin Enzyme Immunoassay Test Kit to determine their iron status and iron deficiency was defined as serum Ferritin level <12ng/dl. Other information obtained include the age, weight and sex of the subjects. Data was analyzed using *IBM-SPSS Version 22.*

The data were coded into 6 variables each for the Cases and Controls. Initially, the various **descriptive statistics** were obtained for the participants in each group. This was then followed by an attempt establish whether there was any association/correlation between PCV and Serum Ferritin using the Pearson Correlation Coefficient.

Ethical approval for the research was obtained from the Ethical Committee of ESUTH. Informed consent was obtained from the parents and care-givers of the subjects.

RESULTS

1. Descriptive Statistics

A total of 356 children were studied, divided into anaemic and non anaemic groups of 178 each. The anaemic group has PCV of less than 30%, while the non anaemic group has PCV of greater than or equal to 30%. Among the 178 anaemic group, there were 100 males (56.2%) and 78 females (43.8%). This relationship is also mirrored in the non anaemic group, 101 males (56.7%) and 77 females (43.3%). These are summarized in *Table i.*

*Table ii*below summarizes the Ages and Weights of the Participants. This shows that for the Cases, their weights ranged from 2.6kg to 23kg (Mean of 10.7 kg), while for the Controls, the weight range is 4.4kg to 21.0kg (average of 11.0kg). The table also shows that the average age among the Cases were 21.4 months (3 - 56 months) and 20.1 months (3-59 months) respectively for the Cases and Controls. These statistics confirms that the study groups are identical to each other, and can therefore be compared where necessary.

Another descriptive variable analyzed were those for the PCV and Serum Ferritin (SF), and this is summarized in *Table iii*below. *Among the Cases, the* average PCV was 35.5% (Range of 30 to 43%), while the average Serum Ferritin Level was 52.7ng/ml (ranging from 0.2 to 454ng/ml). On the other hand, the Controls have an average PCV of 23.4%, with a range of 8% to 29%, while the average for the SF average was 77.5ng/ml (range from 0.5 to 531.3ng/ml). These show that the PCV and SF are not identical among these groups, which is not surprising given that these variables are the very basis for distributing the participants into the two groups.

2. Correlation between PCV and Serum Ferritin

This study's primary aim is to see if there is a correlation between PCV and SF in children aged less than 5 years. This was answered using the Pearson Correlation Coefficient, with the value expected to be significant at a p-value of less than 5%. The Pearson Coefficient was used because the

Table 1: Description of Study Participants (Cases and Controls) by Gender

	Anaemics (%)	Non-anaemics (%)
Male	100 (56.2)	101 (56.7)
Female	78 (43.8)	77 (43.3)
Total	**178 (100.0)**	**178 (100.0)**

Table II: Description of Study Participants by Age and Weight

	Age: (Months)		Weight (Kg)	
	Anaemics (N 178)	Non-anaemics (N = 178)	Anaemics (N = 178)	Non-anaemics (N = 178)
Mean	21.5	20.1	10.8	10.9
Mode	24.0	24.0	13.0	10.0
Median	17.0	17.0	10.0	10.0
Range	56.0	56.0	20.4	16.6
Minimum	3.0	3.0	2.6	4.4
Maximum	59.0	59.0	23.0	21.0

Table III: Description of Study Participants by PCV and Serum Ferritin (SF)

	PCV (%)		Serum Ferritin, SF (ng/ml)	
	Anaemics (N=178)	Non-anaemics (N=178)	Anaemics (N=178)	Non-anaemics (N=178)
Mean	35.5	23.4	56.7	77.5
Mode	35.0	29	1.6	1.1
Median	35.0	24.5	31.0	34.9
Range	14.0	21	453.8	530.8
Minimum	29.0	8	0.2	0.5
Maximum	43.0	29	454.0	531.3

Table iv: Analyzing Association between PCV and Serum Ferritin for Cases and Controls (using the Pearson Correlation Coefficient)

Anaemics (N = 178)		Non-anaemics (N = 178)	
Pearson Coefficient	Significance ($p<0.05$)	Pearson Coefficient	Significance ($p<0.05$)
-0.089	0.237	-0.101	0.182

variables were from a Continuous Data. The findings are shown in *Table iv.*

For the Cases, the Pearson Coefficient between the PCV and SF was found to be -0.089, with a p-value of 0.237. This shows a very weak, negative association which is not statistically significant. Similarly, for the Controls, the Pearson Coefficient between the PCV and SF was found to be -0.101, with a p-value of 0.182. This mirrors the statistics for the Cases, and also reflects a very weak, negative association, equally, with no statistical significance.

DISCUSSION

The results illustrated above have shown that among both anaemic and non-anaemic children aged from 2-59 months, values of PCV cannot predict the Serum Ferritin levels, and therefore it will not be wise to continue to use this as a basis for diagnosing iron deficiency as is currently the practice in some developing countries.

The study age group particularly the age 13 – 23 months has been shown to be at higher risk for iron deficiency anaemia in previous studies(Ekwochi et al, 2014). This could be as a result of imbalance between iron requirement and iron supply in this age group. The rapid growth and development which characterize this age places them on a higher metabolic and micronutrient demand including iron, the major component of the haemoglobin.

The mean SF level of the anaemic group is lower compared to that of the non anaemic group. Serum ferritin being a reliable tool in diagnosing iron deficiency, the finding supports the fact that iron deficiency is the commonest cause of anaemia in childhood (Tympa-Psirropoulous et al 2005). Similar findings have been documented by Khan et al in their study where they found a highly significant difference between the serum Ferritin levels of the normal and anaemic children (Khan et al, 2005).

Our study found a weak negative correlation between PCV and SF in both anaemic and non anaemicgroups. This finding is in keeping with that of a study done at Ibadan which found a negative correlation between the PCV and SF levels in children with malaria anaemia (Anumudu et al, 2006). Contrarily, Okpokam et al 2012, found a strong and significant correlation between the two parameters among adult male blood donors in Calabar, Nigeria. The observed difference could be caused by the age difference of the subjects of these studies. Moreover, PCV values have been shown to be affected (increased) by other factor like dehydration (emedicinehealth.com 2014) which is a common clinical condition in under-fives and was not ruled out in our study. These factors could lead to variation in the PCV values and ultimately affect its correlation with SF.

Serum Ferritin has been shown to be a more sensitive indicator of iron status compared to other parameters like serum iron, Total Iron Binding Capacity (TIBC) and transferring saturation (Khan et al, 2005). Therefore, it could be inferred that any parameter with a significant positive correlation with serum Ferritin could be a close substitute and a potential diagnostic tool for iron status.

Nevertheless, our study established a rather negative correlation signifying that PCV alone would not be a reliable tool for evaluation of iron status or screening for iron deficiency state.

CONCLUSION AND RECOMMENDATION

In summary, PCV cannot predict Serum Ferritin, both in children with anaemia and those without it. This study therefore faults the basis for using PCV as a tool for estimating iron-deficiency anaemia, and therefore recommends that such practices be reviewed in view of this. There is room for further studies to explore other possibilities that can effectively estimate iron-deficiencies, and we recommend that future studies explore this for use in resource-limited settings.

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