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Research Paper

Inter-Laboratory Analysis Of Some Blood Cell Parameters(Packed Cell Volume And Total White Cell Counts)In Some Private And Public Medical Laboratories In Yenagoa Bayelsa State, Nigeria

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***ABSTRACT**: Giving quality and reliable results is of utmost importance in Medical Laboratory Science to aid doctors give accurate and effective treatments to patients. Recent observations reveal that there might be issues in the reliability of test results from the public and private laboratories. Therefore this study was aimed at looking at the results on packed cell volume (PCV) and white cell count (WBC) from six public and private laboratories in Yenagoa metropolis in Bayelsa state Nigeria. A cross sectional study design was employed. Twenty (20) subjects selected by convenience sampling were used. In all laboratories PCV was done by the Microhaematocrit method, WBC was done manually by using the Turks solution and counting chamber. The results show that no two laboratories were able to give the same result. When analyzed, the results from the six laboratories revealed significant mean difference (P=0.000) for PCV and (P=0.000) for WBC. We recommend that training and re-training of medical Laboratory personnel be taken seriously and if possible made mandatory periodically and also the medical laboratory science council of Nigeria should also intensify their regulatory duties to both public and private laboratories.*

***KEYWORDS:** Blood cell parameters, Public/Private Laboratories, Packed Cell Volume, White Cell Count*

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I. INTRODUCTION

In the haematology laboratory, both accuracy and precision are maintained by internal quality control and perfected by external quality assessment schemes. Quality assessment is a system of observational and objective comparison of results from different private laboratories by means of proficiency testing organized by the laboratory agency [1, 2, 3]. Quality assessment is a set of practices carried out by laboratory staff which involves the continuous monitoring of operation and the result of measurement in order to decide whether results are reliable enough to be released [4]. Thus atolerable level of quality is necessary for ensuring that hematology laboratory results are reliable and would therefore require both internal quality assessment and external quality assessment [5, 6]. Turnaround time, Internal and External quality assessments are all indicators to monitor the value of a laboratory's performance [7, 8]. The Medical Laboratory Science Council of Nigeria in its guideline for opening Laboratories states that an 'Action plans for improvement shall be developed, documented and implemented, as appropriate. Laboratory management shall ensure that the laboratory participates in continual improvement activities that encompass relevant areas and outcomes of patient care [9]. Packed Cell Volume (PCV) is the percentage of the total volume of whole blood occupied by packed red blood cells after a known volume of whole blood is centrifuged at a constant speed for a constant period of time [10, 11, 12]White cell count (WBC) is the number of white cells in a cubic milliliter of blood [13]. All new WBC except for lymphocytes are produced in the bone marrow, most new lymphocytes are produced by colonies of

cells in lymphoid tissue such as lymph nodes [14]. It is also used to investigate HIV/AIDS infection and unexplained fever. WBC is also actively involved in the body's immune mechanism [4, 15, 16].

In Yenagoa, Bayelsa State of Nigeria,many laboratories were found to be operating manual system of PCV and WBC counting (either as a routine or when their automated machines fails). This study was thus aimed at assessing some routine haematological parameters (PCV and WBC) results in some public and Private Laboratories in Yenagoa, Bayelsa State to assess their state of accuracy and precision.

II. MATERIALS AND METHODS

This study was carried out in Yenagoa metropolis, at six different public and privately owned laboratories. The six laboratories were randomly picked. The authors obtained permission from the proprietors of the various facilities with an understanding not to disclose the identities of the facilities.

Subjects were drawn randomly from apparently healthy and sick persons in the metropolis. The study was conducted between January and March 2022. A total of twenty (20) persons ranging from the age of twenty one (21) to fifty three (53) years were used. Written consent was sought from all the participating individuals by giving a consent form before collecting their blood. Ethical approval was obtained from the Research and Ethics committee of the Research and Manpower Development Department of the Bayelsa State College of Health Technology.

Test Procedures; Ten (10ml) mls of blood was collected into an appropriate EDTA container and dispensed equally into six (6) plain containers, which were sent to the six different laboratories. For the purpose of this research, the team and its support staffs distributed the samples to the various laboratories immediately after collection. The longest time of arrival at the last laboratory from the time of collection was ten (20) minutes. Also, all two parameters were analyzed immediately after reception of samples at the various laboratories. There was no storage of sample before analysis. All six laboratories used the same reagents and test procedures for all tests.

White cell count: All four laboratories used the new improved Nebauer counting chamber and the Turks solution method.

Procedure; 0.38ml of diluting fluid was measured and dispensed into a small test tube. 0.02ml of well mixed anticoagulant blood was added to the tube and contents mixed properly. The counting chamber was cleaned and cover slip placed on it. The diluted blood sample was remixed and with the aid of a pasteur pipette held at an angle of about 45^0, one of the grids of the chamber was filled with the sample, taking care not to overfill the area. The chamber was left undisturbed for 2 minute to allow time for the white cells to settle. The underside of the chamber was dried and placed it on the microscope stage. White cells in the four large corner squares of the chamber marked w1 w2 w3 w4 were counted. Number of white cells per litre of blood was calculated and reported.

Packed cell volume: The micro-haematocrit method was used by all four laboratories.

Procedure; The blood in an EDTA container was mixed gently but thoroughly. A plain capillary tube is filled with blood by capillary action to 3 /4 full. Next, the dry end of the tube is sealed with a sealant. The tubes were placed in the radial grooves of the haematocrit centrifuge with the open ends towards the center and lid replaced. Centrifugation was for 5 minutes at 12,000 rpm. Centrifuge is allowed to stop on its own. The tube is removed and the haematocrit reader is used to read the PCV. [5, 10].

III. RESULTS

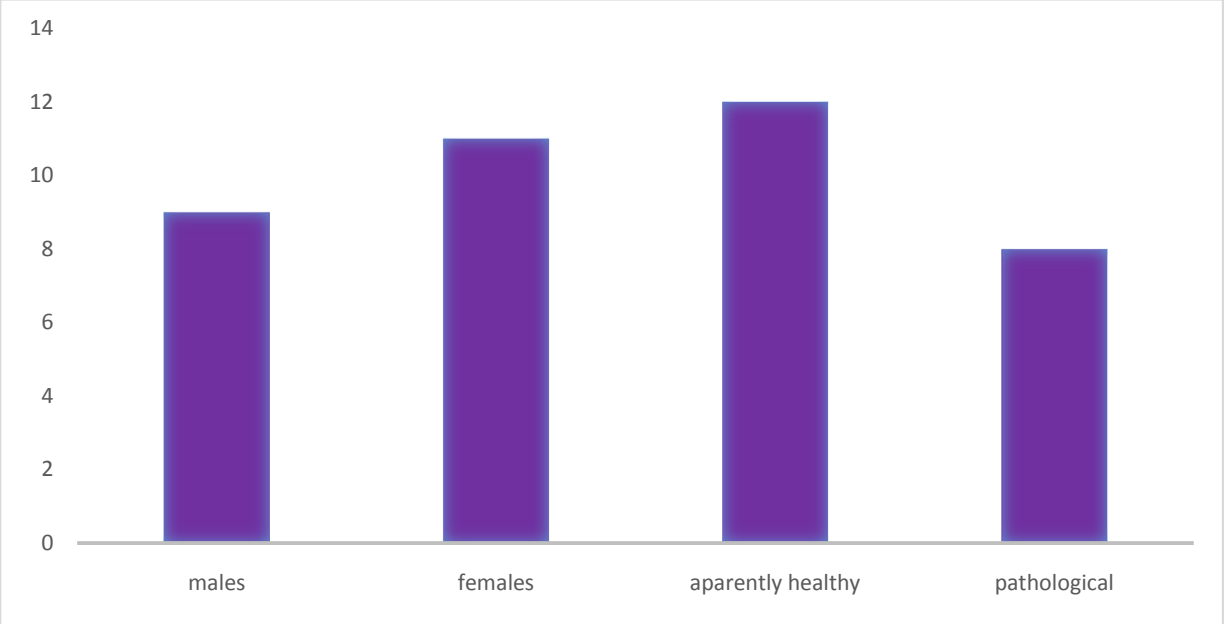

Figure 1 demographic details of subjects

The figure above tells that twenty subject were used in the study. Out of these, nine (9) were males while eleven (11) were females. Also out of the twenty samples collected, twelve (12) were from apparently healthy subjects while the rest eight (8) constituted samples collected from sick persons.

Table 1.are values of the Range and Mean results from the twenty samples analyzed for PCV and WBC in the six different laboratories. It is seen that for PCV sample 1 has a range of 25 – 47% and a mean value of 35.5% while sample 20 has a range of 27 – 40% and a mean value of 32.0%. For WBC, sample 1 range of values is 4.7 – 10.2 X 10^9/l and a mean value of 6.4 X 10^9/l while sample 20 has a range of 6.9 – 10.1 X 10^9/l and a mean value of 8.4.

Table 1. Range and mean results from samples.

	PCV (%)		**WBC (X 10^9/l)**	
Samples	**Range**	**Mean value**	**Range**	**Mean value**
1	**25 - 47**	**35.5**	**4.7 – 10.2**	**6.4**
2	**19 - 39**	**27.2**	**3.7 – 11.6**	**6.6**
3	**39 - 48**	**42.7**	**6.3 – 10.0**	**7.8**
4	**22 - 39**	**29.2**	**4.6 – 8.1**	**5.9**
5	**31 - 49**	**38.2**	**4.7 – 11.7**	**7.5**
6	**33 - 46**	**39.6**	**4.8 – 10.7**	**7.4**
7	**19 - 49**	**40.3**	**5.5 – 10.0**	**7.7**
8	**36 - 47**	**40.6**	**4.5 – 8.9**	**6.9**
9	**39 - 27**	**31.5**	**6.0 – 10.2**	**7.2**
10	**30 - 49**	**39.2**	**4.6 – 8.5**	**6.7**
11	**20 – 47**	**37.7**	**4.1 – 9.7**	**5.4**
12	**27 - 46**	**36.3**	**4.1 – 8.9**	**7.3**
13	**30 - 45**	**35.3**	**5.1 – 8.1**	**6.8**
14	**27 - 46**	**34.6**	**5.5 – 12.2**	**8.3**
15	**30 - 48**	**40.5**	**4.5 – 11.3**	**7.1**
16	**38 - 40**	**39.0**	**5.1 – 13.5**	**7.5**

17	**37 – 44**	**40.5**	**4.6 – 13.0**	**7.0**
18	**26 – 41**	**33.7**	**4.3 – 8.9**	**7.1**
19	**27 - 48**	**35.6**	**3.7 – 12.6**	**6.7**
20	**27 - 40**	**32.0**	**6.9 – 10.1**	**8.4**

Table 2 shows the Mean ± SD of measured parameters. For PCV%, Lab 1 had 35.25±6.61, 42.65 ± 5.77 for Lab 2, 33.10 ± 7.69 for Lab 3, 41.70 ± 5.66 for lab 4, 33.65± 6.24 for Lab 5 and 34.55 ±6.03 for LAB 6. When subjected to analysis (ANOVA) the F value is F=1.170 and P value was 0.000. For WBC 10^9 /l the Mean ± SD was 6.8 ± 1.33, 6.7 ± 2.09, 9.84 ± 2.07,6.6 ± 1.84, 5.67 ± 1.57 and 6.7 ± 1.79 for Labs. 1, 2, 3, 4, 5 and 6 respectively. Analysis (ANOVA) gave values of F=12.45 and P=0.000.

Table 2: Mean ± SD of PCV and WBC

parameter		**Lab 1**	**Lab 2**	**Lab 3**	**Lab 4**	**Lab 5**	**Lab 6**	**F,df**	**P value**
		n=20	**n=20**	**n=20**	**n=20**	**n=20**	**n=20**		
PCV	**Mean±SD**	**33.25 ± 6.61**	**42.65 ± 5.77**	**33.1 ± 7.69**	**41.70 ± 5.66**	**33.65 ± 6.24**	**34.55±6.03**	**9.74,5**	**0.000**
WBC	**Mean±SD**	**6.8±1.33**	**6.7±2.09**	**9.84±2.07**	**6.6±1.84**	**5.67±1.57**	**6.7 ± 1.79**	**12.44,5**	**0.000**

Key; PCV=Packed Cell Volume. WBC=White Cell Count. Lab. 1-6= Laboratories 1-6

The next table,Table.3 is the Post Hoc analysis of PCV and WBC values. In the first part of the table, the PCV results of the various laboratories were compared with one another. Eight (8) comparisons yielded statistically significant ($p<0.05$) results.They are; Labs. 1 vs 2 (33.25 ± 6.61 vs42.65±5.77) p=0.001, 1 vs 4 (33.25 ± 6.61 vs 41.70 ± 5.66) p=0.005, 2 vs 3 (42.65 ± 5.77 vs 33.1 ± 7.69) p=0.001, 2 vs 5 (42.65 ± 5.77 vs 33.65 ± 6.24), p=0.002, 2 vs 6 (42.65 ± 5.77 vs 34.5 ±6.03), p=0.009, 3 vs 4 (33.1 ± 7.69 vs 41.70 ± 5.66), p=0.004, 4 vs 5 (41.70 ± 5.66 vs 33.65 ± 6.24), p=0.010 and 4 vs 6 (41.70 ± 5.66 vs 34.5 ±6.03), p=0.034. The other comparisons are Labs. 1 vs 3 (.25 ± 6.61 vs 33.1 ± 7.69), p=1.000. 1 vs 5 (33.25 ± 6.61 vs 33.65 ± 6.24), p=1.000, 1 vs 6 (33.25 ± 6.61 vs 34.5 ±6.03), p=0.999, 2 vs 5 (33.1 ± 7.69 vs 33.65 ± 6.24), p=1.000, 3 vs 6 (33.1 ± 7.69 vs 34.5 ±6.03), 0.991 and 5 vs 6 (33.65 ± 6.24 vs 34.5 ±6.03), 0.999.

The second part of table 2 is the post –hoc analysis of WBC results for the six laboratories. The comparisons that gave significant p values ($p<0.05$) are Labs. 1 vs 3, p=0.000, 2 vs 3, p=0.000, 3 vs 4 p=0.000, 3 vs 5, p=0.000 and 3 vs 6, p=0.000. The rest gave p values of $p>0.05$. They are Labs. 1 vs 2, 1 vs 4, 1 vs 5, 1 vs 6, 2 vs 4, 2 vs 5, 1 vs 6, 4 vs 5, 4 vs 6 and 5 vs 6 with p values of 1.000, 1.000, 0.564, 1.000, 1.000, 0.579, 1.000, 0.744, 1.000 and 0.638 respectively.

Table 3. Post Hoc analysis of PCV and WBC values

Parameter		**PCV**	**P value**	**WBC**	**P value**
		n=20		**n=20**	
1 vs 2	**Mean±SD**	**33.25 ± 6.61 vs42.65±5.77**	**0.001**	**6.8 ± 1.33 vs 6.7 ± 2.09**	**1.000**
1 vs 3	**Mean±SD**	**33.25 ± 6.61 vs 33.1 ± 7.69**	**1.000**	**6.8 ± 1.33 vs 9.84 ± 2.07**	**0.000**
1 vs 4	**Mean±SD**	**33.25 ± 6.61 vs 41.70 ± 5.66**	**0.005**	**6.8 ± 1.33 vs 6.6 ± 1.84**	**1.000**
1 vs 5	**Mean±SD**	**33.25 ± 6.61 vs 33.65 ± 6.24**	**1.000**	**6.8 ± 1.33 vs 5.67 ± 1.57**	**0.564**
1 vs 6	**Mean±SD**	**33.25 ± 6.61 vs 34.5 ±6.03**	**0.995**	**6.8 ± 1.33 vs 6.7 ± 1.79**	**1.000**
2 vs 3	**Mean±SD**	**42.65 ± 5.77 vs 33.1 ± 7.69**	**0.001**	**6.7 ± 2.09 vs 9.84 ± 2.07**	**0.000**
2 vs 4	**Mean±SD**	**42.65 ± 5.77 vs 41.70 ± 5.66**	**0.999**	**6.7 ± 2.09 vs 6.6 ± 1.84**	**1.000**
2 vs 5	**Mean±SD**	**42.65 ± 5.77 vs 33.65 ± 6.24**	**0.002**	**6.7 ± 2.09 vs 5.67 ± 1.57**	**0.579**
2 vs 6	**Mean±SD**	**42.65 ± 5.77 vs 34.5 ±6.03**	**0.009**	**6.7 ± 2.09 vs 6.7 ± 1.79**	**1.000**
3 vs 4	**Mean±SD**	**33.1 ± 7.69 vs 41.70 ± 5.66**	**0.004**	**9.84 ± 2.07 vs 6.6 ± 1.84**	**0.000**
3 vs 5	**Mean±SD**	**33.1 ± 7.69 vs 33.65 ± 6.24**	**1.000**	**9.84 ± 2.07 vs 5.67 ± 1.57**	**0.000**
3 vs 6	**Mean±SD**	**33.1 ± 7.69 vs 34.5 ±6.03**	**0.991**	**9.84 ± 2.07 vs 6.7 ± 1.79**	**0.000**
4 vs 5	**Mean±SD**	**41.70 ± 5.66 vs 33.65 ± 6.24**	**0.010**	**6.6 ± 1.84 vs 5.67 ± 1.57**	**0.744**
4 vs 6	**Mean±SD**	**41.70 ± 5.66 vs 34.5 ±6.03**	**0.034**	**6.6 ± 1.84 ± vs 6.7 ± 1.79**	**1.000**

5 vs 6	**Mean±SD**	**33.65 ± 6.24 vs 34.5 ±6.03**	**0.999**	**5.67 ± 1.57VS 6.7 ± 1.79**	**0.638**

Key; PCV=Packed Cell Volume. WBC=White Cell Count.. 1-6= Laboratories 1-6

Table 4 gives the values when PCV and WBC results are compared between public and private laboratories. For PCV (**36.13± 7.78 vs 36.63± 6.91**) gives a t value of t= -0.379 and a p value of p= 0.710. That of WBC is (**7.81 ±2.33 vs 6.34 ± 1.78**) giving a t value of t =3.890 and a p value of p= 0.000

Table 4. Comparison of PCV and WBC values of public and private Labs,

Parameter	Public Lab	Private Lab	t,df	P value
	n=60	**n=60**		
PCV	**36.13± 7.78**	**36.63± 6.91**	**-0.379,118**	**0.710**
WBC	**7.81 ±2.33**	**6.34 ± 1.78**	**3.89,118**	**0.000**

Key; PCV=Packed Cell Volume. WBC=White Cell Count.

IV. DISCUSSION

The accuracy and precision of laboratory results are vital in the haematology laboratory and an acceptable level of quality control is therefore necessary to ensure that such laboratory results are trustworthy [5]. And so these results may not be considered reliable if there are many differences in values for a particular test results in different laboratories for a single patient. The results indicate that for PCV there were differences of up to 20% using the same person sample (e.g. sample 1) and for WBC a difference of up to 8.4 X 10^9/l (e.g. sample 16) for the same test across the six different laboratories. This disparity of results is evident when mean values were compared among the various laboratories; when subjected to ANOVA test, they all revealed a significant value (F=9.74, P=0.0.000 for PCV and F= 12.44, p= 0.000 for WBC).

Table 3 presents the post-Hoc analysis. In the fifteen comparison between the laboratories,there were eight (8) significant results (P<0.05) and seven insignificant (p>0.05) results for PCV. While for that of WBC, there were five (5) significant results (p<0.05) and ten (10) insignificant (p>0.05) results. When divided into public and private laboratories, insignificant p value was obtained for PCV (p= 0.710) while a significant P value (p=0.000) was obtained for WBC.

The reason for these inaccurate resultsamong laboratories might not be farfetched. It could be one, as a result of faulty facility equipments. In our third world country where finances are always inadequate, it might be that the equipments are not well maintained or serviced or old and needs to be replaced. The equipments used here are the Microhaematocrit centrifuge for PCV and the New improved Nebauer Counting Chamber for WBC. An old ill- maintained counting chamber can become permanently stained and lead to false higher WBC counts. The U S national council on research opined that when you own a lab, you know it is crucial to keep your equipment and facility clean and maintained for your experiments to turn out accurate and reliable. For most science experiments, getting precise measurements is critical. Failure to maintain your facility and your equipment can derail an entire scientific study [17].

Also, in the dynamic nature of our world and profession, training and re-training of staffs is very very essential for optimum performance. These might be lacking hence the observed discrepancies in the results.

Another thing that might contribute to the observed anomaly is improper handling of the sample. Using heparinized capillary tube for anticoagulated sample and improper sealing of the tube are some reasons that can result to inaccurate results for PCV. Also the measurement of diluentsand pipetting of blood if not properly done can alter the outcome of WBC results. Lugos *et al*., 2018 [18] also found inaccuracy in a similar research in Nothern Nigeria. Implementation of External Quality Assesment scheme is of utmost importance [19]

However the above mentioned problems are not expected to occur in the medical laboratory or at worse should be minimized owing to sanctity of human life we deal with.

V. CONCLUSION

From the results gotten it is clear that no two laboratories could produce the same result from the same specimen. It implies that different medical personnel would handle this same patient differently because of these results. We recommend that training and re-training of medical laboratory personnel be taken seriously and if possible made mandatory periodically. The medical laboratory science council of Nigeria should intensify their regulatory duties to public and private laboratories.

COMPETING INTEREST: We the authors declare that there are no competing interests existing in this work.

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