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# Comparative Study of Haematological Values Using Manual and Automated Techniques in Apparently Healthy Adult Nigerians.

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## ABSTRACT

***Background:*** *Many public medical laboratories use automated techniques for analysis of samples due to the few number of laboratory staff required and the speed at which it operates. This study was carried out to compare haematological values obtained from automated techniques and manual techniques.*

***Method:*** *A total of 86 apparently healthy adult Nigerians, aged 18-50 years comprising 50 males and 36 females who came for medical examination between June, 2004 and May, 2005 at Aminu Kano Teaching Hospital, Kano were used for the study. Standard manual methods and cell-dyn® 3700cs system techniques were used to determine haematocrit, total and differential leucocyte counts.*

***Results:*** *Statistically significant differences were found between automated and manual techniques in males with regard to haematocrit levels, total white cell counts, differential monocyte and basophil counts (0.45 ± 0.03l/l, 5.1 ± 1.9 x $10^9$/l, 0.54 ± 0.19 x $10^9$/l and 0.11 ± 0.08 x $10^9$/l respectively) for automation and 0.42 ± 0.04l/l, 4.4 ± 1.4 x $10^9$/l, 0.05 ± 0.06 x $10^9$/l and 0.004 ± 0.013 x $10^9$/l respectively for manual methods at P<0.001, P<0.05, P<0.001 and P<0.001 respectively while there were no significant differences in differential neutrophil, lymphocyte and eosinophil counts (2.1 ± 0.7 x $10^9$/l, 2.2 ± 0.7 x $10^9$/l and 0.14 ± 0.16 x $10^9$/l respectively) of the automation when compared to 2.1 ± 0.5 x $10^9$/l, 2.1 ± 0.5 x $10^9$/l and 0.09 ± 0.09 x $10^9$/l respectively using manual methods (P>0.05). There were no statistically significant differences between automated and manual methods in females with regard to total white cell count, differential neutrophil, lymphocyte and eosinophil counts (5.8 ± 2.3 x $10^9$/l, 2.6 ± 0.9 x $10^9$/l, 2.4 ± 0.8 x $10^9$/l and 0.1 ± 0.1 x $10^9$/l respectively) of the automation when compared to 4.9 ± 1.6 x $10^9$/l, 2.5 ± 0.7 x $10^9$/l, 2.3 ± 0.6 x $10^9$/l and 0.06 ± 0.09 x $10^9$/l respectively of manual techniques (P>0.05) while significant differences were observed in haematocrit, differential monocyte and basophil counts (0.39 ± 0.03l/l, 0.55 ± 0.3 x $10^9$/l and 0.1 ± 0.09 x $10^9$/l respectively) of automation when compared to 0.37 ± 0.03l/l, 0.03 ± 0.04 x $10^9$/l and 0.002 ± 0.01 x $10^9$/l respectively of the manual methods at P<0.01, P<0.001 and P<0.001 respectively.*

***Conclusion:*** *The results have proven that differential monocyte and basophil counts from automation are unreliable and efforts should be made to carry out manual differential counts for confirmation.*

***KEYWORDS:*** *Haematological values; manual and automated techniques.*

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## INTRODUCTION

The concept of counting blood cells automatically began in the mid-1930s with a report discussing a photoelectric method for counting cells passing through a capillary tube using darkfield optics[1]. In the late 1940s and early 1950s, two instruments were introduced and the first one was the modification of the original capillary method using darkfield optics while the second instrument was based on a completely new monoptical principle of cell counting through electrical gating or electrical impedance[2,3]. In the early 1970s, two different techniques for automating differentials were refined sufficiently to be acceptable for clinical laboratory use and the principle of one is based on detecting cell images electronically and interpreting them with a computer programmed with descriptions while the other is based on light scatter and cytochemical staining for the identification of leucocytes[4]. The development of the automated haematology analyzer has been continuous with each step increasing the number of tests performed simultaneously, increasing the speed and decreasing the required sample volume[4,5].

Manual semi-automated or automated techniques can be used to determine the various elements of the full blood counts. Manual techniques are generally of low cost with regard to equipment and reagents but are labour intensive while automated techniques entail high capital costs but permit rapid performance of large number of counts by a small number of laboratory workers[5]. However, automated techniques are not designed to identify immature cells or other abnormal features of morphology such as toxic granulations, blast forms which can be categorized as between lymphocytes and monocytes while increased number of eosinophils may blend with other granulocytes or fall between monocytes and granulocytes[4,5].

Many laboratories now use automated

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techniques exclusively but manual techniques remain the basis of haematological practice[5].

The aim of this study is to determine if there are significant differences between automated and manual haematological values since most of the public medical laboratories use automation for the analysis of samples and the results are interpreted based on the reference values from the manual methods.

## MATERIALS & METHODS

Subjects for this study were selected from apparently healthy adults who came for medical examination between June, 2004 and May, 2005 at Aminu Kano Teaching Hospital, Kano. A total of 86 subjects (50 males and 36 females) were used for this study, aged 18-50 years. Venous blood was collected from each subject into dipotassium ethylene diamine tetra-acetic acid ($K_2$ EDTA) containers and properly mixed with the anticoagulant. Standard manual techniques[5] were employed in the estimation of haematocrit (PCV), total and differential leucocyte counts while cell-dyn® 3700CS analyzer was calibrated and its techniques were used to estimate haematocrit, total and differential counts[6]. Day to day verification of the system calibration was performed using cell-dyn controls.

Means of haematological values were compared using student's t-test and a P-value of below 0.05 was considered significant.

## RESULTS

Tables I and II show results of comparative studies of packed cell volumes, total and differential white blood cell counts using automated and manual techniques in males and females respectively. The difference in differential neutrophil, lymphocyte and eosinophil counts in males were not statistically significant (P>0.05) while significant differences were found in haematocrit (PCV), total white cell count, differential monocyte and basophil counts (P<0.001, P<0.05, P<0.001 and P<0.001 respectively) in Table I. Table II shows no statistically significant differences in total white cell count, differential neutrophil, lymphocyte and eosinophil counts in females (P>0.05) while the differences in haematocrit, differential monocyte and basophil counts were statistically significant (P<0.01, P<0.001 and P<0.001 respectively). Table III shows the comparison of male and female haematological values using automation. The differences in total white cell count, differential lymphocyte, monocyte, eosinophil and basophil counts were not statistically significant (P>0.05) while haematocrit and differential neutrophil count were statistically significant (P<0.001 and P>0.01 respectively). Table IV shows the comparison of male and female haematological values using manual methods. The differences in total white cell count, differential lymphocyte, monocyte, eosinophil and basophil counts were not statistically significant (P>0.05) while differences in haematocrit and differential neutrophil count were statistically significant (P<0.001 and P<0.01 respectively).

**Table I. Comparison of haematological values between automated and manual techniques in males.**

| Haematological Parameter | Automation (n = 50) | Manual (n = 50) | |
|---|---|---|---|
| PCV (l/l) | 0.45 ± 0.03 | 0.42 ± 0.04 | <0.001 |
| TOTAL WBC x $10^9$/l | 5.1 ± 1.9 | 4.4 ± 1.4 | <0.05 |
| NEUTROPHILS x $10^9$/ | 2.1 ± 0.7 | 2.1 ± 0.5 | >0.05 |
| LYMPHOCYTES x $10^9$/ | 2.2 ± 0.7 | 2.1 ± 0.5 | >0.05 |
| MONOCYTES x $10^9$/ | 0.54 ± 0.19 | 0.05 ± 0.6 | <0.001 |
| EOSINOPHILS x $10^9$/ | 0.14 ± 0.16 | 0.09 ± 0.00 | >0.05 |
| BASOPHILS x $10^9$/ | 0.11 ± 0.08 | 0.004 ± 0.09 | <0.001 |

n = number of subjects

**Table II. Comparison of haematological values between automated and manual techniques in females**

| Haematological Parameter | Automation (n = 50) | Manual (n = 50) | p-vale |
|---|---|---|---|
| PCV (l/l) | 0.39 ± 0.03 | 0.37 ± 0.03 | <0.01 |
| TOTAL WBC x $10^9$/l | 5.8 ± 2.3 | 4.9 ± 1.6 | >0.05 |
| NEUTROPHILS x $10^9$/ | 2.6 ± 0.9 | 2.5 ± 0.7 | >0.05 |
| LYMPHOCYTES x $10^9$/ | 2.4 ± 0.8 | 2.3 ± 0.6 | >0.05 |
| MONOCYTES x $10^9$/ | 0.55 ± 0.3 | 0.03 ± 0.04 | <0.001 |
| EOSINOPHILS x $10^9$/ | 0.1 ± 0.1 | 0.06 ± 0.09 | >0.05 |
| BASOPHILS x $10^9$/ | 0.1 ± 0.09 | 0.002 ± 0.01 | <0.001 |

n = number of subjects

**Table III. Comparison between male and female haematological values using automation**

| Haematological Parameter | Automation (n = 50) | Manual (n = 50) | p-vale |
|---|---|---|---|
| PCV (l/l) | 0.45 ± 0.03 | 0.39 ± 0.03 | <0.001 |
| TOTAL WBC x $10^9$/l | 5.1 ± 1.9 | 5.8 ± 2.3 | >0.05 |
| NEUTROPHILS x $10^9$/ | 2.1 ± 0.7 | 2.6 ± 0.9 | <0.01 |
| LYMPHOCYTES x $10^9$/ | 2.2 ± 0.7 | 2.4 ± 0.8 | >0.05 |
| MONOCYTES x $10^9$/ | 0.54 ± 0.19 | 0.55 ± 0.3 | >0.05 |
| EOSINOPHILS x $10^9$/ | 0.14 ± 0.16 | 0.1 ± 0.1 | >0.05 |
| BASOPHILS x $10^9$/ | 0.11 ± 0.08 | 0.1 ± 0.09 | >0.05 |

n = number of subjects

**Table IV. Comparison between male and female haematological values using manual techniques**

| Haematological Parameter | Automation (n = 50) | Manual (n = 50) | p-vale |
|---|---|---|---|
| PCV (l/l) | 0.42 ± 0.04 | 0.37 ± 0.03 | <0.001 |
| TOTAL WBC x $10^9$/l | 4.4 ± 1.4 | 4.9 ± 1.6 | >0.05 |
| NEUTROPHILS x $10^9$/ | 2.1 ± 0.5 | 2.5 ± 0.7 | <0.01 |
| LYMPHOCYTES x $10^9$/ | 2.1 ± 0.5 | 2.3 ± 0.6 | >0.05 |
| MONOCYTES x $10^9$/ | 0.05 ± 0.06 | 0.03 ± 0.4 | >0.05 |
| EOSINOPHILS x $10^9$/ | 0.09 ± 0.09 | 0.06± 0.09 | >0.05 |
| BASOPHILS x $10^9$/ | 0.004 ± 0.01 | 0.002 ± 0.01 | >0.05 |

n = number of subjects

## DISCUSSION

The study was aimed at comparing haematological values obtained from apparently healthy adult Nigerians who came for medical examination using manual and automated techniques.

The study shows lower values of haematocrit, total white cell count in manual techniques in both sexes (Tables I & II).

Dacie et al[5] reported that automation had little connection with packing of red cells coupled with the effect of cold agglutinins which justify lower values of haematocrit in both sexes.

Total leucocyte counts had ranges of $4.4\pm1.4x10^9$/l and $4.9\pm1.6x10^9$/l for males and females respectively. These results are in agreement with reports made on haematological values by previous authors in Nigeria[7,8,9]. However, the differences observed in total white cell counts in both sexes when automated techniques were compared to manual methods could be due to counting of residual particles in a diluted blood sample in addition to white cells after red cell lysis[5].

Significant differences in this study in differential monocyte and basophil counts between automated and manual techniques could be due to inability of the automated techniques to identify abnormal features of morphology which make white cells to be categorized as between lymphocytes and monocytes while increased number of eosinophils may blend with other granulocytes or fall between monocytes and granulocytes[4,5].

Ranges of $0.42\pm0.04$l/l, $4.4\pm1.4x10^9$/l, $2.1\pm0.5x10^9$/l, $2.1\pm0.5x10^9$/l, $0.05\pm0.06x10^9$/l, $0.09\pm0.09x10^9$/l and $0.004\pm0.01x10^9$/l for PCV, total white blood cell count, differential neutrophil, lymphocyte, monocyte, eosinophil and basophil counts respectively in males and $0.37\pm0.03$l/l, $4.9\pm1.6x10^9$/l, $2.5\pm0.7x10^9$/l, $2.3\pm0.6x10^9$/l, $0.03\pm0.04x10^9$/l, $0.06\pm0.09x10^9$/l, and $0.002\pm0.01x10^9$/l respectively in females were found using manual methods. The findings are consistent with the previous findings in haematological values in Northern Nigeria[9].

In conclusion, many medical laboratories in the world now use automated techniques which entail high capital costs but have the ability to analyse large number of samples within few minutes and with few number of laboratory staff unlike manual techniques which can be carried out with low cost regarding equipment and reagents but labour intensive. Upon the mentioned advantages of automated techniques, it is advisable to carry out manual differential counts for confirmation since automation has proven to be unreliable most especially with differential monocyte and basophil counts due to poor differentiation of white cells.

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