Original Research Article

Effect of Socioeconomic Status on Haematological Indices in Port Harcourt

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Abstract: *Background*: The World Health Organization is saddled with the responsibilities of regulating health care services across the globe and had over the years provided reference values to various medical parameters for clinicians and medical research. However, due to socio-economic variations amidst different populations in various parts of the world, the standard reference values had significantly differed among different races, tribes, gender and socio-economic backgrounds. Consequently, several regions of the world now had their respective local medical references. Back home in Nigeria and Port Harcourt in particular, over-reliance on this WHO references still prevail as a result of the absence of our local reference data. To this end, this study therefore investigates the Effect of Socioeconomic Status on Haematological Indices in Port Harcourt Nigeria. *Materials and Methods*: A total of 112 participants across 3 different socio-economic classes (Upper, Middle and Lower Classes) were recruited into the study using well-structured questionnaires based on purposive non-probability sampling techniques. Blood samples were also aspirated and analysed for haematological parameters (Hb, PCV, RBC, WBC, Platelets) against their socio-economic variables (gender, level education, income level and nutritional intakes). *Results and Discussions*: Result from the study showed that both male and female haematological parameters were significantly ($\rho \leq 0.05$) different from the WHO reference. Significant difference in low and high level education was also noted among the educational group whereas the middle class education was not. The income level among the 3 economic classes and their nutritional groups were also significant ($\rho \leq 0.05$) whereas those on balanced diets were not. *Conclusion*: The study therefore concluded that gender, income, education and nutrition of the people of Port Harcourt significantly ($\rho \leq 0.05$) affected their haematological parameters as compared with the global WHO Standards.
Keywords: Hb, PCV, RBC, WBC, Platelets.

INTRODUCTION

Background to the Study

Different researches had over time showed a correlation between haematololgical parameters and socioeconomic status. Hackett *et al.,* (2021) concluded that Socioeconomic status (SES) is recognized as a major contributor to health disparities in overall disease rate, morbidity, mortality, and quality of life. The further stated that low SES independent of race, has a negative impact on solid and haematologic outcomes. Haematological components, which consist of red blood cells, white blood cells or leucocytes, mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration are valuable in monitoring the effect of socioeconomic status (Oyawoye & Ogunkunle, 2004).

Haematology relate to blood and blood forming processes its analysis involves the determination of the various blood parameters of erythrocytes (red blood cells), leucocytes (white blood cells WBC), platelets. Determination of haematological indices is used in the assessment of clinical entities related to the oncology (Dezayee *et al.,* 2016).

The body contains about 5 to 6 quarts (about 5 liters) of blood. Once blood is pumped out of the heart, it takes 20 to 30 seconds to make a complete trip through the circulation and return to the heart. Blood performs various essential functions as it circulates through the body. It delivers oxygen and essential nutrients (such as sugars, minerals, and vitamins) to the body's tissues. It carries carbon dioxide to the lungs and other waste

products to the kidneys for elimination from the body. It transports hormones (chemical messengers) to allow various parts of the body to communicate with each other. Also, it carries components that fight infection and stop bleeding (Sarode, 2021).

Socio-Economic Status (SES) measures family economic and social position in relation to others, based on various variables responsible for social and economic development (Zafer, *et al.,* 2015). Generally, socioeconomic status can be seen as a hypothetical construct and is measured using a combined parameter of education, health, poverty, income and consumption. SES affects education, health seeking behavior, feeding, income, life style amongst others (Baker & Gibson 2014).

Normal blood level which can serve as an indicator of physiological functioning represent a critical link for understanding the relationship between Socio-economic Status (SES) because they can reveal common biological pathways between health and SES. Studies have argued that individuals of low SES have a higher prevalence of sub-clinical markers of disease risk (Kohler *et al.,* 2013). Individuals with lower education, occupational position and income level have a decreased life expectancy and suffers more often from acute t chronic diseases compared with individuals with more favorable socioeconomic status (Rieger *et al.,* 2017). According to Kim, *et al.,* (2013), the relationship between socioeconomic status and low blood cells prevalence in adolescent girls in Korea, Asia was significantly decreased with the prevalence of low blood cells in the adolescent of higher SES which was adduced to be a result of more intake of iron and vitamin C among the higher SES. This indicates a relationship between blood and nutrition. Low SES is associated with abnormal increase in blood volume and pressure and this was linked with the poor level of education on health management (Leng *et al.,* 2015). Another study carried out by (Rieger *et al.,* 2017) in Germany, Europe on the physiologic distribution of blood parameter of children of different socioeconomic group, comparing their iron related blood parameter (haemoglobin, ferritin and transferrin) noted an increase in the haemoglobin level and decrease in transferrin level of children of higher SES. This indicates a difference in the blood parameter of the different SES. Influence of socioeconomic status on the whole blood transcriptome in African-Americans'

results revealed that people of lower SES were prone to some disease conditions (Gaye *et al.,* 2017). In Nigeria, SES has been said to have a significant relationship with blood metabolism and its component or parameters (Adedoyin *et al.,* 2013). Poor socioeconomic status had showed an adverse effect on the nutritional status and hemoglobin level (Animasahun *et al.,* 2011). Although these studies had showed significant relationship between socioeconomic status and blood related health disorders in different parts of the world; there is however not any study done or established reference local values of haematological parameters in their different socioeconomic groups in Port Harcourt, Rivers State Nigeria. This study thus aimed at investigating the effect of Socio-economic variables on haematological Indices in Port Harcourt. The effect of level of income, level of education and nutritional status on haematological indices were carefully examined. Furthermore, this study examined possible relationship between gender and haematological parameters and findings were compared with the WHO standards.

MATERIAL AND METHODS

Study Area
The Area of the Study was Port Harcourt, the capital city of Rivers State, Nigeria. Both the structured questionnaire and the blood samples collection for haematological investigations were all carried out on participants in the same city. The bench work for haematological investigations was done at the Laboratory Unit of the Department of Human Physiology, Faculty of Basic Medical Sciences, College of Medical Sciences, Rivers State University, Port Harcourt, Nigeria.

Population of the Study
The population used in this study comprised of apparently healthy male and female volunteers of different socioeconomic classes in Port Harcourt. A total of 118 participants of 3 socio-economic classes was recruited into the study. On the other hand, patient with HIV/AIDS, pregnant women, chronic diseases and individuals below the age of 16 were excluded from the research. Also, individuals above 50 years were not engaged in the study.

Research Design

Table 1: Tabular Summary of Research Design

Socio-Economic variables	Sub-Groups (N = 118)	Hb (g%)	PCV (%)	RBC Count (m/mm³)	WBC Count (cmm)	Platelets (cmm)
WHO Reference	Control					
Gender	Male (53)					
	Female (65)					
Education	FSLC/SSCE					
	NCE/ND/ HND/BSc					
	PG					
Income	Lower Class (<100,000)					

Socio-Economic variables	Sub-Groups (N = 118)	Hb (g%)	PCV (%)	RBC Count (m/mm³)	WBC Count (cmm)	Platelets (cmm)
	Middle Class (101,000-300,000)					
	Upper Class (>301,000)					
Nutrition	Carbohydrate					
	Proteins					
	Vitamins/Minerals					
	Balanced Diet					

Table 1 above is the summary of design that was undertaken in this study of effect of socio-economic status on haematological indices in Port Harcourt, Rivers State, Nigeria. The study recruited 118 participants of various socio-economic status with male participants constituting 53 while the females making up the other 65. Group 1 was the globally established values by the World Health Organizations and was made the Control Group. Group 2 to 5 was the experimental groups of 4 socio-economic variables: Group 2 compared the gender difference with haematological indices in Port Harcourt, Group 3 examined the level of education with haematological indices, Group 4 investigated the possible effect of income level on haematological indices while Group 5 explained possible relationship between level of nutrition with haematological indices in Port Harcourt.

Sample and Sampling Techniques

The sample size was a total number of 118 participants from the three socioeconomic groups of which 34 belonged to upper class, 38 middle class and 46 lower class. Sampling techniques used for questionnaire administration was purposive non probability sampling technique also known as judgmental sampling technique. The technique defines a deliberate or purposive selection of respondent base specific desirable characteristics such as their various socio-economic classes. The reason for this choice of sampling technique was to ensure that members of all

SES and their haematological relationship were represented in the study for analysis and comparison.

Ethical Consideration

The Letter of Introduction was taken from my Head of Department, Human Physiology. Consent of participants was sought after while presenting the letter of Introduction. All procedures were done in consonant with the ethical standards of the Rivers State University for the use of human volunteers in research. The ethical clearance is presented at Appendix III on page 62 of this research.

Data/Statistical Analysis

All data were analyzed using Statistical Package for Social Sciences (SPSS) version 23.0 and also the Post-hoc test.

RESULTS

Result and Analysis

Findings from this research are presented in this chapter. The analysis includes the statistical presentation of normal haematological parameters among socio-economic classes in Port Harcourt. The analysis also showed comparison between haematological parameters and each of SES indicators including gender, nutrition, level of education and level of income. Multiple comparison of various result for statistical significance are all presented in this chapter.

Table 2: Haematological Indices and Gender Relationship

Gender	N (118)	PCV (%)	Hb (g%)	RBC Count (m/mm³)	WBC Count (cmm)	Platelets (cmm)
Group 1 (Male Control)		46.00±0.00	16.00±0.00	5.40±0.00	7550.00±0.00	275000.00±0.00
Group 2 (Females Control)		42.00±0.00	13.60±0.00	4.80±0.00	7750.00±0.00	264000.00±0.00
Group 3 (Males)	53	42.67±5.31*	14.63± 3.13*	5.11± 0.20*	6289.12± 11.89*	281333.14±189.31
Group 4 (Females)	65	37.21 ±4.23*	11.21 ± 2.41*	3.98± 1.31*	6669.08± 22.31*	271102± 301.20*

Result figures are expressed in Mean ± SEM. * represent values that are statistically significant upon comparison with the control. The mean difference is significant (ρ) at 0.05 level

Table 2 provide the statistical result obtained from haematological indices and gender relationship. Group 1 and 2 are the controls group for males and

female respectively, gotten from the WHO standard while Group 3 and 4 are the males and females from the study research respectively. The results of Group 3 (males) were compared with Group 1 (male control) while the results of Group 4 (females) were compared with Group 2 (female control).

From the table, Group 1 (male control) in the various haematological parameters [PCV (%), Hb Conc. (g%), RBC Count (m/mm^3), WBC count (cmm) and Platelet Count (cmm)] showed 46.00±0.00, 16.00±0.00, 5.40±0.00, 7550.00±0.00 and 275000.00±0.00 respectively.

Group 3 showed significant statistics of 42.67±5.31*, 14.63±3.13*, 5.11±0.20* 6289.12±11.89* and 281333.14±189.31 for haematological parameters of PCV (%), Hb Conc. (g%), RBC Count (m/mm^3), WBC count (cmm) and platelets respectively.

From the table, Group 2 (female control) in the various haematological parameters [PCV (%), Hb Conc. (g%), RBC Count (m/mm^3), WBC count (cmm) and Platelet Count (cmm)] showed 42.00±0.00, 13.60±0.00, 4.80±0.00, 7750.00±0.00 and 264000.00±0.00 respectively.

Group 4 showed significant statistics of 37.21±4.23*, 11.21 ± 2.41*, 3.89± 1.31*, 6669.08±22.31* and 271102± 301.20* for haematological parameters of PCV (%), Hb Conc. (g%), RBC Count (m/mm^3), WBC count (cmm) and Platelet Count (cmm).

Table 3: Haematological indices and educational level relationship

Level of Education	N (118)	PCV (%)	Hb (g%)	RBC Count (m/mm^3)	WBC Count (cmm)	Platelets (cmm)
Control (WHO Reference)		43.00± 0.00	15.50± 0.00	5.05± 0.00	7550.00±0.00	275000.00± 0.00
Low Level (Prim/Sec)	38	39.12± 3.15*	12.17± 0.30*	4.12± 0.27*	6114.21± 110.12*	272368.42±101.11
Middle Level (Diploma/HND/First Degree)	41	43.10± 0.00	15.20± 3.11	5.00± 0.00	7954.60± 262.44*	274000.00± 122.08
High Level (MSc & PhD)	39	43.24± 6.22	16.00± 1.01*	5.10± 0.14	6615.54± 273.10*	272192.12± 279.33

Result figures are expressed in Mean ± SEM. * represent values that are statistically significant upon comparison with the control. The mean difference is significant (ρ) at 0.05 level

Table 3 showed the statistical result obtained from haematological indices and level of education relationship. The haematological parameters studied are PCV (%), Hb Concentration (g%), RBC Count (m/mm^3), WBC count (cmm) and Platelet Count (cmm). Group 1 is the control used to compare with Group 2(Prim/Sec), Group 3(Diploma/HND/ NCE/ First Degree) and Group 4(Post Graduate) respectively.

From the table, the PCV results obtained are 43.00± 0.00 for Group 1 (control), 39.12± 3.15* for Group 2(Prim/Sec), 43.10± 0.00 for Group 3 (Diploma/HND/ NCE/ First Degree) and 43.24± 6.22 for Group 4(Post Graduate), in comparison with WHO standard, 43.00± 0.00 with39.12± 3.15* and 43.00± 0.00 with 43.10± 0.00 and 43.00± 0.00 with 43.24± 6.22. Group 2 had a significant difference of 39.12± 3.15*.

For Hb Concentration, the results obtained are 15.50± 0.00 for Group 1, 12.17± 0.30* for Group 2, 15.20± 3.11 for Group 3 and 16.00± 1.01* for Group 4, in comparison with WHO standard, 15.50± 0.00 with 12.17± 0.30*, 15.50± 0.00 with 15.20± 3.11 and 15.50± 0.00 with 16.00± 1.01*. Group 2 and 4 had significant

difference of 12.17± 0.30* and 16.00± 1.01* respectively.

For RBC Count, the results are 5.05± 0.00 for Group 1, 4.12± 0.27* for Group 2, 5.00±.00 for Group 3 and 5.10± 0.14 for Group 4, in comparison with WHO standard 5.05± 0.00 with 4.12± 0.27*, 5.05± 0.00 with 5.00± 0.00 and 5.05± 0.00 with 5.10± 0.14. Group 2 had a significant difference of 4.12± 0.27*.

For WBC Count, the results obtained are 7550.00±0.00 for Group 1, 6114.21± 110.12* for Group 2, 7954.60± 262.44* for Group 3 and 6615.54± 273.10* for Group 4, in comparison with WHO standard, 7550.00±0.00 with 6615.54± 273.10*, 7550.00±0.00 with 7954.60± 262.44* and 7550.00±0.00 with 6615.54± 273.10*. Group 2, 3 and 4 all had significant difference of 6114.21± 110.12*, 7954.60± 262.44* and 6615.54± 273.10* respectively.

For Platelet Count, the results obtained are 275000.00± 0.00 for Group 1, 272368.42±101.11 for Group 2, 274000.00± 122.08 for Group 3 and 272192.12± 279.33 for Group 4, in comparison with WHO standard, 275000.00± 0.00 with 272368.42±101.11, 275000.00± 0.00 with 274000.00± 122.08 and 275000.00± 0.00 with 272192.12± 279.33. There was no significant difference between the control and the 3 groups.

Table 4: Haematological Parameters and level of income

Income Level	N (118)	PCV (%)	Hb (g%)	RBC Count (m/mm³)	WBC Count (cmm)	Platelets (cmm)
Control (WHO Reference)		43.00±0.00	15.50± 0.00	5.05± 0.00	7550.00±0.00	275000.00± 0.00
Upper Class (>301,000)	34	42.65± 5.02*	12.27± 3.01*	5.12± 3.21	6655.51± 409.88*	269260.41± 312.33*
Middle Class (100,000-300,000)	38	43.01± 4.21	16.57± 1.31 *	6.12± 2.46*	7602.14± 100.10*	294531.15± 706.35*
Lower Class (<100,000)	46	39.67± 5.42*	11.79± 5.13*	4.02± 1.82*	6588.46±102.88*	275611± 407.25

Result figures are expressed in Mean ± SEM. * represent values that are statistically significant upon comparison with the control. The mean difference is significant (ρ) at 0.05 level

Table 4 shows results obtained for haematological parameters and level of income. The haematological parameters are PCV (%), Hb Concentration (g%), RBC Count (m/mm³), WBC count (cmm) and Platelet Count (cmm). Group 1 is the control used to compare with Group 2(High Class (>301,000), Group 3 (Middle Class (100,000-300,000) and Group 4 (Low Class (<100,000) respectively.

From the table, the PCV results are 43.00±0.00 for Group 1 (control), 42.65± 5.02* for Group 2 (High Class (>301,000), 43.01± 4.21 for Group 3 (Middle Class (100,000-300,000) and 39.67± 5.42* for Group 4 (Low Class (<100,000), in comparison with WHO standard 43.00±0.00 with 42.65± 5.02*, 43.00±0.00 with 43.01± 4.21 and 43.00±0.00 with 39.67± 5.42*. Group 2 and 4 had significant difference of 42.65± 5.02* and 39.67± 5.42* respectively.

For Hb Concentration, the results obtained are 15.50± 0.00 for Group 1, 12.27± 3.01* for Group 2, 16.57± 1.31* for Group 3 and 11.79± 5.42* for Group 4, in comparison with WHO standard, 15.50± 0.00 with 12.27± 3.01* 15.50± 0.00 with 16.57± 1.31* and 15.50± 0.00 with 11.79± 5.42*. Group 2, 3 and 4 had significant difference of 12.27± 3.01*, 16.57± 1.31* and 11.79± 5.42* respectively.

For RBC Count, the results obtained are 5.05± 0.00 for Group 1, 5.12± 3.21 for Group 2, 6.12± 2.46 for Group 3 and 4.02± 1.82 for Group 4, in comparison with WHO standard, 5.05± 0.00 with 5.12± 3.21, 5.05± 0.00 with 6.12± 2.46 and 5.05± 0.00 with 4.02± 1.82. Group 3 and 4 had a significant difference of 6.12± 2.46* and 4.02± 1.82*.

For WBC Count, the results are 7550.00±0.00 for Group 1, 6655.51± 409.88* for Group 2, 7602.14± 100.10* for Group 3 and 6588.46±102.88* for Group 4, in comparison with WHO standard 7550.00±0.00 with 6655.51± 409.88*, 7550.00±0.00 with 7602.14± 100.10* and 7550.00±0.00 with 6588.46±102.88*. Group 2, 3 and 4 had significant difference of 6655.51± 409.88*, 6588.46±102.88* and 6588.46±102.88* respectively.

For Platelet Count, the results are 275000.00± 0.00 for Group 1, 269260.41± 312.33* for Group 2, 294531.15± 706.35* for Group 3 and 275611± 407.25 for Group 4, in comparison with WHO standard, 275000.00± 0.00 with 269260.41± 312.33*, 275000.00± 0.00 with 294531.15± 706.35* and 275000.00± 0.00 with 275611± 407.25. Group 2 and 3 had a significant difference of 269260.41± 312.33* and 294531.15± 706.35* respectively.

Table 5: Haematological parameters and nutritional intake

Nutrition	N (118)	PCV (%)	Hb (g%)	RBC Count (m/mm³)	WBC Count (cmm)	Platelets (cmm)
Control		43.00±0.00	15.50± 0.00	5.05± 0.00	7550.00±0.00	275000.00± 0.00
Carbohydrates	37	44.33± 4.13*	14.67± 2.31*	4.97± 1.52	7209.15±809.22*	244167.29±115.12*
Proteins	23	45.15± 3.01*	16.00± 2.10*	6.25± 1.22*	7714.21±305.17*	277139.15±78.12
Fat/Oil	12	39.21± 5.05*	11.54± 4.65	4.24± 3.31	57322.12±405.39*	206202.16±81.18*
Vitamin/ Minerals	14	47.16± 5.31*	16.21± 2.55*	6.33±0.25*	7780.43±315.49*	291090.20±502.14*
Balanced Diet	32	43.22±4.14	15.24± 3.77	5.07± 1.46	7123.39±324.01*	279856.47±109.49

Result figures are expressed in Mean ± SEM. * represent values that are statistically significant upon comparison with the control. The mean difference is significant (ρ) at 0.05 level

The haematological parameters studied are PCV (%), Hb Concentration (g%), RBC Count (m/mm^3), WBC count (cmm) and Platelet Count (cmm). Group 1 is the control used to compare with Group 2 (Carbohydrates), Group 3 (Proteins), Group 4 (Fat/Oil), Group 5 (Vitamin) and Group 6 (Balanced Diet) respectively.

From the table, the PCV results are 43.00± 0.00 for Group 1 (control), 44.33± 4.13* for Group 2(Carbohydrates), 45.15± 3.01* for Group 3 (Proteins), 39.21± 5.05* for Group 4 (Fat/Oil), 47.16± 5.31* for Group 5 (Vitamin) and 43.22±4.14 for Group 6 (Balanced Diet), in comparison with WHO standard 43.00± 0.00 with 44.33± 4.13*, 43.00± 0.00 with 45.15± 3.01*, 43.00± 0.00 with 39.21± 5.05*, 43.00± 0.00 with 47.16± 5.31* and 43.00± 0.00 with 43.22±4.14. Group 2, 3, 4 and 5 had significant difference of 44.33± 4.13*, 45.15± 3.01*, 39.21± 5.05* and 47.16± 5.31* respectively.

For Hb Concentration, the results are 15.50± 0.00 for Group 1, 14.67± 2.31* for Group 2, 16.00± 2.10* for Group 3, 11.54± 4.65* for Group 4, 16.21± 2.55* for Group 5 and 15.24± 3.77 for Group 6, in comparison with WHO standard 15.50± 0.00 with 14.67± 2.31*, 15.50± 0.00 with 16.00± 2.10*, 15.50± 0.00 with 11.54± 4.65*, 15.50± 0.00 with 16.21± 2.55* and 15.50± 0.00 with 15.24± 3.77. Group 2, 3, 4 and 5 had significant difference of 14.67± 2.31*, 16.00± 2.10*, 11.54± 4.65* and 16.21± 2.55* respectively.

For RBC Count, the results obtained are 5.05± 0.00 for Group 1, 4.97± 1.52 for Group 2, 6.25± 1.22* for Group 3, 4.24± 3.31 for Group 4, 6.33±0.25* for Group 5 and 5.07± 1.46 for Group 6, comparison with WHO standard showed 5.05± 0.00 with 4.97± 1.52, 5.05± 0.00 with 6.25± 1.22*, 5.05± 0.00 with 4.24± 3.31, 5.05± 0.00 with 6.33±0.25* and 5.05± 0.00 with 5.07± 1.46. Group 3 and 5 both had significant difference of 6.25± 1.22* and 6.33±0.25* respectively.

For WBC Count, the results obtained are 7550.00±0.00 for Group 1, 7209.15±809.22* for Group 2, 7714.21±305.17* for Group 3, 57322.12±405.39* for Group 4, 57780.43±315.49* for Group 5 and 7123.39±324.01* for Group 6, comparison with WHO standard showed 7550.00±0.00 with 7209.15±809.22*, 7550.00±0.00 with 7714.21±305.17*, 7550.00±0.00 with 57322.12±405.39* 7550.00±0.00 with 57780.43±315.49* and 7550.00±0.00 with 7123.39±324.01. Group 2, 3, 4, 5and 6 had significant difference of 7209.15±809.22*, 7714.21±305.17*, 57322.12±405.39* 57780.43±315.49* and 7123.39±324.01*.

For platelet count, the results are 275000.00± 0.00 for Group 1, 244167.29±115.12*for Group 2, 277139.15±78.12 for Group 3, 206202.16±81.18* for Group 4, 291090.20±502.14* for Group 5 and 279856.47±109.49 for Group 6, in comparison with the WHO standard 275000.00± 0.00 with 244167.29±115.12*, 275000.00±0.00 with 277139.15±78.12, 275000.00±0.00 with 206202.16±81.18*, 275000.00±0.00 with 291090.20±502.14* and 275000.00± 0.00 with 279856.47±109.49. Group 2, 4 and 5 had a significant difference of 244167.29±115.12*, 206202.16±81.18* and 291090.20±502.14* respectively.

DISCUSSION OF FINDINGS

The study established a haematological reference values in supposedly healthy populations among socio-economic classes in Port Harcourt. Income, education and nutrition were the independent determinants. There were significant socio-economic status and gender-related differences in the haematological reference ranges established in this study that will be used for the assessment of PCV, Hb concentration, RBC Count, WBC Count and platelet Count. Which are usually involved in diagnosis of some health related conditions.

Gender variations and Haematological Parameters in Port Harcourt

In Table 2, observation was made when compared with the reference ranges using the World Health Organization reference value as standard. Reference ranges for PCV, Hb Conc., RBC Count, WBC Count and platelets counts were higher among males compared to females which is attributed to the monthly menstrual blood loss in female and during child birth. This finding tally with reports from other studies in Africa (Lugada *et al.*, 2009) as well as W.H.O values used as the control group. This study is however not in agreement with (kibaya *et al.,* in 2008 and Miri-dashe *et al.,* in 2011), who both concluded in their studies that platelets count is higher in females than in males. While the WBC Count was higher in females than in males which is consistent with reports from W.H.O.

Educational Level and Haematological Parameters in Port Harcourt

In Table 3, Educational status was found to be significantly associated with haematological parameters in group 2 (primary/secondary) with significant difference noted in PCV, Hb Concentration, WBC Count and RBC Count as compared with the control group which are the W.H.O standard values. Those in Group 3 (first degree) had significant changes on just WBC Count while the PCV, Hb Concentration, RBC Count and Platelets had no significant changes when compared with the control group. Those who are in Group 4 (Post Graduate) had significant low WBC Count and Hb Concentration while there was no significant difference in their PCV, Platelets and RBC Count. This study is in consonant with (Raghupathi 2020) who agrees that increased educational level is impacted in the blood compositions.

Income and Haematological Parameters in Port Harcourt

In Table 4, effect of level of income was observed to be significantly different with upper class in PCV, Hb Concentration, RBC count and WBC count, when compared with the control (WHO reference) with no significant difference in Platelets Count. For the middle class, there was significant changes in RBC Count, Hb Concentration, WBC Count and Platelets. While PCV had no significant change. For the lower class, it was observed that there was significant difference in all the haematological parameters (PCV, Hb Concentration, RBC Count, WBC Count and Platelets.) as compared with the control group. This could be as a result of poverty and low quality nutritional differences.

Nutritional Difference and Haematological Parameters in Port Harcourt

In Table 5, nutritional difference was observed to be significantly correlate with haematological parameters in this study. The results with respect to PCV, Hb Concentration, WBC Count and Platelet Count were significantly lower than the control while RBC Count had no significant variation when compared with the control for the Carbohydrates group. For proteins, the results of all the haematological parameters had significant variations except platelets when compared with the control. PCV, WBC Count and Platelet Count had significant variation when compared to the control while Hb Concentration and RBC Count had no significant variations for Fat/oil group. For Vitamins group, there was significant difference with respect to PCV, Hb Concentration, RBC Counts, WBC Counts and Platelet Counts. While in Balanced Diet Group, only WBC Count had significant differences with respect to haematological parameters when compared to the control.

CONCLUSION

Based on the above findings, this study therefore concluded that gender, income, education and nutrition of the people of Port Harcourt significantly ($\rho \leq 0.05$) affected their haematological parameters as compared with the global WHO Standards.

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