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Variation in blood count parameters of children aged 5 to 11 years in Abidjan, Côte d'Ivoire

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Abstract

Background: In Côte d'Ivoire, as in most developing countries, the reference values of hematological indices currently in use come from data collected from populations living in industrialized countries. The aim of this study was to determine variations in the child's blood count in Cote d'Ivoire.

Materials and Methods: This descriptive cross-sectional study has focused on 310 children (172 girls and 138 boys) aged 5 to 11 years selected from three municipalities of Abidjan. Blood samples were taken from each child in order to assess the parameters of the blood count.

Results: The results revealed that the means of the different hematological parameters (red blood cells, hemoglobin, hematocrit, white blood cells, neutrophils, eosinophils, monocyte, mean corpuscular volume, mean corpuscular hemoglobin and mean corpuscular hemoglobin concentration) were in accordance with the normal physiological reference values from the literature apart lymphocyte. The rate of lymphocytes (51.3 ± 0.5) was higher overall. All the parameters did not indicate significant differences between girls and boys ($p > 0.05$) except mean corpuscular volume, and mean corpuscular hemoglobin that were statistically different by sex ($p < 0.05$). The percentage of having a rate of haemoglobin lower than 11.5 decreased significantly ($p<0.005$) when the age increased. In addition, the rate of hemoglobin and hematocrit increased slightly starting from the age of 8 years. There is a significant difference ($p < 0.05$) in hemoglobin level between girls and boys in the age group of 9 years. Leukopenia is observed in a minority of children in the age groups of 5, 6, 7, 8, and 10 years.

Conclusion: Some hematological parameters were different from other data published in the literature, which suggested a local development of reference values for children.

Keywords: Blood count, Children, Hematological

Introduction

Reference values are essential for the interpretation of hematologic data in clinical practice and scientific research. The values of hematological parameters can vary, depending on several factors, even in healthy populations. These factors include age, sex, ethnicity, body constitution, and social, nutritional, and environmental factors (1). Reliable interpretation of blood count results should be based on the comparison of these results with normal values, inappropriately called usual values or biological constants (2). Most of the reference values of haematological indices currently in use in Africa come from data collected from populations living in industrialized countries (3). These references still do not agree with the clinical reality of all countries, particularly in Africa (4). Also, nowadays one of the most prescribed examinations in pediatrics and the most useful in current medical practice is the blood count. Its modifications can reveal many pathologies (5). Therefore, a correct interpretation is essential to guide the diagnosis. In Côte d'Ivoire, laboratories practically do not have their own reference blood count values, particularly in children. It thus seemed useful to survey

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healthy children aged 5 to 11 years, in the district of Abidjan, in order to define the normal values of the various parameters of the blood count. The objective of the study was to establish the variation in hematological parameters of children aged 5 to 11 years, to provide specific values of reference for the child in Côte d'Ivoire.

Materials and Methods

Subjects and study design

In this descriptive cross-sectional study, a total of 310 school children including 172 girls and 138 boys were selected. The sex ratio was 1.5. The mean age of the study population was 7.7 ± 0.1 years and ranged from 5 to 11 years (Table I). The investigation was a descriptive cross-sectional study on school children living in three municipalities in Abidjan. For the selection of subjects, a set of criteria including clinical and biological signs allowed to exclude and include topics for the needs of this investigation. Since the study was conducted in primary schools, all boys and girls between the ages of 5 and 11 years attending these schools were initially selected. Of these children, those with various complications (digestive, hematological, and inflammatory) or newly transfused children reported in their health records, and also girls at the menstruation stage were excluded. All these observations were carried out by a medical team from the National Institute of Public Health (INSP) in Abidjan (Côte d'Ivoire). This work was carried out from September 2010 to December 2012. These children were informed of the experimental protocol and their parents signed a consent form free. This investigation was conducted under the supervision of school officials and school health.

Blood samples and determination of biological parameters

Samples of venous blood from each child were taken into tubes containing an anticoagulant, Ethyl Diamine Tetra Acetic Acid (EDTA) in the morning between 7:00 and 8:00. These blood samples were shipped on the same day of collection at the Biological Laboratory of the National Institute of Public Health for the realization of the full blood count. The determination of hematological parameters of blood count was performed immediately after homogenization on Coulter of the samples contained in EDTA tubes by an automatic analyser, the Sysmex KX 21N. Standardization, calibration of the instrument, and processing of the samples were done according to the manufacturer's instructions. The machine automatically dilutes whole-blood sample of 50 µl in the CBC/Differential mode, lyses and enumerates white blood cells (WBC), red blood cells (RBC), hemoglobin concentration (Hb), pack cells volume (PCV), platelets, lymphocytes, neutrophils, and red blood cell indices (Mean Corpuscular Volume (MCV), Mean corpuscular hemoglobin (MCH), and Mean corpuscular hemoglobin concentration (MCHC)). It however did not count for eosinophils, monocytes, and basophil counts. Therefore, a manual differential count was done on well prepared thin blood films colored by the May-Grünwald Giemsa (MGG). The values absolved from the neutrophils, eosinophils, lymphocytes, and monocytes, expressed in percentage (%), were deducted from the leucocyte numeration measured by the automated and manual differential count.

Evaluation and statistical analysis of haematological parameters

To better obtain the different prevalence of hematological status of the study population, reference limits of each parameter were used (6). Thus, the prevalence and proportions of main hematological parameters have been defined. Data were expressed as means ± standard error of mean (SEM). For statistical analysis, data were entered and analyzed by the STATISTICA software

(Windows version 7.1). The mean values of different investigated parameters in children were compared using the non-parametric Mann Whitney U test. The comparisons of different proportions of the main obtained biological parameters from the blood count were performed by the likelihood-ratio test (Test "G") with the statistical software "R" version 2.0.1 Windows. A $p < 0.05$ was considered as indicative of significance.

Ethical consideration

Experimental procedures and protocols used in this study were approved by the ethical committee of Health Sciences, Nangui Abrogoua University (Ethical code: UNA/CNER: 20013.728). These guidelines were in accordance with the internationally accepted principles for laboratory use and care. Approval was also obtained from the Ministry of Higher Education and Scientific Research and the Ministry of Health and Public Hygiene in the Republic of Côte d'Ivoire.

Results

Mean values of hematological parameters in total population

The means values of the different hematological parameters associated with the standard error of the mean (SEM) were presented in table II. These values were in accordance with the normal physiological reference values from the literature. However, the rate of lymphocytes (51.3 ± 0.5) was higher overall and by sex. All the parameters did not indicate significant differences between girls and boys ($p > 0.05$). In contrast, mean corpuscular volume and mean corpuscular hemoglobin have been statistically different by sex ($p < 0.05$). These two hematological parameters were higher in girls compared to boys (77.9 ± 0.4 fl vs. 76.6 ± 0.5 fl; 25.2 ± 0.2 pg vs. 24.6 ± 0.2 pg, respectively). The minimum value observed for each hematological parameter was lower than the lower limit of the reference values outside the red blood cells.

Evolution of the means value of hematological parameters in population according to age and sex

Table III shows the evolution of biological parameters according to age and sex. The rate of red blood cells, white blood cells, neutrophils, lymphocytes, monocyte, eosinophil, and thrombocyte were almost identical in all age groups. On the other hand, the rate of hemoglobin and hematocrit increase slightly starting from the age of 8 years. There was a significant difference in hemoglobin level between girls and boys in the age group of 9 years. The girls had a higher rate of hemoglobin (12.5±0.1) than the boys (11.9±0.2). In addition to these reports, MCV and MCH content increased slightly starting from the age of 7 years. These two parameters were significantly higher in girls (MCV = 78.6 ± 0.7 & MCH = 26.2 ± 0.5) than in boys (MCV = 75.6 ± 1.1 & MCH = 24.5 ± 0.5) of the age of 8 years.

In the same age group, the rate of white blood cells was still significantly higher in girls than in boys (6.5 ± 0.3 VS 5.0 ± 0.6). The thrombocyte rate increased in patients aged 5 to 7 years. From the age of 8 years, this thrombocyte level dropped regularly with age.

Proportions of the main erythrocyte parameters according to the age and sex

The distribution of erythrocyte parameters of all age groups according to international reference standards is presented in Table IV. According to this table, the percentage of child had a rate of hemoglobin lower than 11.5 decreased significantly when the age increased. The rate of pathological haematocrit was practically the same in all age groups apart from the 9 and 11- year-olds. It was lower in these two age groups. There was no macrocytosis in the 8-year-old children in this study. Hypochromia was very high in children aged 5, 6, and 7 years. The rates were 41.4%, 54.3%, and 39.5% respectively in these age groups.

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Proportions of main white blood cells and thrombocytes parameters according the age and sex

Table V shows the distribution of the white blood cells thrombocytes. Leukopenia was observed in a minority of children in the age groups of 5, 6, 7, 8, and 10 years. Hyperleukocytosis was only seen in 5 year olds. Neutropenia was seen in all age groups. In the age group over 5 years, the lymphocyte level was greatly increased in all other age groups. Lymphopenia was observed in the 5-year age group. Low proportion of monocytopenia was present in all age groups except 11-years-old. Also, although low thrombocytopenia was observed in all age groups except 9 and 11 years old. In all age groups, this investigation reported normal rate of eosinophils.

Table I: Distribution of children by sex and age group

Childrens	Different ages of children (year)							
	5	6	7	8	9	10	11	Total
	N(%)	**N(%)**	**N(%)**	**N(%)**	**N(%)**	**N(%)**	**N(%)**	**N(%)**
Girls	14(8.14)	35(20.35)	27(15.70)	32(18.60)	34(19.77)	30(17.44)	3(1.74)	172(100)
Boys	15(10.86)	35(25.36)	11(7.97)	21(15.22)	29(21.10)	19(13.76)	5(3.62)	138(100)
Total	29(9.35)	70(22.58)	38(12.26)	53(17.10)	63(20.32)	49(15.80)	8(2.58)	310(100)

Childrens	Different ages of children (year)							
	5	6	7	8	9	10	11	Total
	N(%)	**N(%)**	**N(%)**	**N(%)**	**N(%)**	**N(%)**	**N(%)**	**N(%)**
Girls	14(8.14)	35(20.35)	27(15.70)	32(18.60)	34(19.77)	30(17.44)	3(1.74)	172(100)
Boys	15(10.86)	35(25.36)	11(7.97)	21(15.22)	29(21.10)	19(13.76)	5(3.62)	138(100)
Total	29(9.35)	70(22.58)	38(12.26)	53(17.10)	63(20.32)	49(15.80)	8(2.58)	310(100)

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Table II: Mean values of haematological parameters in total population

Haematological parameters	Total population N=310			Girls N=172			Boys N=138			p value	Reference values (6)
	Mean ± SEM	**Min**	**Max**	**Mean ± SEM**	**Min**	**Max**	**Mean ± SEM**	**Min**	**Max**		
Red blood cells (10^{12}/l)	4.8 ± 0.02	3.6	6.5	4.2 ± 0.003	3.7	6.5	4,9 ± 0,004	3.6	5.9	0,3(NS)	3,5 - 5
Hemoglobin (g/dl)	11,9 ± 0,1	8.6	14.3	12,04 ± 0,1	8.7	14.3	11,8 ± 0,1	8.6	14.2	0,09(NS)	11,5 - 16
Hematocrit (%)	37.2 ± 0.2	27.8	42.7	37.4 ± 0.2	27.8	42.7	37 ± 0.2	30.2	42.4	0,3(NS)	36 - 44
MCV (fl)	77.3 ± 0.3	56	90.6	77.9 ± 0.4	56	88.4	76.6 ± 0.5	64.5	90.6	**0,01(S)**	70 - 86
MCH (pg)	24.9 ± 0.1	16.6	37.9	25.2 ± 0.2	17.6	37.9	24.6 ± 0.2	16.6	33.6	**0,01(S)**	24 - 31
MCHC (g/dL)	32.1 ± 0.8	25	35.5	32.2 ± 0.1	27.6	35.5	31.9 ± 0.1	25.1	35	0,1(NS)	32 - 36
Leucocytes (10^6/l)	6.04 ± 0.1	3.1	13.1	6 ± 0.1	3.5	13.1	6.1 ± 0.1	3.1	10.4	0,4(NS)	4 - 12
Neutrophils (%)	41.5 ± 0.5	21	75	40.8 ± 0.5	23	75	42.3 ± 0.8	21	63	0,1(NS)	40 - 70
Eosinophils (%)	2.1 ± 0.1	1	5	2.1 ± 0.1	1	5	2.1 ± 0.1	1	5	0,4(NS)	1 - 5
lymphocytes (%)	51.3 ± 0.5	15	75	52.02 ± 0.5	15	72	50.4 ± 0.9	26	75	0,2(NS)	20 - 40
Monocytes (%)	5.2 ± 0.1	2	8	5.1 ± 0.1	2	8	5.2 ± 0.1	2	8	0,2(NS)	4 - 10
Thrombocytes (10^6/l)	324.1 ± 5.1	87	589	328.1 ± 7	100	589	319.2 ± 7.6	87	575	0,3(NS)	150 - 400

N: Total number of each subjects group; MCV: Mean Corpuscular Volume; MCH: Mean corpuscular hemoglobin; MCHC: Mean corpuscular hemoglobin concentration; SEM: Standard error of mean; Min: Minimum; Max: Maximum; S: Statistically different for p value < 0.05; NS: Not statistically significant for p value < 0.05

Table III: Evolution of the means value of heamatological parameters in children according to age and sex

Haematological parameters		Different ages of children (year)							p	Reference values (6)
	Sex	**5 Mean ± SEM**	**6 Mean ± SEM**	**7 Mean ± SEM**	**8 Mean ± SEM**	**9 Mean ± SEM**	**10 Mean ± SEM**	**11 Mean ± SEM**		
RBC (10^{12}/l)	TP	4.8±0.1	4.8±0.1	4.7±0.1	4.8±0.0	4.9±0.0	4.9±0.1	4.9±0.1	0.6	3,5 – 5
	B	4.8±0.4	4.8±0.1	4.9±0.1	4.9±0.1	4.9±0.1	4.9±0.1	4.7±0.2	0.9	
	G	4.7±0.1	4.8±0.1	4.7±0.1	4.7±0.7	4.9±0.1	4.9±0.1	4.9±0.1	0.4	
Hb (g/dl)	TP	11.6±0.2	11.5±0.1	11.8±0.1	12.1±0.1	12.2±0.1	12.4±0.1	12.1±0.5	0.00	11,5 - 16
	B	11.7±0.2	51.4±0.2	11.9±0.3	11.9±0.2	11.9±0.2*	12 .3±0.2	12.6±0.4	0.08	
	G	11.4±0.3	11.5±0.1	11.8±0.2	12.2±0.2	12.5±0.1	12.5±0.2	11.7±0.8	0.00	
Hte (%)	TP	36.3±0.5	36.4±0.3	36.3±0.4	37±0.4	37.9±0.3	38.3±0.4	38.3±0.8	0.00	36 - 44
	B	36.4±0.7	36.3±0.4	37.0±0.1	36.7±0.6	37.4±0.5	38.1±0.5	39.3±1.4	0.2	
	G	36.2±0.7	36.5±0.3	36.9±0.5	37.2±0.8	38.4±0.3	38.4±0.5	37.7±0.4	0.00	
MCV (fl)	TP	76.1±0.8	75.8±0.7	78.2±1.1	77.4±0.6	77.8±0.7	78.4±0.6	79.2±2.3	0.1	70 - 86
	B	75.4±1.1	75.7±0.9	76.1±2.1	75.6±1.1*	77.1±1.1	77.9±1.1	83.7±2.8	0.6	
	G	76.8±1.2	75.9±1.2	79.1±1.2	78.6±0.7	78.4±0.8	78.8±0.8	76.5±2.8	0.4	
MCH (pg)	TP	24±0.3	24.2±0.8	25.1±0.4	25.5±0.4	25.1±0.3	25.5±0.3	25.1±1.4	0.00	24 - 31
	B	24.±0.5	24.1±0.4	24.5±0.7	24.5±0.5*	24.6±0.5	25.2±0.5	26.9±1.2	0.5	
	G	24.2±0.5	23.9±0.5	25.4±0.8	26.2±0.5	25.5±0.4	25.6±0.4	23.9±2.0	0.00	
MCHC (g/dL)	TP	31.9±0.2	31.4±0.2	32.1±0.2	32.7±0.2	32.2±0.2	32.4±0.2	31.5±1.0	0.00	32 - 36
	B	32.0±0.2	31.5±0.2	32.1±0.5	32.4±0.3	31.8±0.3	32.4±0.3	32.2±0.6	0.08	
	G	31.8±0.4	31.4±0.2	32.0±0.3	32.9±0.2	32.5±0.2	32.5±0.2	31.0±1.6	0.00	
WBC (10^6/l)	TP	6.5±0.4	6.1±0.18	6.2±0.3	6±0.2	5.9±0.2	5.9±0.2	6±0.3	0.9	4 - 12
	B	6.4±0.8	6.3±0.3	5.9±0.2	5.0±0.6*	5.7±0.2	6±0.2	6.4±0.4	0.2	
	G	6.2 ±0.3	5.8±0.3	7±0.7	6.5±0.3	6.1±0.2	5.8±0.3	5.4±0.8	0.1	

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N (%)	TP	44.1±2.1	41±1.1	44.4±0.1	41.2±1.1	40.9±1.1	42.1±1.1	38.5±2.2	0.5	40 - 70
	B	43.60±2.7	42.5±1.5	40.8±1.1	42.3±2.0	42.2±1.9	41.7±1.8	38.7±2.7	0.8	
	G	44.6±3.4	39.5±1.7	41.6±1.3	40.5±1.2	39.8±1.3	42.3±1.3	38.4±3.4	0.7	
E (%)	TP	2.3±0.2	2.0±1.1	2.0±0.1	2.2±0.1	2.0±0.1	2.0±0.1	2.1±0.3	0.6	1 - 5
	B	2.3±0.3	2.1±0.1	1.9±0.2	2.2±0.2	2.2±0.2	1.6±0.2*	2.7±0.3	0.3	
	G	2.4±0.3	1.9±0.2	2.0±0.1	2.3±0.2	2.0±0.1	2.2±0.1	1.8±0.4	0.3	
L (%)	TP	48.1±2.3	52±1.3	51.4±1.0	51.3±1.2	52.0±1.3	50.7±1.2	53.8±2.5	0.5	20 - 40
	B	48.9±3.01	50.3±1.6	52.0±1.1	50.3±2.3	50.5±2.1	51.2±1.9	53.3±2.7	0.9	
	G	47.35±3.68	53.6±1.9	51.2±1.5	52±1.3	53.4±1.5	50.4±1.5	54.0±4.1	0.5	
M (%)	TP	5.4±0.2	5.0±0.1	5.2±0.1	5.2±0.1	5.0±0.1	5.3±0.1	5.6±0.5	0.4	4 - 10
	B	5.3±0.3	5.1±0.1	5.3±0.1	5.1±0.3	5.1±0.2	5.5±0.2	5.3±0.3	0.8	
	G	5.6±0.3	4.9±0.2	5.1±0.2	5.3±0.1	4.9±0.2	5.1±0.1	5.8±0.7	0.3	
T (10^6/l)	TP	317.1±18.4	332.7±11.1	358±16.2	316.2±11.8	328.2±10.9	298.6±11.7	288±21	0.1	150 - 400
	B	318±29.7	329±15.2	306.4±34.5	314.7±12	317.7±17.9	232±14.2	282.7±27.4	0.7	
	G	317.1±18.4	336.37±16.5	379.4±16.7	317.1±17.9	337.1±13.3	302.8±16.9	234±31.5	0.06	

RBC: Red blood cells; Hb: Haemoglobin; Hte: Haematocrits; MCV: Mean Corpuscular Volume; MCH: Mean corpuscular hemoglobin; MCHC: Mean corpuscular hemoglobin concentration; WBC: White blood cells; N: Neutrophils; E: Eosinophils, L: Lymphocytes; M: Monocytes; T: Thrombocytes; SEM: Standard error of mean, TP: Total population , B: Boys, G: Girl; P: p value;. *: Groups with differences were significant at $p < 0.05$. **: Groups with differences were significant at $p < 0.01$.

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Table IV: Proportions (%) of the main erythrocyte parameters according to the age

Erythrocytes parameters		Different ages of children (year)							p-values
		5 N(%)	**6 N(%)**	**7 N(%)**	**8 N(%)**	**9 N(%)**	**10 N(%)**	**11 N(%)**	
Hb (g/dL)									
8.6 - 11.5	TP	14(48.3)	36(51.4)	13(34.2)	14(26.4)	8(12.7)	8(16.3)	01(12.5)	S
	B	08(53.3)	17(48.6)	04(36.4)	05(23.8)	07(24.1)	03(15.8)	00(00)	NS
	G	06(42.9)	19(54.3)	09(33.3)	09(28.1)	01(02.9)	05(11.7)	01(20)	NS
11.5 - 14.3	TP	15(52.7)	34(48.6)	25(65.8)	39(73.6)	55(87.3)	41(83.7)	07(87.5)	NS
	B	07(46.7)	18(51.4)	07(63.6)	16(76.2)	22(75.9)	16(84.2)	03(100)	NS
	G	08(57.1)	16(45.7)	18(66.7)	23(71.9)	33(97.1)	25(83.3)	04(80)	NS
Hte (%)									
27.8 - 36	TP	12(41.4)	28(40)	15(39.5)	17(32.1)	09(14.3)	06(41.2)	01(12.5)	NS
	B	08(53.3)	14(40)	03(27.3)	06(28.6)	07(24.1)	02(10.5)	00(00)	NS
	G	04(28.6)	14(40)	12(44.4)	11(34.4)	02(05.9)	04(13.3)	01(20)	NS
36 - 42.7	TP	17(58.6)	42(60)	23(60.9)	36(67.9)	54(85.7)	43(87.8)	07(87.5)	NS
	B	07(46.7)	21(60)	08(72.7)	15(71.4)	22(75.9)	17(89.5)	03(100)	NS
	G	10(71.4)	21(60)	15(55.6)	21(65.6)	32(94.1)	26(86.7)	04(80)	NS
MCV (fl)									
56 - 70	TP	01(03.5)	12(17.1)	04(10.5)	04(07.6)	08(12.7)	02(04.1)	01(12.5)	NS
	B	01(06.7)	06(17.1)	02(18.2)	03(14.3)	06(20.7)	01(05.3)	00(00)	NS
	G	00(00)	06(17.1)	02(07.4)	01(03.1)	02(05.9)	01(03.3)	01(20)	NS
70 - 86	TP	27(93.5)	55(78.6)	29(76.3)	49(92.5)	51(62.5)	44(89.8)	06(75)	NS
	B	14(93.3)	28(80)	08(72.7)	18(85.7)	20(68.9)	17(36.8)	02(66.7)	NS
	G	13(92.9)	27(77.1)	21(77.8)	31(96.9)	31(91.2)	27(90)	04(80)	NS
86 – 90.6	TP	01(03.5)	03(04.3)	05(13.2)	00(00)	04(04.8)	03(06.1)	01(12.5)	NS
	B	00(00)	01(02.9)	01(09.1)	00(00)	03(10.3)	01(05.3)	01(33.3)	NS
	G	01(07.1)	02(05.7)	04(14.8)	00(00)	01(02.9)	02(06.7)	00(00)	NS
MCHC (pg)									
16.6 - 24	TP	12(41.4)	37(54.3)	15(39.5)	12(22.6)	19(30.2)	11(22.5)	02(25)	NS

	B	06(40)	19(54.3)	08(72.7)	08(38.1)	13(44.8)	07(36.8)	00(00)	NS
	G	06(42.9)	18(51.4)	07(25.9)	04(12.5)	06(17.7)	04(13.3)	02(40)	NS
31 – 37.9	TP	00(00)	01(1.4)	00(00)	01(01.9)	00(00)	00(00)	00(00)	NS
	B	00(00)	01(02.9)	00(00)	00(00)	00(00)	00(00)	00(00)	NS
	G	00(00)	00(00)	00(00)	01(03.1)	00(00)	00(00)	00(00)	NS
24-31	TP	17(58.6)	32(44.2)	23(60.5)	40(75.5)	44(69.8)	38(77.6)	06(75)	NS
	B	09(60)	15(42.9)	03(27.3)	13(61.9)	16(55.2)	12(63.2)	03(100)	NS
	G	08(57.1)	17(48.6)	20(74.1)	27(84.4)	28(82.4)	26(86.7)	03(60)	NS

N: Total number of each subjects group; Hb: Hemoglobin; Hte: Hematocrit; MCV: Mean Corpuscular Volume; MCH: Mean corpuscular hemoglobin; MCHC: Mean corpuscular hemoglobin concentration; TP: Total population , B: Boys, G: Girl; S: Statistically different for p value < 0.05; NS: Not statistically significant for p value < 0.05.

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Table V: Proportions (%) of the main white blood cells and thrombocytes parameters in all school children

WBC and T parameters		Different ages of children (year)							p-values
		5 N(%)	6 N(%)	7 N(%)	8 N(%)	9 N(%)	10 N(%)	11 N(%)	
WBC (10^6/l)									
3.1 - 4	TP	02(06.9)	05(07.2)	01(02.6)	02(03.8)	00(00)	03(06.1)	00(00)	NS
	B	01(06.7)	03(08.6)	01(09.1)	01(04.8)	00(00)	02(10.5)	00(00)	NS
	G	01(07.1)	02(05.7)	00(00)	01(03.1)	00(00)	01(03.3)	00(00)	NS
4 - 12	TP	25(86.2)	65(92.9)	37(97.4)	51(96.2)	63(100)	46(93.9)	08(100)	NS
	B	14(93.3)	32(91.4)	10(90.9)	20(95.2)	29(100)	17(89.5)	03(100)	NS
	G	11(78.6)	33(94.3)	27(100)	31(96.9)	34(100)	29(96.7)	05(100)	NS
12 – 13.1	TP	02(06.9)	00(00)	00(00)	00(00)	00(00)	00(00)	00(00)	NS
	B	00(00)	00(00)	00(00)	00(00)	00(00)	00(00)	00(00)	NS
	G	02(14.3)	00(00)	00(00)	00(00)	00(00)	00(00)	00(00)	NS
N (%)									
21- 40	TP	09(31.1)	33(47.1)	14(36.8)	20(37.1)	36(57.1)	22(44.9)	05(62.5)	NS
	B	04(26.7)	14(40)	04(36.4)	08(38.1)	17(58.6)	08(42.1)	02(06.7)	NS
	G	05(35.7)	19(54.3)	10(37.1)	12(37.5)	19(55.9)	14(46.7)	03(60)	NS
40 - 70	TP	19(65.5)	37(52.9)	24(63.2)	33(62.3)	27(42.9)	27(55.1)	03(37.1)	NS
	B	11(73.3)	21(60.)	07(63.6)	13(61.9)	12(41.4)	11(57.9)	01(33.3)	NS
	G	08(57.1)	16(45.7)	17(63)	20(62.5)	15(44.1)	16(53.3)	02(40)	NS
70 - 75	TP	01(03.5)	00(00)	00(00)	00(00)	00(00)	00(00)	00(00)	NS
	B	00(00)	00(00)	00(00)	00(00)	00(00)	00(00)	00(00)	NS
	G	01(07.1)	00(00)	00(00)	00(00)	00(00)	00(00)	00(00)	NS
E (%)									
1 – 5	TP	29(100)	70(100)	38(100)	53(100)	63(100)	49(100)	08(100)	NS
	B	15(100)	35(100)	11(100)	21(100)	29(100)	19(100)	03(100)	NS
	G	14(100)	35(100)	27(100)	32(100)	34(100)	30(00)	5(100)	NS

L (%)									
15 - 20	TP	01(03.4)	00(00)	00(00)	00(00)	00(00)	00(00)	00(00)	NS
	B	00(00)	00(00)	00(00)	00(00)	00(00)	00(00)	00(00)	NS
	G	01(07.1)	00(00)	00(00)	00(00)	00(00)	00(00)	00(00)	NS
20 – 40	TP	04(13.8)	09(12.9)	02(05.3)	06(11.3)	08(12.7)	04(8.7)	01(12.5)	NS
	B	02(13.3)	05(14.3)	00(00)	05(23.8)	05(17.2)	02(10.5)	00(00)	NS
	G	02(14.3)	04(11.4)	02(07.4)	01(03.1)	03(08.8)	02(06.7)	01(20)	NS
40 - 75	TP	24(03.5)	61(87.1)	36(94.7)	47(88.7)	55(87.3)	45(91.8)	07(87.5)	NS
	B	13(86.7)	30(85.7)	11(100)	16(76.2)	24(82.8)	17(89.5)	03(100)	NS
	G	11(78.6)	31(88.6)	25(92.6)	31(96.9)	31(91.2)	28(93.3)	04(80)	NS
M (%)									
2 - 4	TP	02(06.9)	06(08.6)	02(05.3)	04(07.6)	04(06.4)	05(10.2)	00(00)	NS
	B	02(13.3)	04(11.4)	00(00)	04(19.1)	02(06.9)	03(15.8)	00(00)	NS
	G	00(00)	02(05.7)	02(07.4)	00(00)	02(05.9)	02(06.7)	00(00)	NS
4 – 10	TP	27(93.1)	64(91.4)	36(94.7)	49(92.5)	57(93.7)	44(89.8)	08(100)	NS
	B	13(86.7)	31(88.6)	11(100)	17(81)	25(86.2)	16(84.2)	03(100)	NS
	G	14 (100)	33(94.3)	25(92.6)	32(100)	32(94.1)	28(93.3)	05(100)	NS
T 10^6/l)									
87 - 150	TP	01(03.5)	01(01.4)	00(00)	01(01.8)	01(01.6)	02(04.1)	00(00)	NS
	B	01(06.7)	00(00)	00(00)	00(00)	01(03.5)	00(00)	00(00)	NS
	G	00(00)	01(02.9)	00(00)	01(03.1)	00(00)	02(06.7)	00(00)	NS
150 – 400	TP	21(72.4)	55(078.6)	28(73.7)	40(75.5)	49(77.8)	42(85.9)	07(87.5)	NS
	B	10(66.7)	29(82.9)	09(81.8)	19(90.5)	23(79.3)	18(94.7)	03(100)	NS
	G	11(78.6)	26(74.3)	19(70.4)	21(65.6)	26(76.5)	24(80)	04(80)	NS
400 - 589	TP	07(24.1)	14(20.2)	10(26.3)	12(22.6)	13(20.6)	05(10.2)	01(12.5)	NS
	B	04(26.7)	06(17.1)	02(18.2)	02(09.5)	05(17.2)	01(05.3)	00(00)	NS
	G	03(91.4)	08(22.9)	08(29.6)	10(31.3)	08(23.5)	04(13.3)	01(20)	NS

N: Total number of each subjects group; WBC: White blood cells; N: Neutrophils; E: Eosinophils, L: Lymphocytes; M: Monocytes; T: Thrombocytes; TP: Total population, B: Boys, G: Girl; P: p value, NS: Not statistically significant for p value < 0.05.

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Discussion

The most frequently prescribed laboratory test was the complete blood count. It offered valuable information since it can distinguish a normal situation from a pathological situation in a multitude of conditions. This study was carried out in order to reveal variations in blood count parameters among a population of healthy Ivorian children aged 5 to 11 years. Firstly, the values of blood count in this study were in accordance with the normal physiological reference values from the literature concerning the mean values (6). The minimal value for each studied hematologic parameter was always below the lower limit of the usual values apart from the rate of red blood cells which was higher. The minimum value of thrombocytes was particularly low. Such differences had also noted in many black populations, apart from any signs of hemorrhage, suggesting a probable implication of dietary, genetic and/or environmental factors (2). This fact must be taken into account in the interpretation of the blood count in Côte d'Ivoire, especially when defining the threshold for thrombocytopenia.

Concerning the higher limits, the maximum values of each parameter were above the upper limit of the usual values with the exception of the values of hemoglobin, hematocrit, and monocytes. Thus, the upper limits of hemoglobin, hematocrit, and monocytes were lower in this population. The lower hemoglobin values in the study population compared to the Caucasian population could be explained by a higher frequency of iron deficiency in underdeveloped countries, itself attributed to differences in standard of living and food. Comparison of these results with those of the Caucasian population showed the lower reference limits in children as noted in some African studies (7).

The studies carried out in different countries all converge on the variability of the reference values of the hematological and biochemical parameters according to several factors such as age, sex, ethnicity, pregnancy, and smoking, alcohol, or drug consumption (8, 9). Thus, an increase in the mean values of hematological parameters depending on age was observed.

Specifically, this variation was statistically very significant for the rates of hemoglobin and hematocrit. These two parameters increased with age as observed in several studies (10,11,12). Dapper et al. found no significant difference in their study between pre-primary and primary school children. Nevertheless, they revealed that the hematocrit values in primary school subjects were marginally higher (13). The study showed a significant difference in certain erythrocyte parameters especially mean corpuscular volume and mean corpuscular hemoglobin between girls and boys as reported by several studies in the literature (7,14,15,16). Contrary to what was reported in the literature, in the children of this study, these parameters were higher in the girls than in boys. It was known that the rates of erythrocyte constancy increased until puberty, when differences between the two sexes appeared. It was thought that this increase was more precocious in girls since they reached maturity earlier than boys in Côte d'Ivoire. This would have the effect of increasing their parameters. On the other hand, concerning the leukocyte parameters, the study did not show any difference according to sex. The general absence of sex differences for white blood cell counts was in agreement with the results of previous reports (10, 17, 18). In children from 8 years of age, there was a moderate decrease in the values of platelet counts with age as confirmed in the study of

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Balduini (19). Lymphocytosis was very high in a study population. This lymphocytosis increased significantly with age. For the rest of the leukocyte parameters, there was no variation in pathological rate according to age.

Conclusion

The blood count was one of the most prescribed and useful laboratory tests in pediatric medical practice. Its modifications can reveal very diverse pathologies in children. Its reference values may change depending on several parameters in the child such as age, sex, ethnicity, and drug consumption. This study revealed variation in blood count parameters in children by age and sex. Results for some hematological parameters were different from other data published in the literature, which suggested that local development of reference values for children was essential for Côte d'Ivoire.

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Conflict of interest

The authors declare no conflict of interest.

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