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NORMAL VALUES FOR HAEMOGLOBIN PACKED CELL VOLUME, AND ERYTHROCYTE SEDIMENTATION RATE IN HEALTHY NIGERIAN ADULTS

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Summary

The haemoglobin (Hb), packed cell volume (PCV) and erythrocyte sedimentation rate (ESR) of healthy medical students, resident medical staff and student nurses were determined. Of the 163 males and 193 females studied for Hb and PCV, the mean Hbs were 15.2 and 13.8 g/dl respectively and the mean PCVs were 0.46 and 0.41 l/l respectively. Of the 108 males and seventy-two females investigated for ESR the mean values were 3.0 mm and 6.4 mm in the first hour respectively. The mean Hb for the 282 male blood donors studied in comparison was 13.4 g/dl.

The results of the survey show that both Hb and PCV compare favourably with those obtained from studies in Western countries, but differ significantly from those in Nigerian and other tropical areas. Similarly, all the ESR values in males and females in the present study come within the accepted range in Western studies. It is suggested that Hb, PCV, and ESR determinations obtained from healthy Nigerians in whom nutritional deficiencies are absent are comparable with results obtained from subjects in Western countries.

Résumé

Le hémoglobine (Hb), le hématoците (PCV) et la vitesse de sédimentation des hématies (ESR) pour les étudiants en médecine, les infirmières étudiantes et les médecins ont

été fait. Des 163 mâles et 193 femmes examinés pour le Hb et le PCV, le moyen Hb étaient 15.2 et 13.8 g/dl respectivement. Les moyens PCV étaient 0.46 et 0.41 L/L respectivement. Hors de 108 mâles et soixante-deux femelles étudiés pour la vitesse de sédimentation les valeurs moyen étaient 3.0 et 6.4 mm après 1 h respectivement. Le moyen Hb pour 282 donneurs de sanguine mâles était 13.4 g/dl.

Les résultats de l'épreuve montre que le Hb et le PCV sont similaires à ceux des pays de l'Ouest, mais ils diffèrent d'une manière significative des résultats Nigériens et les autre pays tropicales. Tous les valeurs de la ESR mâles et femelles dans notre étude sont dans le range normal pour les études de l'Ouest. Nous constatons que le Hb, le PCV et la ESR pour les Nigériens bien portants sont comparable des résultats pour les sujets dans les pays de l'Ouest.

Introduction

Haemoglobin (Hb) and packed cell volume (PCV) reported as normal for Nigerians are lower and the erythrocyte sedimentation rate (ESR) is higher than values found in Western texts (Ojo, 1974; Araba, 1976). It has been suggested that differences in values of Hb and PCV may be due to malnutrition (Ojo, 1974; Araba, 1976) and intestinal parasitic infestations such as hookworm (Ojo, 1974).

The high ESR values were thought to be

due to an abnormal plasma protein pattern (Ojo, 1974). In spite of the varying values, these authors suggested that their results could form the basis of assessment of Nigerian patients.

It has, however, been emphasized (WHO, 1959, 1968, 1972) that the distribution of normal haematological values such as Hb and PCV is likely to be the same the world over when allowance has been made for age, sex, altitude and pregnancy. Such normal values could therefore be determined from a sample of healthy persons in whom nutritional deficiencies are absent (WHO, 1972).

In this study we have investigated a representative group of healthy Nigerians and compared our data with those reported in earlier studies in Nigeria as well as studies from some other tropical and temperate countries.

Subjects and methods

The subjects comprised medical students, student nurses and resident medical staff of the University of Nigeria Teaching Hospital, Enugu, Nigeria; there were 163 males and 193 females, and their ages ranged from 19 to 32 years with a mean age of 25 years. They were all in good health without a history of recent illness or of pregnancy. They were investigated for Hb and PCV, but the ESR was done for 108 males and seventy-two females only. For comparison, 282 apparently healthy blood donors were included in the study. All were males and their ages ranged from 21 to 35 years with a mean of 26.3 years.

Venous blood was drawn into vacutainer tubes containing tripotassium ethylene diamine

tetra-acetate (K_3 EDTA) anticoagulant, sampling being carried out between 9 and 11 a.m. Hb was determined as cyanmethaemoglobin using a spectrophotometer. The PCV was estimated using Clay-Adams micro-haematocrit centrifuge which was spun at 12,000 g for 5 min before reading. Both Hb and PCV were performed in duplicate. The ESR was determined by diluting four parts K_3 EDTA anticoagulated blood in one part of 0.9% saline solution (Dacie & Lewis, 1975; Gambino *et al.*, 1965; Lascari, 1972). The blood was then drawn up to zero mark in a Westergren tube, set at the vertical in a tube rack and allowed to sediment for 1 h after which the reading was taken. All ESR estimations were carried out within 2 h of drawing blood, in an air-conditioned room at 20°C.

Results

Table 1 shows the range of values, mean and standard deviation (s.d.) for Hb, PCV, and ESR. Table 2 shows the mean Hb, s.d., number of subjects studied, nature of subjects, country of origin, and authors of several studies; corresponding data for PCV are shown in Table 3. The mean Hb for males in the present study was similar to the result for city dwellers in Canada ($P>0.05$; Hawkins, Speck & Leonard, 1954), in the U.S.A. ($P>0.05$; Greendyke *et al.*, 1962), and in Norway ($P>0.05$; Natvig, Bjerkedal & Jonassen, 1963), and in Nigerian medical and pharmacy students ($P>0.05$; Watson & Etta, 1975) (Table 4). However there is a highly significant difference between the mean Hb of the present study and those of Nigerian blood donors at Ibadan ($P<0.001$; Ojo, 1974), and the blood donors in the present study ($P<0.001$). The difference occurs also

TABLE 1. Haemoglobin, PCV and ESR of medical and nursing students and of resident medical staff

Test	Sex	No. of subjects	Mean	Range	s.d.
Haemoglobin (g/dl)	M	163	15.2	12.3-18.5	1.3
	F	193	13.8	11.4-16.8	1.0
PCV (L/L)	M	163	0.46	0.37-0.54	0.036
	F	193	0.41	0.34-0.49	0.030
ESR (mm in 1 h)	M	108	3.0	0-13	1.9
	F	72	6.4	1-16	3.2

TABLE 2. Mean haemoglobin and s.d. in present and other studies

Sex	Number studied	Mean Hb (g/dl)	s.d.	Subjects	Country	Author
M	163	15.2	1.3	Medical and nursing students, resident medical staff	Nigeria	Present study
F	193	13.8	1.0			
M	282	13.4	1.8	Blood donors	Nigeria	Present study
M	91	15.1	0.95	Medical and pharmacy students	Nigeria	Watson & Etta (1975)
M	323	13.7	1.2	Civilians, hospital workers, medical students	Nigeria	Araba (1976)
F	77	11.5	1.1			
M	114	13.7	1.8	Blood donors	Nigeria	Ojo (1974)
M	60	13.2	1.3	Villagers	Nigeria	Gilles (1965)
F	112	11.2	1.4			
M	371	15.0	1.0	Subjects of all classes	Nigeria	Ukaejiofo <i>et al.</i> (1979)
F	270	12.8	1.1			
M	83	15.1	1.2	City dwellers	Canada	Hawkins <i>et al.</i> (1954)
M	200	15.4	0.83	City inhabitants	U.S.A.	Greendyke <i>et al.</i> (1962)
M	1975	15.3	0.95	City inhabitants	Norway	Natvig <i>et al.</i> (1963)
F	7787	13.7	1.37	City inhabitants	U.K.	MRC (1945)
M	72	14.1	1.4	Villagers	Kenya	Levy (1969)
M	94	11.4	1.8	City manual workers	Tanganyika	Robson (1964)

TABLE 3. Mean PCV and s.d. in present and other studies

Sex	Number studied	Mean PCV (l/l)	s.d.	Subjects	Country	Author
M	163	0.46	0.036	Medical students, student nurses and resident doctors	Nigeria	Present study
F	193	0.41	0.03			
M	114	0.44	0.036	Blood donors	Nigeria	Ojo (1974)
F	20	0.37	0.032	Civilians	Nigeria	Harrison (1966)
M	91	0.45	0.029	Medical and pharmacy students	Nigeria	Watson & Etta (1975)
F	371	0.45	0.027	Subjects of all classes	Nigeria	Ukaejiofo <i>et al.</i> (1979)
M	270	0.40	0.03			

with healthy subjects of all classes from the Nigerian population ($P < 0.05$; Ukaejiofo *et al.*, 1979), Nigerian civilians and hospital workers ($P < 0.001$; Araba, 1976), Luo villagers in Kenya ($P < 0.001$; Levy, 1969) and city manual workers in Tanganyika ($P < 0.001$; Robson, 1964).

The mean Hb for females in the present study is comparable to that obtained in a Medical Research Council (U.K.) Survey ($P > 0.05$; MRC, 1943) (Table 5), but is significantly different from that of healthy subjects

of all classes from the Nigerian population ($P < 0.001$; Ukaejiofo *et al.*, 1979), Nigerian civilians and hospital workers ($P < 0.001$; Araba, 1976), Nigerian villagers ($P < 0.001$; Gilles, 1965) and Luo villagers in Kenya ($P < 0.001$; Levy, 1969). In Table 6, the mean PCV for male subjects in the present study is shown to be similar to that of Nigerian medical and pharmacy students ($P > 0.05$; Watson & Etta, 1975), but is significantly higher than that of Nigerian blood donors ($P < 0.001$; Ojo, 1974), and Nigerian subjects

TABLE 4. Comparison of mean haemoglobin: present and other studies: males

Source	Mean Hb (g/dl)	Difference between means	t value	Significance of difference
Present study	15.2	—	—	—
Present study (blood donors)	13.4	1.8	12.1	$P < 0.001$
Hawkins <i>et al.</i> (1954)	15.1	0.1	0.60	$P > 0.05$
Greendyke <i>et al.</i> (1962)	15.4	0.2	1.7	$P > 0.05$
Ojo (1974)	13.7	1.5	7.7	$P < 0.001$
Araba (1976)	13.7	1.5	12.3	$P < 0.001$
Watson & Etta (1975)	15.1	0.1	0.70	$P > 0.05$
Gilles (1965)	13.2	2.0	10.2	$P < 0.001$
Ukacjiofo <i>et al.</i> (1979)	15.0	0.2	1.75	$P < 0.05$
Natvig <i>et al.</i> (1963)	15.3	0.1	0.96	$P > 0.05$
Levy (1969)	14.1	1.1	5.67	$P < 0.001$
Robson (1964)	11.4	3.8	17.9	$P < 0.001$

TABLE 5. Comparison of mean haemoglobin: present and other studies: females

Source	Mean Hb (g/dl)	Difference between means	t value	Significance of difference
Present study	13.8	—	—	—
MRC (1945)	13.7	0.1	1.36	$P > 0.05$
Araba (1976)	11.5	2.3	22.7	$P < 0.001$
Gilles (1965)	11.2	2.6	17.2	$P < 0.001$
Ukacjiofo <i>et al.</i> (1979)	12.8	1.0	10.8	$P < 0.001$
Levy (1969)	12.6	1.2	6.28	$P < 0.001$

TABLE 6. Comparison of mean PCV in present and other studies (male and female)

Source	Sex	Mean PCV (l/l)	Difference between means	t value	Significance of difference
Present study	M	0.46	—	—	—
	F	0.41	—	—	—
Ojo (1974)	M	0.44	0.02	4.6	$P < 0.001$
Harrison (1966)	F	0.37	0.04	5.4	$P < 0.001$
Ukacjiofo <i>et al.</i> (1979)	M	0.45	0.01	3.16	$P < 0.001$
	F	0.40	0.01	3.36	$P < 0.001$
Watson & Etta (1975)	M	0.45	0.01	1.4	$P > 0.05$

of all classes ($P < 0.001$; Ukacjiofo *et al.*, 1979). Again the mean PCV for females in this study was significantly greater than that of Nigerian civilians ($P < 0.001$; Harrison, 1966), and of healthy Nigerian subjects of all classes ($P < 0.001$; Ukacjiofo *et al.*, 1979).

With respect to the ESR determinations, in the present study, as well as in reports by Lascari (1972), Dawson (1960) Dacie and

Lewis (1975) and Wintrobe (1974), no persons were found to have ESR values in excess of 20 mm in the hour. However Ojo (1974) and Araba (1976) reported among males, ESR in excess of 20 mm in the hour, in 21 and 5% of subjects respectively, while Araba (1976) noted that 13% of his female subjects had values in excess of 20 mm.

Discussion

Haemoglobin and packed cell volume

The mean Hb and PCV of our subjects agree closely with those reported by Hawkins *et al.* (1954), Greendyke *et al.* (1962), Natvig *et al.* (1963) and MRC (1943), and with results of the Nigerian authors, Watson and Etta (1975).

However, our values differ widely from those of previous Nigerian studies. As has been noted (Ojo, 1974; Araba, 1976), the differences can be accounted for by the effect of malnutrition and intestinal parasites on their subjects who were mostly blood donors. These findings among blood donors would be expected as our experience in this study is that the majority of blood donors come from the lower income groups of the urban areas or from the villages. Among the rest of our subjects, resident medical staff come within the higher income bracket and live reasonably well. Medical students and student nurses live in hostels, have satisfactory food and are under medical supervision. The three groups are therefore expected to be in much better general health than blood donors. It is noteworthy that the mean Hb values of university students who formed a proportion of those investigated by Watson and Etta (1975), is comparable with our results.

Anaemia is widely prevalent in tropical countries as has been clearly shown in several surveys and reports (Woodruff & Schofield, 1957; Forsyth, 1970; Chopra & Byam, 1968; Woodruff, 1972; Levi, 1969). Normal Hb and PCV values should therefore not be assessed by investigation of the 'general population' or subjects chosen from the rural areas as these often have parasitic infestations and nutritional deficiencies and therefore are likely to have low haemoglobin. Hb surveys when carried out under such conditions in Nigeria as well as in other tropical countries should serve as a basis for estimating the prevalence of anaemia, and the magnitude of the anaemia as a health problem in the community. Selected groups such as persons from the higher income groups who are reasonably healthy should give a more appropriate estimate of the normal values.

Erythrocyte sedimentation rate

Our ESR results agree closely with those published in Western texts and none of our subjects have values exceeding 20 mm in the first hour. However, our results differ widely from those of other Nigerian studies. Ojo (1974) reported a range of 3.8–98 mm in the hour, in Nigerian blood donors.

The rate of sedimentation of red blood cells is dependent on a number of factors. These include increase in the concentration of plasma proteins such as fibrinogen, α globulin and γ globulin, alteration in the size, shape and haemoglobin content of red blood cells, and the technical and laboratory factors such as dimensions of the sedimentation tube, verticality of the tube, anticoagulant used in collecting blood and the temperature of the environment in which the test was carried out (Schrader, 1963; Dawson, 1960; Miale, 1972; Dacie & Lewis, 1975; Wintrobe, 1974). The present and other studies were based on the standard Westergren technique which takes into account these technical factors. However Araba (1976) and Ojo (1974) used the method involving the dilution of anticoagulated blood with sodium citrate solution. Gambino *et al.* (1965), Lascari (1972) and Dacie and Lewis (1975) on the other hand note that the method in which blood collected in EDTA anticoagulant is diluted with normal saline gives similar ESR results.

Anaemia accelerates the rate of sedimentation of red blood cells by altering the ratio of red cells to plasma and encouraging rouleaux formation – a physical factor of importance in the sedimentation of erythrocytes. Of the subjects studied by Araba (1974), 0.9% of the males and 14.8% of the females had haemoglobin values below 10.5 g/dl. Also 12.4% of Ojo's (1975) male subjects had haemoglobin values below 12.2 g/dl. Anaemia most probably contributed to the high ESR values obtained in their studies.

Among other factors which modify the ESR, the concentration of fibrinogen, α_2 globulin and γ globulin are important since these proteins in the main determine the extent of formation of rouleaux. Edozien (1957) reported an abnormal serum protein pattern in apparently healthy Nigerians, with high globulin and low albumin. Similar

results were reported by Gilles (1965) among Nigerian villagers at Akufo. This situation probably occurs in many parts of the country and may be explained on the basis of sub-clinical protein malnutrition (Collis, Dema & Lesi, 1962), combined with the effect of chronic endemic disease such as malaria. The abnormal protein pattern would, like anaemia, explain the higher sedimentation rates obtained by the Nigerian authors (Ojo, 1974; Araba, 1976). With improved nutrition and good general health of our subjects, the ESR would be expected to be similar to those reported from Western countries. It is significant that the serum protein of Nigerian medical students was found (U. P. Isichei, personal communication) to be no different from those of Caucasian subjects.

Conclusion

The results of this survey support our view that Hb, PCV and ESR determinations carried out among healthy Nigerians in whom nutritional deficiencies are absent are more representative of truly normal values comparable to results obtained from subjects from Western countries, as recommended by the World Health Organization.

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