HAEMATOLOGICAL EVALUATION*

Condensed version by A. M. LUBBE

SUMMARY

The red cell picture for the two populations differed significantly at a 5% level in respect of all the variables, for all age-groups, somewhat excepting the very young group. Neither population can be considered to have shown any real indication of anaemia, although in the rural group the red cell mass was definitely smaller and the MCHC one unit lower than in the urban group. The differences may be due to a probable higher dietary intake of assimilable iron and other haemopoietic factors in the urban as compared with the rural Venda. However, the possibility exists that parasitism could, at least partly, be responsible for the less favourable picture in the rural population.

Differences favourable to the urban group were also found in the sedimentation rates.

Significant differences at a 5% level between the two groups were found in respect of the percentage differential counts as well as the neutrophil/lymphocyte ratio, but not for the total white cell counts. The most striking difference between the rural and urban populations, namely in respect of the total as well as the percentage eosinophil counts, might be explained on the grounds of greater exposure to parasitism in the rural group. The number of eosinophils decreased significantly with advancing age in both groups, the age effect being more prominent in the rural population.

Haematological investigations were carried out on a total of 251 rural and 243 urban subjects. The cell sizes for the various age intervals studied are given in Table I. The total number of subjects included in the haematological surveys is slightly smaller than the totals for the original samples as a result of clotting in a few of the oxalate specimens.

TABLE I. CELL SIZE IN DIFFERENT AGE-GROUPS TOGETHER WITH TOTAL SAMPLE SIZE FOR RURAL AND URBAN VENDA

Locality	17 - 19 yrs	20 - 29 yrs	30 - 39 yrs	40 - 49 yrs	50 - 65 yrs	Total
Rural	**11**	**122**	**38**	**52**	**28**	**251**
Urban	**7**	**35**	**57**	**99**	**45**	**243**

METHOD

An experienced technician was responsble for carrying out the necessary technical procedures in the field. Consistency in respect of all the recommended techniques was expected and strongly emphasized by the haematologist before commencement of the surveys.

Experience gained from the nutritional status surveys on over 2 200 Pretoria schoolchildren from 4 racial groups (1962 - 1965), led to the abandonment of the time-consuming red cell count as it was considered to be redundant in the assessment of the red cell picture in an ambulant population. This procedure, traditionally regarded as a routine necessity, had been found to contribute too little additional information to justify its continued use in large surveys aimed primarily at determining nutrition status.[1]

Haemoglobin was estimated as cyanmethaemoglobin against a commercial standard available in ampoules. The colour intensity of each solution was read in a Unican spectrophotometer.

Macrohaematocrits were determined in the Wintrobe tubes used to obtain one-hour ESR readings. The tubes were subsequently spun for 30 minutes at 6 000 rpm to read the PCV.

White cell counts were done in a haemocytometer counting chamber. The differential counts were limited to the preterminal portion of the smears, according to the method adhered to in the Pretoria surveys.[1] As before, only a hundred cells were enumerated, but this time no special attempt was made to correct any erroneous impression of the percentage eosinophil or basophil counts, so frequently caused by the tendency of these cells to occur in clusters. The cells enumerated were neutrophils, monocytes, lymphocytes (to which category were relegated all abnormal basophilic uninucleated cells and any mast cells encountered), eosinophils and, on this occasion, also basophils (previously added to the neutrophil fraction).

Statistical tests were carried out using an initial programme[2] which tested separately for any significant effects of age in the rural and urban samples by means of a one-way analysis of variance. The means and standard deviations for each age cell and each group as a whole, together with the maximum and minimum values for each group, were also given by this programme. The differential counts were analysed both as percentages of the total white cells and as absolute values calculated from the total counts.

A second programme, devised by Steffens,[3] was thereafter used to identify the age ranges in which there were significant differences (at a 5% level) between the rural and urban Venda in respect of each variable.

RESULTS

The results of the red cell findings are presented in Tables II - IV and Fig. 1. The information presented in Fig. 1 is based on the totals for the haemoglobin and the MCHC values, in the furthest right-hand column and the lowest row respectively, of Table IV.

The haematocrits have not been tabulated and plotted separately as was done in the case of the haemoglobin and MCHC values. The decision to confine the detailed

* This is a condensation by A. M. Lubbe of the original manuscript prepared by M. L. Neser.

TABLE II. MEANS AND STANDARD DEVIATIONS* FOR RED CELL FINDINGS IN RURAL AND URBAN VENDA

Variable Age-group (years)	Rural						Urban					
	17 - 19	20 - 29	30 - 39	40 - 49	50 - 65	Total	17 - 19	20 - 29	30 - 39	40 - 49	50 - 65	Total
Hb	**15·7**	**16·0**	**16·0**	**15·6**	**15·6**	**15·8**	**16·7**	**17·8**	**17·4**	**17·5**	**17·5**	**17·5**
	(1.·2)	**(1·3)**	**(1·2)**	**(1·1)**	**(1·2)**	**(1·2)**	**(1·6)**	**(1·2)**	**(1·4)**	**(2·1)**	**(1·3)**	**(1·7)**
PCV †	**50·2**	**51·1**	**50·8**	**49·7**	**49·7**	**50·6**	**52·3**	**55·4**	**54·0**	**54·4**	**53·6**	**54·3**
	(3·0)	**(3·1)**	**(2·9)**	**(3·1)**	**(3·3)**	**(3·1)**	**(4·6)**	**(3·4)**	**(2·9)**	**(3·2)**	**(3·4)**	**(3·3)**
MCHC	**31·3**	**31·3**	**31·4**	**31·3**	**31·3**	**31·3**	**32·0**	**32·1**	**32·2**	**32·2**	**32·6**	**32·2**
	(1·7)	**(1·5)**	**(1·4)**	**(1·2)**	**(1·2)**	**(1·4)**	**(2·1)**	**(1·3)**	**(1·6)**	**(3·6)**	**(1·6)**	**(2·6)**
ESR	**6·1**	**6·2**	**7·2**	**10·0**	**15·7**	**8·2**	**6·3**	**3·1**	**3·3**	**4·4**	**6·5**	**4·4**
	(6·0)	**(5·8)**	**(7·7)**	**(9·6)**	**(12·8)**	**(8·5)**	**7·5**	**(3·6)**	**(5·0)**	**(4·9)**	**(5·8)**	**(5·1)**

* Standard deviations (SD) given in parentheses.
† Macrohaematocrit (Wintrobe).

TABLE III. STATISTICAL EVALUATION OF RED CELL FINDINGS IN RURAL AND URBAN VENDA

Variable	Effect of age in specified population: Rural	Effect of age in specified population: Urban	Age range in which the two populations differed significantly at a 5% level
Hb	**None**	**None**	**All ages**
PCV	**Significant (P<5%)**	**None**	**All ages**
MCHC	**None**	**None**	**23 - 60 years**
ESR	**Highly significant (P<0·1%)**	**Highly significant (P<1·0%)**	**22 - 65 years**

TABLE IV. CROSS-TABULATION OF HAEMOGLOBIN AGAINST MCHC VALUES IN RURAL AND URBAN VENDA* (ALL AGES COMBINED)

Hb†	MCHC 25	26	27	28	29	30	31	32	33	34	35	36	Totals
10		1											1
11													
12													
13			2	1	3		2	1	1				10
14				1	4	8	4	1	2				20
	1		1							1			3
15				3	7	11	19	16	2				58
				2		2	2	1					7
16					3	8	33	36	9	1	2		92
					1	5	10	12	8	2			38
17						1	18	22	4	4			49
			1		1	6	7	22	17	7			61
18						1	4	6	3	2	1	1	18
						1	10	20	21	18	2	2	74
19							2	1					3
							2	10	12	12	1	1	38
							2	7	7	4		1	21
										1			1
Totals		1	2	4	17	30	80	82	23	8	3	1	251
	1		2	2	2	14	33	72	65	44	4	4	243

* Upper and lower figures respectively.
† Expressed to the nearest whole number.

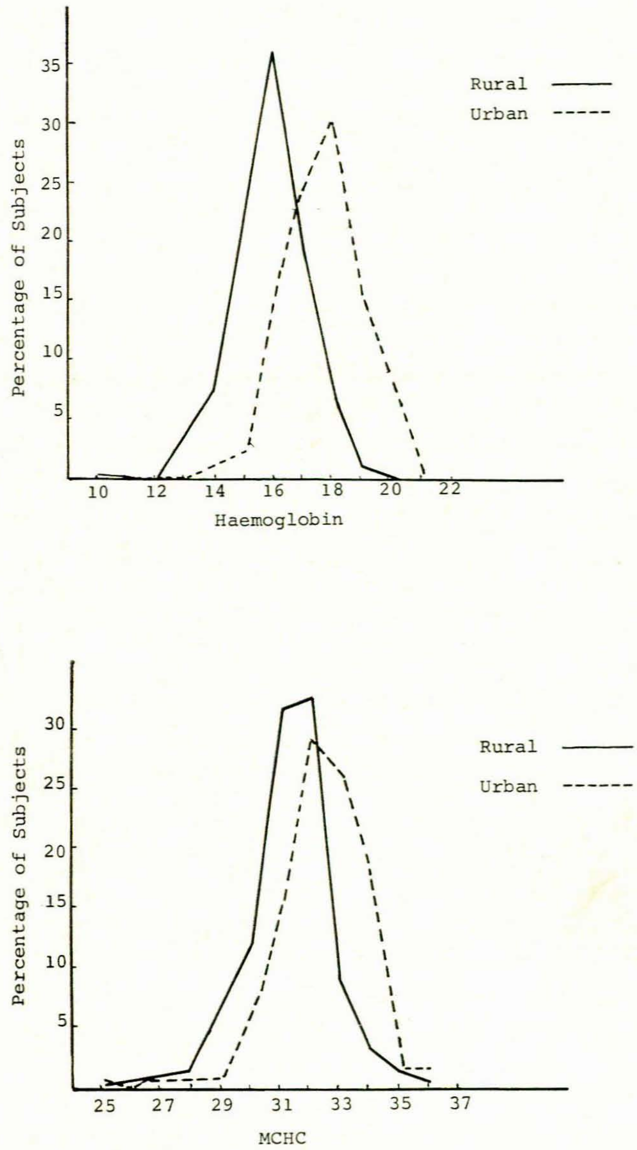

Fig. 1. Percentage distribution of haemoglobin and MCHC values in rural and urban samples (all ages combined).

analysis to the haemoglobin and MCHC values can be considered to have been arbitrary. It was, however, influenced by the fact that much more emphasis is laid on the haemoglobin than the haematocrit values in routine haematology, and also by previous experience pointing to the importance of the MCHC in assessing the red cell picture.[1]

The white cell findings are given in Tables V - VII. The percentage and absolute counts were analysed separately, because it seemed that the calculation of the absolute values would tend to level out the significant differences between the two populations present in the percentage counts. The inclusion of the neutrophil/lymphocyte ratio is an innovation, but gives the same information (in inverse form) as was obtained by the analysis of the lymphocytes as a percentage of the neutrophils in the Pretoria surveys. The mean total white cell counts and the percentage differential counts for the rural and urban samples are given in Table V, the absolute differential counts in Table VI and the results of the statistical analyses for all the white cell counts in Table VII.

DISCUSSION

Red Cell Picture

The two populations differed significantly at a 5% level in respect of all the relevant variables (Table III).

Haemoglobin and MCHC values. The normal percentage value for the MCHC for adult males is considered to be 34 ± 2, according to Wintrobe.[4] This figure corresponds with our own findings for Bantu schoolboys of 14 and 15 years respectively, and also with the mean values for boys of 7 - 11 years in this racial group.[1] The modal value of 32 obtained for both the rural and urban Venda (Table IV and Fig. 1) can therefore not be accepted, as this index has been observed to remain constant (on the average) throughout adult and most of child life.[1,4,5]

In interpreting the blood picture of the two populations, in which no hypochromasia could be detected on any of the smears, it had therefore to be accepted that there might have been an error in either the haemoglobin or the haematocrit values, or in both. Had this error been inconsistent, the results would have been meaningless. However, a clear shift to the right on the part of the urban group in both values (Table III and Fig. 1) suggest that the error was, on the whole, consistent. On account of our own findings for urban Bantu boys, supported by Wasserman's survey of the relevant haematological literature,[5] it seems acceptable that adult male Bantu in the major urban areas in this country should have the normal average value that is claimed for the MCHC in adult males. The MCHC values on the whole would therefore appear to be about 2 units or as much as 6% too low.

The normal haemoglobin and haematocrit values given by Wintrobe[4] for adult males are 16 ± 2 g and 47 ± 7 ml/100 ml, respectively; these mean values being associated with a normal mean MCHC of 34%. The close interrelationship between these variables as pointed out by Wintrobe,[4] have been confirmed by our own findings for both White and Bantu boys.[1] From the results obtained for the Venda (Table II) it may be concluded that there were either consistent errors in the technical procedures or else a general and strangely abnormal red cell picture with the red cell mass increased and its haemoglobin content decreased. Suspicion therefore falls on both the haemoglobin and the haematocrit values as being incorrect. Furthermore, in the rural group a noticeable effect of age was found in the haematocrit but not in the haemoglobin values (Table III). On the whole, the haemoglobin values may be regarded as being about 0·4 g (up to 3%) too low, while the haematocrits are about 2 units (4%) too high.

The dietary findings for the rural group indicate that their iron intake was not, as might have been expected, lower than the latest recommended intake,[6] but considerably higher. If the recommended allowance for iron[6] is accepted to be correct, it can be concluded that the

TABLE V. MEANS AND STANDARD DEVIATIONS* FOR RURAL AND URBAN VENDA BASED ON TOTAL AND PERCENTAGE WHITE CELL COUNTS

Variable Age-group (years):	Rural						Urban					
	17 -19	20 - 29	30 - 39	40 - 49	50 - 65	Total	17 - 19	20 - 29	30 - 39	40 - 49	50 - 65	Total
Total white cells	**7 868**	**6 203**	**6 383**	**6 902**	**6 310**	**6 464**	**5 121**	**6 984**	**5 611**	**8 089**	**6 098**	**6 905**
	(250)	**(180)**	**(194)**	**(272)**	**(151)**	**(208)**	**(77)**	**(298)**	**(164)**	**(1 142)**	**(131)**	**(753)**
% neutrophils	**43**	**42**	**54**	**58**	**57**	**49**	**42**	**48**	**48**	**50**	**51**	**49**
	(13)	**(14)**	**(12)**	**(10)**	**(10)**	**(14)**	**(20)**	**(12)**	**(11)**	**(12)**	**(11)**	**(12)**
% monocytes	**6**	**7**	**7**	**6**	**7**	**7**	**5**	**6**	**6**	**7**	**7**	**6**
	(3)	**(3)**	**(3)**	**(2)**	**(2)**	**(3)**	**(4)**	**(3)**	**(3)**	**(3)**	**(2)**	**(3)**
% lymphocytes	**38**	**40**	**33**	**31**	**32**	**36**	**46**	**40**	**42**	**40**	**38**	**40**
	(9)	**(12)**	**(10)**	**(9)**	**(9)**	**(11)**	**(15)**	**(11)**	**(10)**	**(11)**	**(9)**	**(11)**
% eosinophils	**12**	**10**	**7**	**5**	**3**	**8**	**7**	**6**	**4**	**3**	**3**	**4**
	(8)	**(8)**	**(5)**	**(4)**	**(4)**	**(7)**	**(7)**	**(5)**	**(4)**	**(4)**	**(4)**	**(5)**
% basophils	**0·6**	**0·5**	**0·6**	**0·6**	**0·6**	**0·6**	**0·9**	**0·6**	**0·4**	**0.6**	**0·8**	**0·6**
	(0·9)	**(0·9)**	**(0·7)**	**(0·8)**	**(0·8)**	**(0·8)**	**(1·2)**	**(0·9)**	**(0·7)**	**(0.8)**	**(0·9)**	**(0·8)**

* Standard deviations (SD) given in parentheses.

TABLE VI. MEANS AND STANDARD DEVIATIONS* FOR RURAL AND URBAN VENDA BASED ON ABSOLUTE WHITE CELL COUNTS

Variable	Rural						Urban					
Age-group (years):	17 - 19	20 - 29	30 - 39	40 - 49	50 - 65	Total	17 - 19	20 - 29	30 - 39	40 - 49	50 - 65	Total
Neutrophils	3 442	2 681	3 516	3 889	3 629	3 189	2 140	3 539	2 744	4 328	3 130	3 564
	(1 720)	(1 370)	(1 689)	(1 823)	(1 025)	(1 577)	(1 035)	(2 529)	(1 247)	(7 392)	(1 044)	(4 931)
Monocytes	465	406	455	406	419	418	248	408	334	509	422	431
	(236)	(176)	(209)	(199)	(205)	(192)	(162)	(277)	(172)	(764)	(186)	(519)
Lymphocytes	2 885	2 474	2 043	2 019	1 996	2 286	2 349	2 617	2 302	2 994	2 305	2 634
	(851)	(902)	(614)	(718)	(636)	(834)	(780)	(825)	(670)	(3 534)	(607)	(2 343)
Eosinophils	1 017	650	355	279	201	499	334	382	210	211	189	235
	(772)	(562)	(258)	(234)	(251)	(505)	(340)	(420)	(256)	(326)	(215)	(314)
Basophils	66	31	39	41	34	36	49	39	21	47	52	41
	(113)	(52)	(45)	(58)	(52)	(57)	(70)	(59)	(37)	(99)	(55)	(75)
Neutrophil	1·28	1·24	1·94	2·08	1·97	1·60	1·19	1·42	1·29	1·46	1·46	1·41
Lymphocyte	0·76	0·77	1·26	0·93	0·84	0·98	1·03	0·97	0.63	1·06	0·66	0·89

* Standard deviations (SD) given in parentheses.

TABLE VII. STATISTICAL EVALUATION OF WHITE CELL FINDINGS IN RURAL AND URBAN VENDA

Variable	Effect of age in specified populations: Rural	Effect of age in specified populations: Urban	Age range in which the two populations differed significantly at a 5% level
Total white cells	Highly significant (P<0·1%)	None	None
% neutrophils	Highly significant (P<0·1%)	None	48 - 65 years
% monocytes	None	None	None
% lymphocytes	Highly significant (P<0·1%)	None	23 - 65 years
% eosinophils	Highly significant (P<0·1%)	Significant (5%)	17 - 43 years
% basophils	None	None	None
Total neutrophils	Highly significant (P<0·1%)	None	None
Total monocytes	None	None	None
Total lymphocytes	Highly significant (P<0·1%)	None	None
Total eosinophils	Highly significant (P<0·1%)	Significant (5%)	All ages
Total basophils	None	None	None
Neutrophil / Lymphocytes	Highly significant (P<0·1%)	None	17 - 32 years

iron intake of the rural Venda must either have been present mostly in an unassimilable form, or else that parasitism was responsible for occult blood loss. The latter view appears to be supported by the white cell findings. As for the urban Venda, such changes as can be attributed to a transfer from the rural to an urban environment seem to suggest ordinary response to reduced parasitism and an increased dietary intake of assimilable iron as well as other haemopoietic factors.

Sedimentation rate. The results, on the whole, indicate that significantly higher values were found in the rural as compared with the urban population (Tables II and III). No relationship between age and haemoglobin or the white cell pictures could be found to account for the age effects in the sedimentation rates.

White Cell Picture

No significant difference between the two populations in respect of total white cell counts could be demonstrated at a 5% level (Table VII). However, the two groups differed significantly within certain age ranges in respect of the percentage counts for neutrophils, lymphocytes and eosinophils. On the basis of the absolute values for the differential counts, on the other hand, a significant difference for all age-groups was found in respect of eosinophils only.

The greater incidence of both a relative and an absolute eosinophilia in the rural group can almost certainly be considered to indicate that parasitism was more common in this group than in the urban group.

This finding is not at all surprising as the rural group lived in an area where rivers and streams are infected with bilharzia. Other sources of parasitism, particularly those which accompany poor sanitation, should however also be considered as possible causes for the increased eosinophilia. The higher incidence of eosinophilia in the younger age-groups of both populations might be associated with the fact that younger persons would be more likely to bathe in rivers and streams than older persons. The fact that the age range in which there was a significant difference between the two groups was greater in respect of the total eosinophil counts than in the percentage counts, may be ascribed to differences, although not statistically significant, in the total white cell counts.

A significant difference between the two populations was also found with regard to the neutrophil/lymphocyte ratio for the age-group 17 - 32 years, but it is difficult to draw any conclusions from this finding at this stage. It might, however, be worth while to obtain more information on this variable in future haematological surveys.

As stated before, no association could be found between any aspect of the white cell counts and the sedimentation rates that could be held to point to a greater incidence of focal or general sepsis on the part of the rural population. The presence of streptococcal or staphylococcal infection can normally be expected to cause a rise in the total leucocytes as well as in the total and percentage neutrophil counts, together with an increase in the sedimentation rates. An increased incidence of virus or even bacillary infections is not necessarily excluded, however, by the rural findings.

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