INFLUENCE OF VARIOUS BIOCHEMICAL AND HAEMATOLOGICAL FACTORS ON "PACKED CELL VOLUME"

By

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In spite of differences in racial and Socio-Economical conditions, remarkable uniformity in the average normality of packed cell volume at sea level has been observed all over the world (Wintrobe 1933, Nelson & Stoker, 1937, Hamre & Auim, 1942). Packed cell volume is estimated as a part of the haematological investigations. Little attempt has been made in correlating and statistically analysing the influence of various biochemical and haematological factors associated with it.

Keeping this in view the present study was undertaken on normal healthy Indians (I. C. M. R. 1953).

MATERIAL AND METHODS

The investigation was carried out on 56 males and 44 females in the morning hours in the post-absorptive period, McCarthy, *et. al.* (1939); Brown, *et al.* (1946). The blood containing a mixture of potassium and ammonium oxalate in the ratio 2 : 3, as suggested by Heller and Paul (1934) was used for various estimations.

Wintrobe haematocrit was used for measuring packed cell volume (spinning being done for 50–55 minutes) Chaplin and Mollison (1952).

Thompkins modification (1948) of Haymes fluid was employed for the enumeration of erythrocytes.

Haemoglobin was measured by means of Leitz photocolorimeter which was calibrated according to Van Slyke (1927) oxygen capacity method.

Serum Calcium values were obtained by titrimetric method of Clark and Collip (1925) and phosphorus values by photocolorimetric technique of Fisk and Subbarow (1925).

Total proteins and albumin and globulin fractions were obtained by Nesslerization (King 1951).

OBSERVATIONS

The figures for the packed cell volume in 56 males and 44 females are given in Table I.

Part of the work was done as a thesis for M. D. examination of the University of Punjab at Lady Hardinge Medical College, New Delhi.

TABLE I

Packed cell volume

Sex.	No. of observations.	Max.	Min.	Average.	Variance	Standard deviation.	Co-eff of variation
Males	56	53%	33%	45·0536	23·2153	4·8182	10 69
Females	44	51%	34%	41·6227	21·3531	4·6215	11·10

Table No. II gives distribution of the cases in males and semales.

TABLE II

Sex	P. C. V. range	No. of cases	Percentage
Males	45% and above	31	55·36
	40–44%	19	33·93
	Below 40%	6	10·71
Females	45% and above	9	20·45
	40–44%	20	45·45
	Below 40%	15	34·10

The figures given in literature as compared to the present study are tabulated in Table III A and B.

TABLE IIIA

MALES

Range	S. D.	Average	Cases	Authorities
55·60–44·10	3·02	50·53	30	Napier and Das Gupta (1936)
40·02–32·47	..	41·72	121	Sokhey *et al* (1939)
51·23–28·34	4·81	42·18	25	Napier and Mazumdar (1938)
..	4·17	47·00	75	Khanna and Sachdev (1946)
50·00–40·00	..	46·00	38	Chini and Chen-Ting (1947)
..	4·12	49·27	100	Ramalinga Swami and Venkatachalam (1950)
55·50–35·00	5·17	45·25	..	Chaudhri and Mitra (1957)
52·00–34·50	6·74	43·55	..	Do.
51·00–28·00	..	44·00	12	Do.
45·00–30·00	..	37·00	22	Do.
53·00–33·00	4·82	45·05	56	Present study.

TABLE III B

FEMALES

Range	S. D.	Average	Cases	Authorities
..	..	38·04	50	Wintrobe (1930) uncorrected
..	..	39·50	50	Do. corrected
..	..	38·35	369	Do. (1933) uncorrected
..	..	41·80	369	Do. corrected
47·60–17·99	7·34	37·07	25	Napier and Mazumdar (37-38)
..	2·98	41·72	..	Sohhey *et al.* (1937)
44·67–28·40	3·048	36·269	101	Sokhey *et al.* (1938)
42·00–30·00	3·10	34·60	20	Napier and Billimoria (1937)
..	1·04	41·80	25	Khanna and Sachdev (1946)
46·00–37·00	..	41·00	43	Chini and Chen-Ting (1947)
49·00–10·50	..	28·80	12	Chaudhri and Mitra (1951)
38·00–16·00	..	29-90	22	Do.
49·00–29·59	4·12	53·30	106	Do.
47·00–32·00	5·05	47·40	50	Do.
..	2·70	41·60	100	Singh *et al.* (1953)
51·00–34·00	4·6215	41·622	44	Present study

Relation of plasma protein to packed cell volume.

It was observed it both sexes that with a fall of total protein level there was a decline in the values of cell volume (Table IV). This was specially so when the deflection was in the albumin fraction (Table V). No such relation with globulin fraction was ohserved (Table VI).

TABLE IV

Males			Females	
Range total protein gm. per cent	Average total protein gm. per cent	Average PCV per cent	Average total portein gm. per cent	Average PCV per cent
Above 8·00	8·23	46·67	8·03	50·0
7·5–7·99	7·75	44·83	7·675	43·8
7·0–7·49	7·23	43·61	7·219	41·62
6·5–8·99	6·74	44·93	6·73	40·0
6·0–6·49	6·1	42·16	6·18	42·0
Below 6·00	..	39·00	5·96	35·00

TABLE V

	Males		Females	
Range albumin gm. per cent	Average albumin gm. per cent	PCV per cent	Average albumin gm. per cent	PCV per cent
Above 5·25	5·350	..	5·350	43·00
5·00-5,24	5·087	46·22	5·114	43·67
4·75-4·99	4·867	45·50	4·880	40·80
4·50-4·74	4.583	45·50	4·593	42·875
5·25-4·49	4·371	45·20	4·408	42·00
4·00-4·24	4·123	45·20	4·I44	41·64
3.75-3·99	3·900	41·45	3·990	41·00
3·50-3.74	3·550	41·45	3·700	40·50
Below 3·50	..	32·10	..	..

TABLE VI

Range Globulin gm. per cent	Average Glob. gm. per cent	PCV per cent	Average Glob. gm. per cent	PCV per cent
Above 3·50	3·59	48·00	3·62	38·00
3·35-3·49	3·876	46·00	3·37	42·70
3·00-3·24	3·10	47·50	3·10	42·70
2·75-2·99	2·82	44‘50	2·84	43·30
2·50-2·74	2·634	44·80	2·63	42·40
2·25-2·49	2·372	47·25	2·173	45·70
Below 2·00	1·910	38·67	1·1847	41·50

Multiple correlation and multiple regression equation of PCV on albumin and protein was calculated for males.

Multiple correlation: 0.372.

Multiple regression equation of PCV (25·3146—2·3825 total proteins 0·6850 albumin).

Standard error was 8·9446.

As multiple correlation was not significant and sensitivity test was not positive so this formula could not be recommended for prediction purposes.

Relationship of serum calcium and phosphorus to PCV

No relationship of serum calcium or inorganic phosphorus to PCV was observed (Table No. VII & VIII).

TABLE VII

Males			Females	
Range Calcium mg. per cent	Average calcium mg. per cent	PCV per cent	Average calcium mg. per cent	PCV per cent
Above 11·00	11·750	46·9	11·23	49·00
10·50-10·99	10·765	46·4	10·60	43·625
10·00-10·49	10·203	46·5	10·11	41·75
9·50- 9·99	9·694	46·13	9·67	43·20
9·00- 9·49	9·16	44·63	9·13	38·14
8·50- 8·99	8·77	41·00	8·67	39·00
8·00- 8·49	8·229	40·25	8·185	37·02

TABLE VIII

Males			Females	
Range Phosphorus mg. per cent	Average Phosphorus mg. per cent	PCV per cent	Average Phosphorus mg. per cent	PCV per cent
5·00-5·25	5·107	41·00	5·05	39·00
4·75-4·99	4·912	43·20	4·915	39·45
4·50-4·74	4·610	43·50	4·59	45·66
4·25-4·49	4·334	46·25	4·325	43·00
4·00-4·24	4·088	45·40	4·163	41·50
3·75-3·99	3·774	46·71	3·847	44·142
3·50-3·74	3·510	48·33	3·568	39·833
3·25-3·49	3·275	40·75	3·568	39·833
Below 3·25	2·984	45·67	..	..

Relation of red blood cell count and haemoglobin to PCV.

In the analysis of this relationship, it was observed that with a fall of red blood cells the packed cell volume and the haemoglobin showed a progressive fall (Table IX). This direct relationship was confirmed in the study of packed cell volume to red blood cells (Table X).

TABLE IX

Males				Females		
Range RBC millions/cmm.	Average RBC	Haemoglobin gm. per cent	PCV per cent	Average RBC	Hb. gm. per cent	PCV per cent
Above 6·25	6 366	16·15	50·00	..	..	..
6·00-6·25	6·187	17·375	51·00	..	..	..
5·75-5·99	5·933	15·82	51·66	..	..	..
5·50-5·74	5·560	15·975	46·75	..	..	..
5·25-5·49	5·340	10·179	48·50	54·40	14·66	48·66
5·00-5·24	5·070	15·070	44·875	53·09	13·96	46·64
4·75-4·99	4·840	14·300	43·943	43·87	13·89	43·90
4·50-4·74	4·610	14·464	42·143	42:899	12·61	39·12
4·25-4·49	4·290	13·230	39·750	42·32	12·35	38·66
4·00-4·24	4·750	11·750	39·000	42·07	12·05	37·00
Below 4·00	3·660	12·317	35·330	09·903	09·43	35·25

TABLE No. X

Males				Females		
Range PCV	Average PCV per cent	Hb. gm. per cent	RBC cmm.	Average PCV per cent	Hb. gm. per cent	RBC cmm.
Above 51	51·75	17·16	6 04	51·00	12·80	5·50
49-50·9	49·28	16·56	5·59	49·50	13·85	5·125
57-48·9	47·33	13·93	5·19	47·30	15·20	5·120
45-46·9	45·85	14·76	5·05	45·50	12·65	4·890
43-44·9	43·50	15·36	4 95	43·917	14·55	4·980
41-42·9	41·57	13·84	4·64	41·580	13·426	4·579
39-40·9	39·80	13·56	4·55	39·710	12·685	4·510
37-38·9	37·00	13·20	3·95	37·200	10·780	4·150
35-36·9	35·66	12·63	4·28	35·430	11·510	4·090
33-34·9	33·00	..	3·35	34·000	09·800	3·850

Multiple correlation of PCV on red blood cells and haemoglobin was calculated and was 0·732053. This was highly significant. Regression and multiple regression equation for either sex was formulated.

MALES :

PCV:—10·3244 plus 4·6207 R. B. C. plus 0·7502 Hb.

Standard error:—4·9880

Regression of PCV on Haemoglobin :—PCV :—9·18207 plus 2·262 Hb.

Regression of PCV on RBC :—PCV :—14·52222 plus 6.0048 RBC.

FEMALES :—

PCV:—4·2387 plus 6·6273 RBC plus 0·521 Hb.

Regression of PCV on haemoglobin :—17·216 plus 1·878 Hb.

Regression of PCV on RBC :—0·1817 plus 8·9641 RBC.

Since significantly high correlation existed between these two factors individually and collectively so an attempt has been made to prepare a nomogram (Graphs 1 & 2).

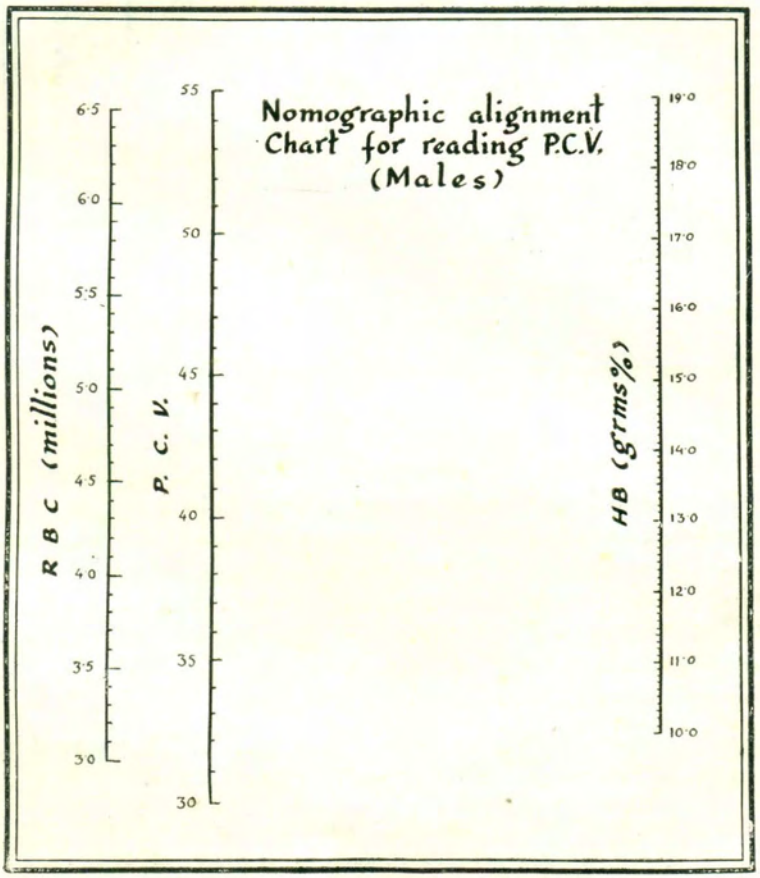

Fig. 1.

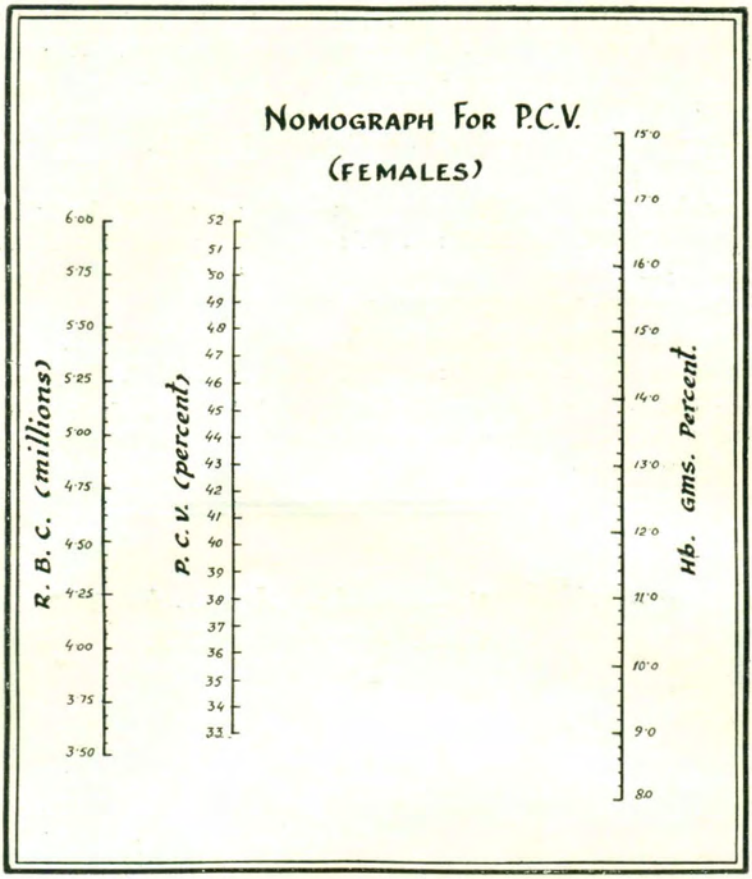

Fig. 2.

DISCUSSION

The average packed cell volume was 45·05±4·81 in males and 41·62±4·6 in females with a spread of 33 to 53 per cent in males and 34 to 51 per cent in females. When compared to the values reported in the literature, the average in the female series agreed closely to the values reported by Singh *et al.* (1953), Sokhey *et al.* (1957) and Khanna and Sachdev (1946). The male values were in agreement with Chini and Chen-Ting (1947) and Chaudhry and Mitra (1957).

The values quoted by various workers vary widely. They spread between 56·00% to 28·39% in males and 49·00% to 10·5% in females.

The high values recorded may be due to low revolution per minute of the centrifuges which are commonly used in ordinary laboratories, though

the spinning might have been done for 50 minutes or more, since it is the speed of the centrifuging which influences the packing more than the time.

The low values recorded may be due to the random collection of the samples without regard to the criterion of health of subjects.

Plasma proteins and especially the albumin fraction seemed to posses some relotionship to PCV while globulin fraction had none. An increase or decrease in total proteins and albumin was associated with an increase or decrease in packed cell volume per cent in both sexes. The specific mechanism by which they influence it, is a matter of future study (Tables IV, V and VI). The statistical analysis revealed no significant relationship. Multiple regression equation was calculated but is of no practical value. No other biochemical factors studied appeared to have any influence on cell volume. Haematological factors, especially red blood cells and haemoglobin, had direct relationship to packed cell volume (Table IX & X). Since statistical analyses revealed a significantly high correlation, a multiple regression equation could be recommended for prediction purposes.

Like other nomograms this nomogram is based on statistical calculations and is good enough to find out approximate values, but for research or accurate values the usual estimations should be done.

SUMMARY

1. Average packed cell volume for either sex with statistical findings have been calculated.

Males :—45·05±4·82

Females :—41·62±4·62

2. Influence of total protein (total protein and albumin fractions) on PCV was studied and total protein and albumin fraction were found to have some bearing on it.

3. Relation of PCV to RBC and haemoglobin was analysed and an alignment chart prepared.

4. No relationship between PCV and serum calcium or phosphorus was found.

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