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Correlation between Cyanomethaemoglobin and Oxyhaemoglobin Levels and other Haematological Parameters in Two Contrasting Populations

SANAT K. BHATTACHARYA[1], PARTHA P. MAJUMDER[2]

[1] *Biochemistry Unit, Indian Statistical Institute, 203 B. T. Road, Calcutta-700 035.*
[2] *Applied Statistics Division, Indian Statistical Institute, 203 B. T. Road, Calcutta-700 035.*

Abstract : The paper deals with the estimation of oxyhaemoglobin and cyanomethaemoglobin levels of two populations ; and to find the correlation between them. The study shows that a high correlation between the two types of haemoglobins exists, and with the help of regression equations cyanomethaemoglobin may easily be estimated from oxyhaemoglobin without losing much accuracy.

INTRODUCTION

The estimation of haemoglobin and haematocrit levels in the human blood is of obvious clinical importance (Graitcer *et al.* 1981 ; Hunter *et al.* 1972), especially in view of the fact that anaemia is a common health problem in developing countries like India. From a bio-anthropological standpoint also, it is often necessary to estimate the haemoglobin and haematocrit levels of population groups inhabiting various physical environmental and sociocultural niches (Basu *et al* 1979). As is well known, an estimate, although rough, of haemoglobin level can be obtained by measuring the oxyhaemoglobin level (Kolmer 1951). However, the measurement of oxyhaemoglobin does not take into account the total haemoglobin content in the blood, since derived haemoglobins are ignored in this process of measurement (Hawk 1978 ; Dacie 1958). To account for this error in measurement, techniques have recently been developed to chemically transform all haemoglobins to a stable form of cyanomethaemoglobin (Blood information service 1977) and then to measure the quantity of this transformed compound to estimate the total haemoglobin level in blood (Dacie 1958). It may be important to stress the fact that while cyanomethaemoglobin gives a more accurate picture of the total haemoglobin content than oxyhaemoglobin, the quantitative measurement of cyanomethaemoglobin is far more tedious than that of oxyhaemoglobin. The simplicity of the technical procedure for measurement of oxyhaemoglobin is ideal for population screening studies.

In view of this, efforts were made to find out whether the oxyhaemoglobin and haematocrit levels could be used to predict, with reasonable accuracy, the cyanomethaemoglobin level of an individual. Two population groups, one

residing in the plains and the other in the highlands of West Bengal, were chosen for this study. The reason for selecting two groups inhabiting two contrasting ecological niches was to examine whether the presumably contrasting ecological stresses lead to differential predictive abilities.

MATERIALS AND METHODS

About 900 blood specimens were collected from the adults of both sexes by finger-pricking from the residents of Chakpota village in the Uluberia subdivision, Howrah District, and those of several villages in the Kalimpong subdivision, Darjeeling Disttrict, in West Bengal. Chakpota is situated in the deltaic plain region, while the villages in Kalimpong subdivision lie in medium altitudes. All blood specimens were electrophoretically screened, and the results of the haemoglobins of only those individuals who were homozygous HbAA were selected (n=880) for this study.

RESULTS

The sample sizes are given in Table 1. Henceforth we shall designate Oxyhaemoglobin as OHb, cyanomethaemoglobin as CHb, and haematocrit (Packed Cell Volume) as PCV.

Table 1. *Mean values and standard deviations of age, CHb, OHb and PCV classified by sex and resident status*

Variable	PLAINS-RESIDENTS (n=313)				MOUNTAIN-DWELLERS (n=567)			
	Male (n=195)		Female (n=118)		Male (n=276)		Female (n=291)	
	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
Age	37.835	13.985	36.457	12.905	41.311	14.388	37.755	13.406
CHb	14.528	2.058	13.019	1.176	14.221	2.486	12.342	2.289
OHb	13.372	1.683	11.731	1.201	13.177	2.352	11.246	2.113
PCV	43.197	5.290	37.745	4.452	41.558	5.759	36.879	5.017

The mean values and standard deviation of the variables Age, CHb, OHb and PCV are presented in Table I separately by sex and habitat, i.e., plains or highlands. In order to check whether the data need to be treated separately by sex and residence status, we performed tests, separately for the four variables, to compare the equality of mean values of plains residents and highland dwellers within each sex separately.

The values of the large sample N (0,1) test statistic are presented in Table 2 for these comparisons. It is seen that the hypothesis of equality of mean values is rejected in most cases, which indicates that the data need to be treated separately both by sex and by resident status.

From Tables 1 and 2, it is also seen that the males have, on an average, higher values than females; and also that, on an average, the residents of plains

Table 2. *Values of the test—statistic for testing equality of mean values of different variables for various group comparisons*

Groups Compared			Variable			
			Age	CHb	OHb	PCV
Plains-resident Male	vs.	Mountain-dweller Male	-2.62*	1.46	1.05	3.19*
Plains-resident Female	vs.	Mountain-dweller Female	-0.91	3.93*	3.04*	2.68*
Plains-resident Male	vs.	Plains-resident Female	0.89	8.25*	10.04*	9.77*
Mountain-dweller Male	vs.	Mountain-dweller Female	3.04*	9.35*	10.27*	10.29*

*Significant at the 5% level.

have higher values than the highland dwellers. In Tables 3 and 4 are presented the correlation matrices among the variables for residents of plains and highlanders, respectively. There is a significant decrease in the values of haematological traits with advancing age among males; the pattern among females seems to be inconsistent. The correlation between CHb and OHb is, as expected, higher in all cases than that between CHb and PCV or between OHb and PCV. Thus only PCV may not be a suitable predictor of CHb or OHb. The pairwise correlations among the haematological traits are consistently higher among the highland dwellers than among the residents of plains.

Table 3. *Matrix of pairwise correlation coefficients among variables for residents of plains (Figures below the diagonal pertain to females, and those above the diagonal pertain to males)*

	Age	CHb	OHb	PCV
Age	1.000	-0.314*	-0.331*	-0.335*
CHb	-0.042	1.000	0.800*	0.622*
OHb	0.068	0.838*	1.000	1.739*
PCV	-0.009	0.430*	0.425*	1.000

*Significant at the 5% level

Table 4. *Matrix of pairwise correlation coefficients among variables for mountain dwellers (Figures below the diagonal pertain to females, and those above the diagonal pertain to males)*

	Age	CHb	OHb	PCV
Age	1.000	-0.253*	-0.249*	-0.276*
CHb	0.210*	1.000	0.960*	0.899*
OHb	0.180*	0.920*	1.000	0.906*
PCV	0.192*	0.893*	0.948*	1.000

*Significant at the 5% level

In order to find out which one of the variables OHb, PCV and age are significant for the purpose of predicting CHb, we performed a stepwise regression analysis. In this analysis, the variable most correlated with CHb is entered

into regression equation first, and variables are entered successively, in decreasing order of importance in prediction (as judged by the multiple correlation coefficient), into the regression equation. The results of this analysis are presented in Table 5.

Table 5. *Results of stepwise regression analysis : Multiple correlation coefficients and final regression equations*

Group	Multiple Correlation Coefficient between CHb and Variables in Regression Equation	Regression Equation				
		Constant	Variable	Coefficient	Variable	Coefficient
Residents of Plains : Male	0.8002	1.4848	OHb	0.9787	—	—
Female	0.8382	3.3854	OHb	0.8212	—	—
Mountain Dwellers : Male	0.9624	-0.0074	OHb	0.8606	PCV	0.0695
Female	0.9226	0.0810	OHb	0.7935	PCV	0.0905

It is seen from this table that age is not a significant predictor of CHb if values of OHb and/or PCV are given. Furthermore, among the residents of plains, given OHb, HCV does not contribute significantly to the predictive ability of CHb, while among highland dwellers PCV does contribute significantly to the predictive ability of CHb although OHb is the more important predictor.

DISCUSSION

That the haematological values of the highland dwellers are lower than those of inhabitants of the plains may be explained by the fact that the former group suffers more from acute hookworm infestation (Bhattacharya 1980, Bhattacharya *et al.* 1981, Bhattacharya *et al.* 1985). The significant decrease of haematological values with advancing age are well known in males (Kolmar 1951). Inconsistent amounts of blood loss at the time of menstruation is known to occur in case of adult females of the child bearing age (Hawk 1978), which may account for the inconsistent patterns in the relationships of haematological values with age in females.

Table 5 also shows that while for the highland dwellers, who have lower haemoglobin level, PCV value is significantly useful predicting CHb, while it is not a significant predictor of CHb for the residents of the plains. The finding that OHb is highly correlated with CHb indicates that 'only OHb level may be used to predict the CHb level with a great deal of accuracy. Among highland dwellers, use of the PCV value along with the OHb level adds significantly to the power of predicting CHb. Thus, use of these regression equations may help in avoiding the laborious chemical estimation of CHb, without losing much accuracy on the average.

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