RESULTS

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In this study three (3) groups of anaemia had been taken to study the level of glycosylated haemoglobin in each group.

The iron deficiency	23 cases
Haemolytic anaemia	23 cases
Hypoplstic anaemia	10 cases

A group of 20 clinically healthy subjects was included forming the reference group.

The results obtained are presented as follows:

Control group:

Consisted of twenty (20) cases with ages ranging between eight and fourty five years. Ten were females and ten were males, (Table I) The haemoglobin value ranged from 10.9 to 12.9 g/dL with a mean value of 11.9±0.73 g/dL. The red cell count ranged from 4.2 to 5.5/Cumm with a mean value of 4.8 ±0.37/Cumm. The packed cell volume (PCV) ranged between 38 to 44 with a mean value of 40±3.97. The level of mean corpuscular volume (MCV) ranged from 75 to 90fl with a mean value of 84.65±5.18 fl. The value of mean corpuscular haemoglobin concentration ranged between

The reticulocytic count ranged between 0.1 to 0.6% with a mean vlue of 0.34 ± 0.19%. The value of fetal haemoglobin ranged between 0.5% to 1.8% with a mean value of 0.83± 0.31 %. The haemoglobin A_2 ranged between 1.5 to 3% with a mean value of 2.41%±0.6%.

The glycosylated haemoglobin level ranged between 5.2% to 8.8% with a mean value of 7.01%±1.1%.

Table II showing the results of the iron deficiency group which consisted of twenty three cases with ages ranging between eighteen to fourty. Five of them were females and eighteen were males.

The haemoglobin vlaue ranged between 5.4 g/dL to 9 g/dL with a mean value of 7.7 g/dL ± 0.79 g/dL. The reld cell count ranged between 3.3/Cumm to 4.1/Cumm with a mean value of 3.8±0.29/Cumm.

The value of packed cell vvolume (PCV) ranged between 20 to 32 with a mean value of 27.6±2.54. The mean corpuscular haemoglobin (MCV) ranged between 64 fl to 77 fl with a mean value of 69.6 fl ± 3.75 fl.

The MCHC value ranged between 20 to 29 g/dL with a mean value of 25.8 ± 2.74 g/dL. The reticulocytic

count ranged between 0.1% to 1.5% with a mean value of 0.44%±0.37%.

Fetal ahemoglobin level ranged between 0.1% to 8.8% with a mean value of 0.51% ± 0.44. The level of serum iron ranged between 29 to 25 mg/L with a mean value of 41±8.43 mg/L. The value of T.I.B.C. ranged between 270 mg/L to 380 mg/L with a mean value of 298±37.83 mg/L. The transferrine percent of saturation ranged from 8.5% to 17% with a mean value of 13.94±2_63.

The glycocylated haemoglobin ranged between 8.4% to 11% with a mean value of 9.9%±0.75%.

Table III showing the haematological data of thalassemia group. Eleven cases were taken the age ranging between two to eleven years eight males and three females.

The haemoglobin level ranged between 2.8 g/dL to 8.9 g/dL with a mean value of 4.7 g/dL ± 1.6 g/dL. The R.B.Cs count ranged between 3.1/Cumm to 4/Cumm, with a mean value of 3.37±0.36/Cumm.

The PCV value ranged between 21 to 29 with a mean value of 28.8 ± 2.52.

The MCV ranged between 62 fl to 70 fl with a mean values of 65.91 fl ± 2.91 fl.

The MCHC level ranged between 11 to 29 g/dL with a mean value of 8.27 ± 5.25 g/dL. The reticulocytic count ranged between 2.2% to 5.5% with a mean value of 4.3% ± 1.5%. The HbF level ranged between 8% to 40% with a mean value of 21.6% ± 10.5.

The level of A_2 ranged between 1.5% to 3.5% with a mean value of 9.59% ± 0.7.

The glycosylated haemoglobin level ranged between 11.2% to 25.2% with a mean vlaue of 4.7% ± 4.5%.

Table IV showing the results for the group of G6PD deficiency which consisted of nine(9) casses all were males aging between four to nine years. The level of total hemoglobin ranged between 3.5 g/dL to 11.1 g/dL with a mean value of 7.03 g/dL ± 2.9 g/dL. The red cell count ranged between 2.5/Cumm to 3.2/Cumm with a mean value of 2.92/Cumm ± 0.24/Cumm. The packed cell volume (PCV) ranged between 44 to 32 with a mean vlaue of 27.4±9.5. The MCV value ranged between 80 to 100 fl with a mean value of 89 fl ± 8.13 fl.

The MCHC value in this group ranged between 17 g/dL to 30 g/dL with a mean value of 24.33 g/dL ± 5.43 g/dL.

The reticulocytic count ranged between 0.6% to 9.0% with a mean value of 4.8% ± 3.3%. The fetal hemoglobin level ranged between 0.3% to 0.8% with a mean value fo 0.54% ± 0.17%.

The haemoglobin A_2 ranged between 1.5% to 3.10% with a mean value of 2.13% ± 0.60%. The glycosylated haemoglobin (HbA_{1c}) ranged between 3.5% to 7% with a mean value of 4.9% ± 1.03%.

Table (V) showing the results of immune haemolytic anaemia group which consisted of three (3) cases all were males aging between 8 to 12 years. The total hemoglobin level ranged between 7 to 12 g/dL with a mean value of 9 g/dL ± 2.7 g/dL.

The R.B.C's count ranged between 2.5/Cumm to 3.2/Cumm with a mean vlaue of 2.9 g/dL ± 0.378/Cumm. The PCV values ranged between 31 to 28.5 with a mean vlaue of 30.5 ± 1.8.

The MCV ranged between 89 fl to 124 fl with a mean vlaue of 105 fl ± 17.61 fl.

The MCHC ranged between 22 g/dL to 39 g/dL with a mean value of 33.5 g/dL ± 7.77 g/dL. The reticulocytic count ranged between 5.3% to 10.5% with a mean value of 7.3% ± 2.8%. The fetal haemoglobin ranged between 5% to 1.0% with a mean value of 0.766%±0.252%. The level of glycosylated haemoglobin ranged between 2.8% to 5.3% with a mean value of 3.9%±1.3%.

Table (VI) showing the results of the hypoplatic anaemia group which consisted of ten (10) patients two of them were females and eight(8) were males aging between eighteen to fourty years.

The haemoglobin level ranged between 2.8 g/dL to 7.2 g/dL with a mean value of 5.4 g/dL ± 1.2 g/dL. The red cell count vlaues ranged between 1.4/Cumm to 2.8/Cumm with a mean vlue of 1.9/Cumm ± 0.449/Cumm.

the packed cell volume (PCV) ranged between 12 to 25 with a mean value of 18.5±3.43. The mean corpuscular volume (MCV) ranged between 64 fl to 100 fl with a mean value of 82.9 fl ± 13.0 fl.

The mean corpuscular haemoglobin concentration (MCHC) ranged between 23 g/dL to 30 g/dL with a mean value of 27.9 ± 1.91 g/dL.

The platlet count in this group ranged between 18.000 IL to 30.000 IL with a mean value of 25.200 ± 3.88.

The reticulocytic count ranged between 0.0 to 0.4% with a mean vlaue of 0.2% ± 0.1%.

The level of fetal hemoglobin ranged between 0.4% to 0.9% with a mean value of 0.54% ± 0.157%.

The glycosylated haemoglobin level ranged betwen 0.2% to 3.2% with a mean value of 2.3% ± 0.8%.

Table VIII shows that HBA_{1c} was higher in thalassaemia than in the control group, and this difference is statistically significant ($P < 0.001$), while it was lower in G6PD deficiency than the control and the difference also highly significant ($P < 0.001$).

Glycosylated haemoglobin was also lower in hypoplastic anaemia group and immune haemolytic anaemia group than the control group, and the difference was also statistically significance ($P < 0.0005$).

In iron dleficiency anaemia group, the HbA_{1c} range ws significantly higher than control group ($P < 0.001$).

However there was a negative correlation between HbA_{1c} and total haemoglobin r = -0.323 P 0.02 Fig. No. 1. Simple regression euqation y = 12.52-0.34. No significant correlation existed between HA_{1c} and the other parameters of iron dleficiency group.

In thalassaemia major there was good correlation between HbA_{1c} and haemoglobin F Fig.2. r=0.245 and the linear regression equation is represented by

$$y = 13.4 + 0.54\ x$$

$$P < 0.01$$

Also there was a correlation between HbA_{1c} and reticulocytic count in the group of thalassaemia major r= 0.007 and P < 0.001. The linear regression equation is presented by

$$Y = 13.75 + 0.21\ X \quad \text{Fig. 3}$$

There was also a correlation bletween HbA_{1c} and MCHC where r = -0.589, P < 0.028 Y = 23.835-0.589x(Fig.4).

In the G6PD deficiency group there was a significant correlation beltween reticulocytic count and HbA_{1c} r=0.125

and the linear regression equation is 4.74 + 0.04 x (Fig. 5). ($P < 0.001$). There was no correlation between HbA_{1c} and the other parameters.

In immune haemolytic anaemia group. There was a positive correlation between HbA_{1c} and the reticulocytic count r=0.979 the simple regression euqation presented as

Y = -1.126 + 2.75 x Fig. 6. (P 0.01).

In the hypoplastic group, there wlas a positive correlation between HbA_{1c} and the total haemoglobin r=0.7427 and $P < 0.007$. Simple regression Y=-1.081+0.7426x Fig. 7. P 0.001.

There was also a correlation between HbA_{1c} and the packed cell volume r=0.667 P 0.010.

Simple regression Y=-1.185+0.667x Fig.8. No significant correlation between HbA_{1c} and other parameters was found.

Table (1): Haematological data in non anaemic groups.

Sex No.	Age	Sex	Hb g/dc	RBC	PCV	MCV	MCHC	Reticule count %	HbF%	HbA_2%	HbA_{1c}%
1	21	F	11.7	4.4	40	90	31	0.3	0.8	1.8	8.8
2	28	M	12.8	5.0	42	84	31	0.1	0.6	2.2	7.0
3	31	F	11.9	4.8	39	81	31	0.3	1.1	3.0	7.7
4	16	M	12.5	5.2	42	81	30	0.5	0.8	2.8	6.3
5	19	M	12.3	5.2	43	83	29	0.2	0.8	2.7	5.2
6	35	F	12.9	4.8	41	85	32	0.2	0.7	2.8	9.0
7	18	F	10.2	5.0	39	78	29	0.5	0.5	1.5	7.5
8	11	M	12.6	5.5	44	85	30	0.3	1.2	1.6	5.7
9	9	M	12.9	4.9	42	86	31	0.2	0.5	2.8	6.1
10	18	M	12.0	5.1	41	81	30	0.5	1.0	3.0	7.0
11	12	M	11.5	4.8	40	84	29	0.4	0.9	2.9	8.0
12	30	F	11.4	4.8	38	79	31	0.6	0.9	1.8	6.6
13	35	M	12.0	5.3	40	75	31	0.3	0.6	2.1	7.2
14	28	F	10.9	4.4	39	88	30	0.3	0.8	1.5	7.5
15	40	M	12.5	4.9	42	86	32	0.2	1.1	2.5	6.1
16	25	F	11.5	4.6	39	87	30	0.3	0.7	2.8	7.5
17	41	M	11.8	4.2	41	95	29	0.1	1.8	1.9	8.8
18	8	F	11.6	4.2	38	90	31	0.3	0.7	1.8	6.0
19	45	F	11.4	4.5	40	88	30	0.5	0.6	3.1	5.8
20	9	F	10.9	4.4	39	87	28	0.6	0.7	2.6	6.9
M			11.9	4.8	40	84.65	31	0.34	0.8389	2.41	7.01
S.D.			0.73	$\pm$0.37	$\pm$3.97	$\pm$5.18	$\pm$1.07	$\pm$0.196	$\pm$0.317	$\pm$0.6	$\pm$1.1

Table (II): Haematological data in iron deficiency group.

Sex No.	Age	Sex	Hb/dL	R.B.C.	PCV	MCV	MCHC	Reticule count %	HbF%	S.I mg/L	T.I.B.C. mg/L	% saturation	HbA_{1c}%
1	18	M	7.7	4.0	28	70	27	0.2	0.1	33	388	8.5	9.9
2	22	M	6.4	4.0	30	75	21	0.1	0.4	50	295	16.3	10.2
3	19	F	7.0	3.8	28	73	25	0.5	0.0	55	290	16.0	10.4
4	19	M	6.3	4.0	26	64	24	0.1	0.09	35	281	14.6	10.5
5	21	M	8.4	3.8	28	73	28	0.2	0.1	37	240	14.3	10.4
6	25	F	8.1	3.9	26	66	28	0.8	0.2	40	280	15.8	10.9
7	28	M	9.0	4.1	20	64	26	0.1	0.6	37	270	13.7	8.4
8	22	M	7.5	3.9	26	66	28	0.1	0.1	42	285	14.8	10.6
9	16	M	7.7	4.1	30	72	26	0.4	0.5	56	280	16.0	8.5
10	31	M	8.5	4.1	30	73	28	0.2	0.2	48	283	11.9	9.9
11	35	M	7.3	3.0	30	65	24	0.5	0.6	31	295	8.1	9.5
12	28	F	5.4	4.1	27	65	20	1.0	0.0	33	300	14.9	10.5
13	39	M	7.3	3.6	25	68	29	0.2	0.8	35	380	14.5	9.6
14	18	M	8.2	3.5	28	77	21	0.5	1.0	45	283	15.5	10.0
15	25	M	7.9	4.0	29	72	27	0.4	0.6	50	280	17.0	10.5
16	33	M	8.1	4.0	28	70	22	1.5	0.9	30	289	11.6	9.2
17	34	M	6.5	3.8	27	69	24	0.8	1.2	40	290	13.9	11.0
18	20	M	7.0	3.3	24	69	29	0.3	0.8	40	350	14.5	9.2
19	26	F	7.1	3.5	26	66	27	0.2	0.2	50	315	16.5	10
20	37	F	8.9	4.0	30	73	29	1.1	0.1	29	290	7.8	9.4
21	40	M	8.4	4.1	32	74	26	0.5	1.6	35	280	14.7	8.5
22	40	M	7.7	3.9	28	69	27	0.3	8.8	42	255	15.0	10.9
23	22	M	8.3	4.0	29	69	28	0.2	1.1	55	370	14.8	10.3
Mean			7.7	3.8	27.6	69.6	25.8	0.44	0.51	41	298	13.94	9.9
S.D.			±0.79	±0.29	±2.54	± 3.75	±2.74	±37	±0.45	±8.43	±37.83	SD±2.63	±0.75

Table (III): Haematological data in thalassaemia major.

Sex No.	Age	Sex	Hb g/dL	R.B.C./ Cuml	PCV	MCVH	MCHC g/dL	Reticule count %	HbF%	HbA_2%	HbA_{1c}%
1	4 6/12	M	2.8	3.4	24	66	11	4.0	35	1.7	25.5
2	8 4/12	M	4.0	3.1	22	62	18	5.5	27	2.8	11.2
3	10	M	3.7	3.3	25	67	15	6.1	20	2.6	15.5
4	10 6/12	F	3.7	3.0	25	70	15	4.8	18	1.6	12.8
5	8	M	5.0	3.0	21	68	23	5.3	15.5	1.5	12.8
6	9 10/12	F	5.2	4.0	29	66	14	4.1	11	2.9	20
7	10 4/12	F	3.9	3.5	26	66	16	2.4	14.2	2.7	10
8	11	M	4.7	3.2	24	64	20	4.1	20	2.6	14.2
9	7 6/12	M	5.5	3.1	23	68	24	3.7	40	1.9	12.0
10	2	M	8.9	4.0	29	60	29	2.2	8	3.5	12.2
11	5 8/12	M	4.1	3.5	25	68	16	4.5	27	2.7	15
M			4.7	3.37	28.81	65.91	18.27	4.3	21.6	2.52	14.7
S.D.			±1.6	±0.36	±2.52	±2.91	±5.25	±1.5	±10.5	±0.7	±4.5

Table (IV): Haematological data in G6PD deficiency group.

Ser. No.	Age	Sex	Hb g/dL	RBC	PCV	MCV	MCHC	Reticule count %	HbF %	HbA_2 %	HbA_{1c} %
1	4	M	11.1	3.2	28	80	30	2.0	0.4	1.5	7.0
2	7	M	8.0	2.8	26	80	29	1.8	0.6	1.8	5.0
3	6	M	4.0	3.0	26	86	17	8.1	0.5	1.9	5.5
4	5 9/12	M	3.5	3.0	24	80	18	7.5	0.5	1.8	5.3
5	8	M	10.2	3.1	30	95	28	1.5	0.3	2.1	4.0
6	9	M	5.4	2.5	25	95	21	9.0	0.6	3.1	5.3
7	6	M	8.2	2.7	28	98	29	7.2	0.4	3.0	4.7
8	6 10/12	M	3.9	3.2	28	87	19	5.5	0.8	2.5	3.5
9	5 6/12	M	9.0	2.8	32	100	28	0.6	0.8	1.5	4.1
M			7.03	2.92	27.44	89	24.33	4.8	0.545	2.13	4.9
S.D.			±2.9	±0.24	±2.5	± 8.13	±5.43	±3.3	±0.174	±0.60	±1.03

Table (V): Haematological data in immune haemolytic anaemia.

Ser. No.	Age	Sex	Hb g/dL	R.B.C. in millions	PCV	MCV fl	MCHC g/dl	Reticule count %	HbF%	HbA_{1c}%
1	9	M	8	3.2	28.5	89	28	10.5	0.8	5.3
2	12	M	12	2.5	31	124	39	6.2	0.5	3.7
3	8	M	7	3.1	32	103	22	5.3	1.0	2.8
M			9	2.9	30.5	105	33.5	7.3	0.766	3.9
S.D.			±2.7	± 0.378	±1.80	±17.61	±7.77	±2.8	±0.252	±1.3

Table (VI): Haematological data in hypo platic anaemia group.

Ser. No.	Age	Sex	Hb g/dL	R.B.C.	PCV	MCV	MCHC	Plat. count	Reticule Count%	HbF%	HbA_{1c}%
1	18	M	5.5	1.4	18	83	30	30	0.0	0.9	2.5
2	24	M	5.0	1.5	18	100	28	25	0.2	0.5	0.2
3	32	F	2.8	1.8	12	66	23	22	0.0	0.7	0.8
4	40	F	60	2.8	22	78	27	18	0.1	0.5	2.6
5	38	M	5.2	1.8	18	64	28	24	0.2	0.5	2.3
6	40	M	4.7	2.2	16	72	29	30	0.0	0.6	1.8
7	40	M	5.3	1.7	18	100	29	28	0.0	0.4	2.5
8	25	M	6.2	2.3	20	86	28	28	0.2	0.5	2.4
9	28	M	5.8	2.1	18	85	29	22	0.4	0.4	2.5
10	30	M	7.2	1.4	25	95	28	25	0.0	0.4	3.2
M			5:4	1.9	18.5	82.9	27.9	25.2	0.2	0.541	2.3
S.D.			±1.2	±0.449	±3.43	±13.0	±1.91	±3.88	±0.12	±0.1578	±0.8

Table (VII): Glycosylated Haemoglobin levels in the different studied groups

Studied Groups	HB A_{1c}		P *
	Range	x ± S.D	
Controls	5.2-8.8	7 ± 1.1	
B-Thalassemia	10-25.5	14.6±4.5	P <0.001
G6-P.D.	3.5-7	4.9±1.0	P <0.001
Fe deficiency anaemia group	8.4-10.9	9.9±0.7	P <0.001
Hypoplastic anaemia group	0.2-2.8	2.0±1.2	P <0.002
Immune haemolytic anaemia group	2.8-5.3	3.9±1.3	P <0.0005

* P by student test, between cases and control

* P <0.05 = significant.

Table (VIII): Statistical correlation of HbA_{1c} between different data in the studied anaemic groups.

HbA_{1c} in diff. group	Hb g/dL	RBC	PCV	MCV	MCHC	Reticule	S.I	T.I.B.C	% Saturate	HbF	HbA_2
iron deficiency											
r	-0.414	-0.012	0.0193	-0.114	-0.072	-	0.1719	-0.0948	0.2646	-	-
p	0.025	N.S.	N.S.	N.S.	N.S.	-	N.S.	N.S.	N.S.	-	-
Thalassaemia											
r	-0.3337	0.2884	0.1735	0.1115	-0.5893	0.007	-	-	-	0.245	-0.2007
P	N.S.	N.S.	N.S.	N.S.	0.028	0.01	-	-	-	0.025	N.S.
G.6.P.D.											
r	0.3584	0.0836	0.1461	-0.1887	01739	0.125	-	-	-	-	-
P	N.S.	N.S.	N.S.	N.S.	N.S.	0.002	-	-	-	-	-
Immune type											
r	-0.7749	-0.4557	0.7573	0.4114	0.5594	0.979	-	-	-	-	-
P	N.S.	N.S.	N.S.	N.S.	N.S.	0.03	-	-	-	-	-
Hypoplastic											
r	0.7427	0.1629	0.6672	0.0794	0.4648	0.0516	-	-	-	-	-
P	0.007	N.S.	0.018	N.S.	N.S.	N.S.	-	-	-	-	-

P <0.05 is significant >0.05 non significant

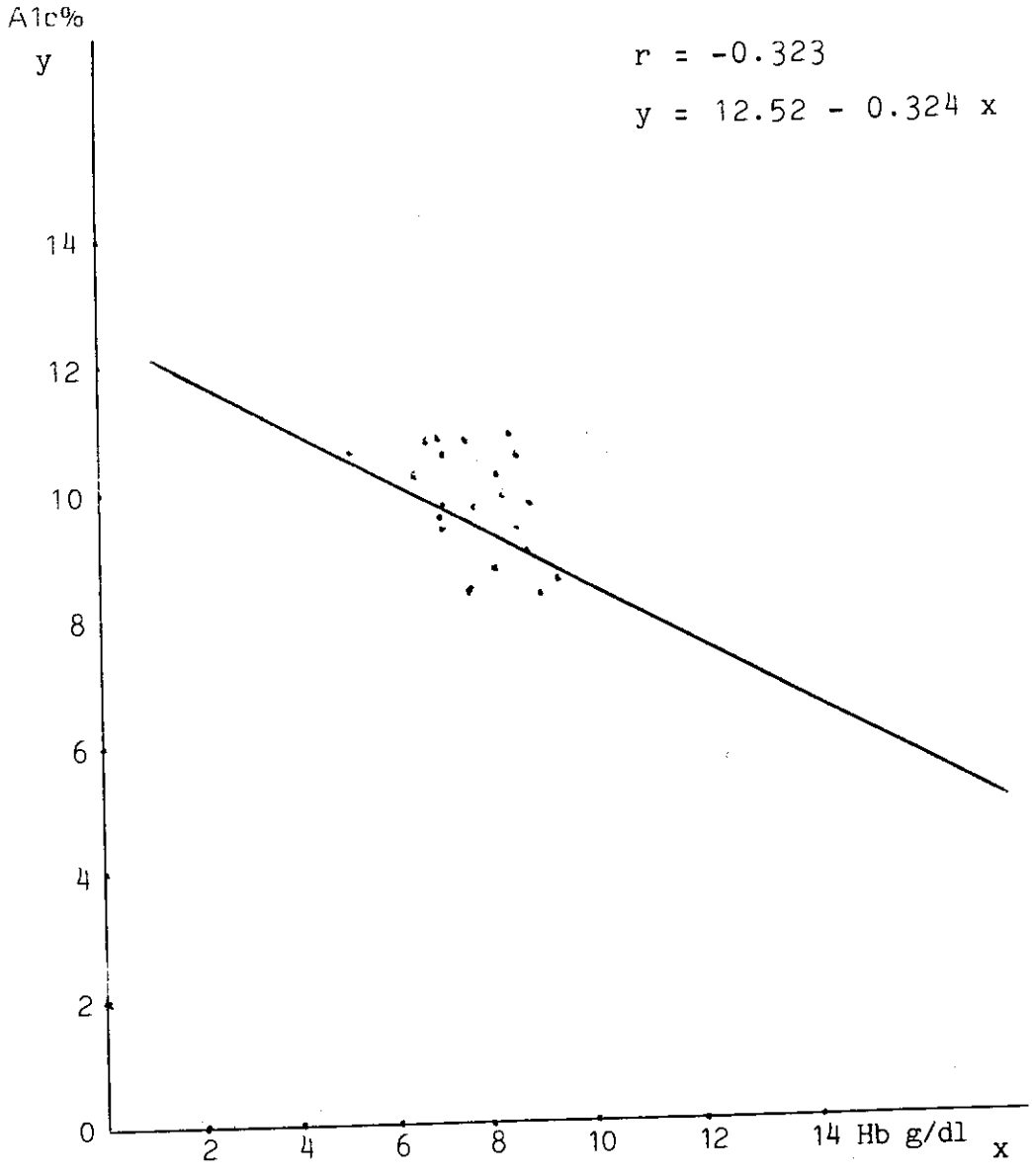

Fig. (1): Correlation between HbA_{1c} and total Hb in iron defecienty group

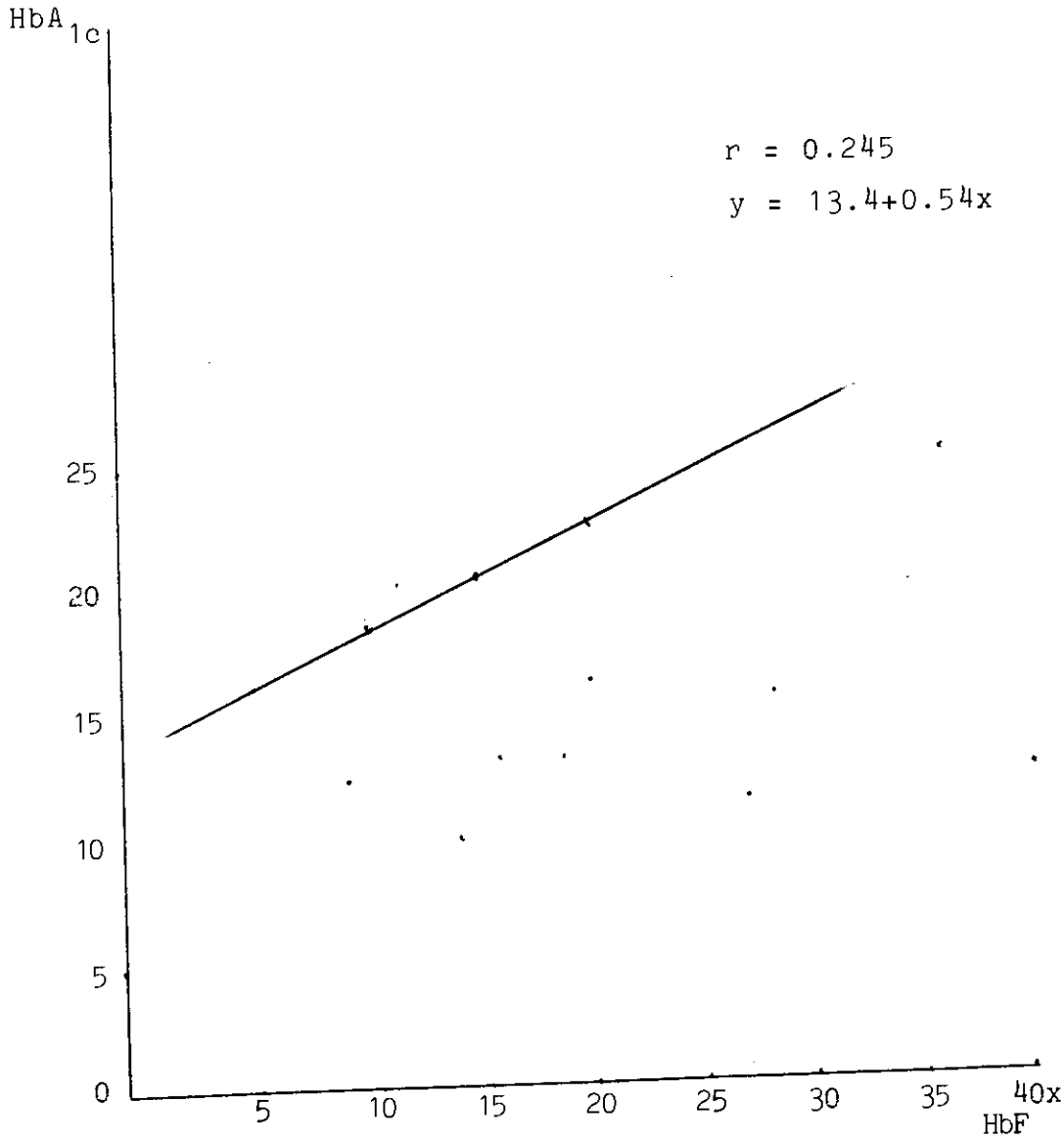

Fig. (2): Correlation between HbF and HbA_{1c} in B thalassaemia major.

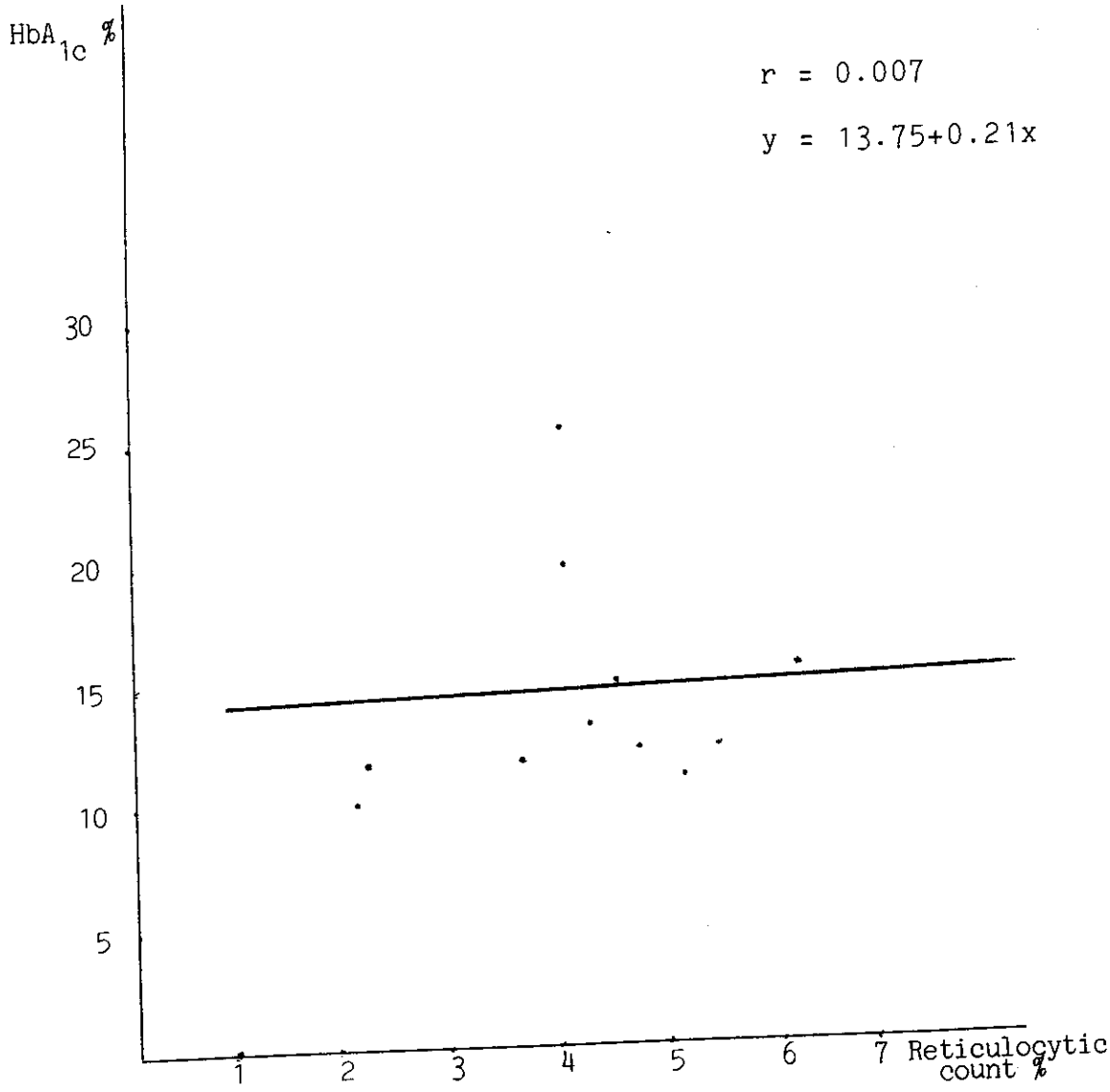

Fig.(3): Correlation between reticulocytic count and HbA_{1c} in B-Thalassaemia major.

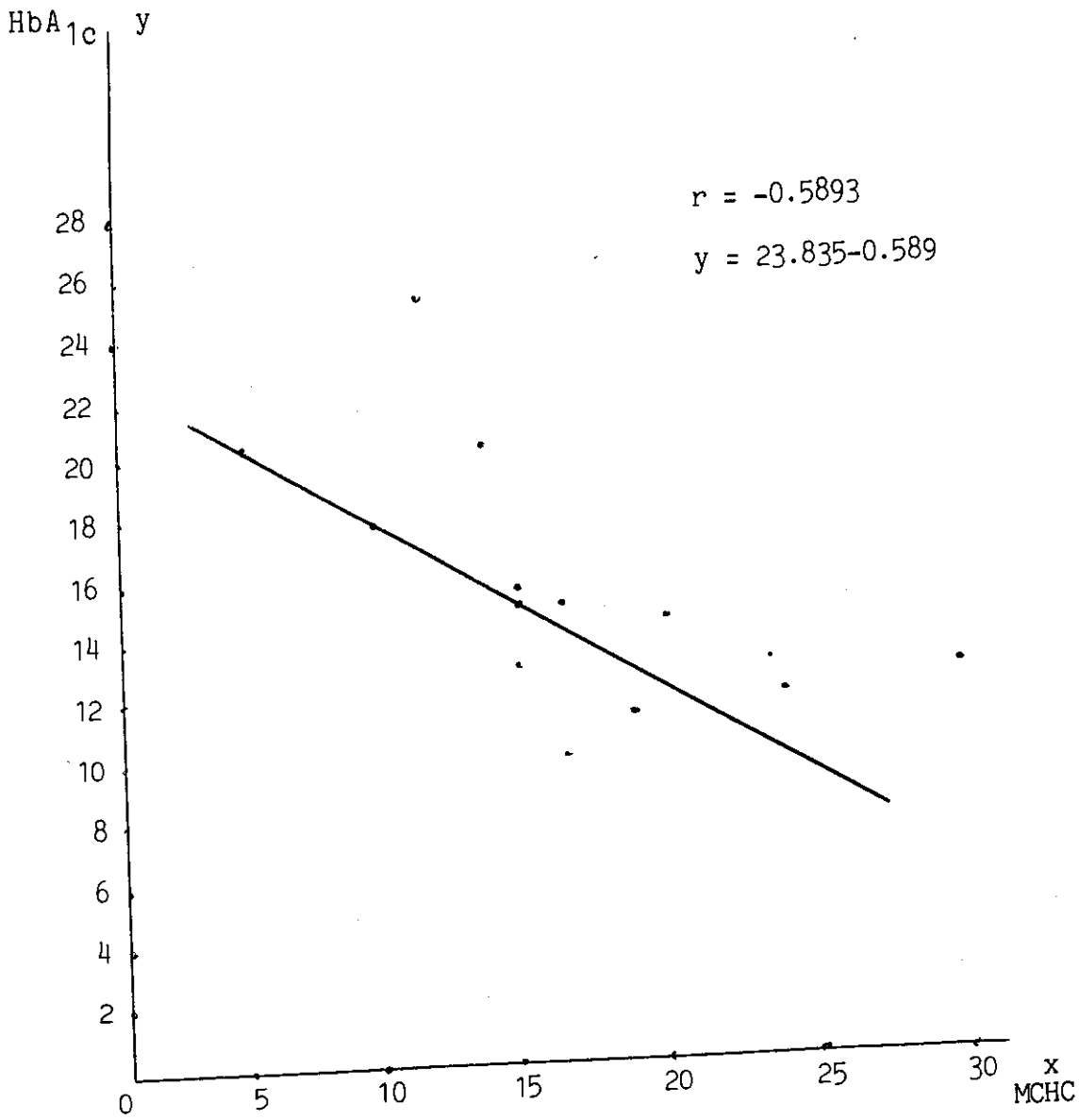

Fig. (4): Correlation between HbA_{1c} and MCHC in thalassaemia.

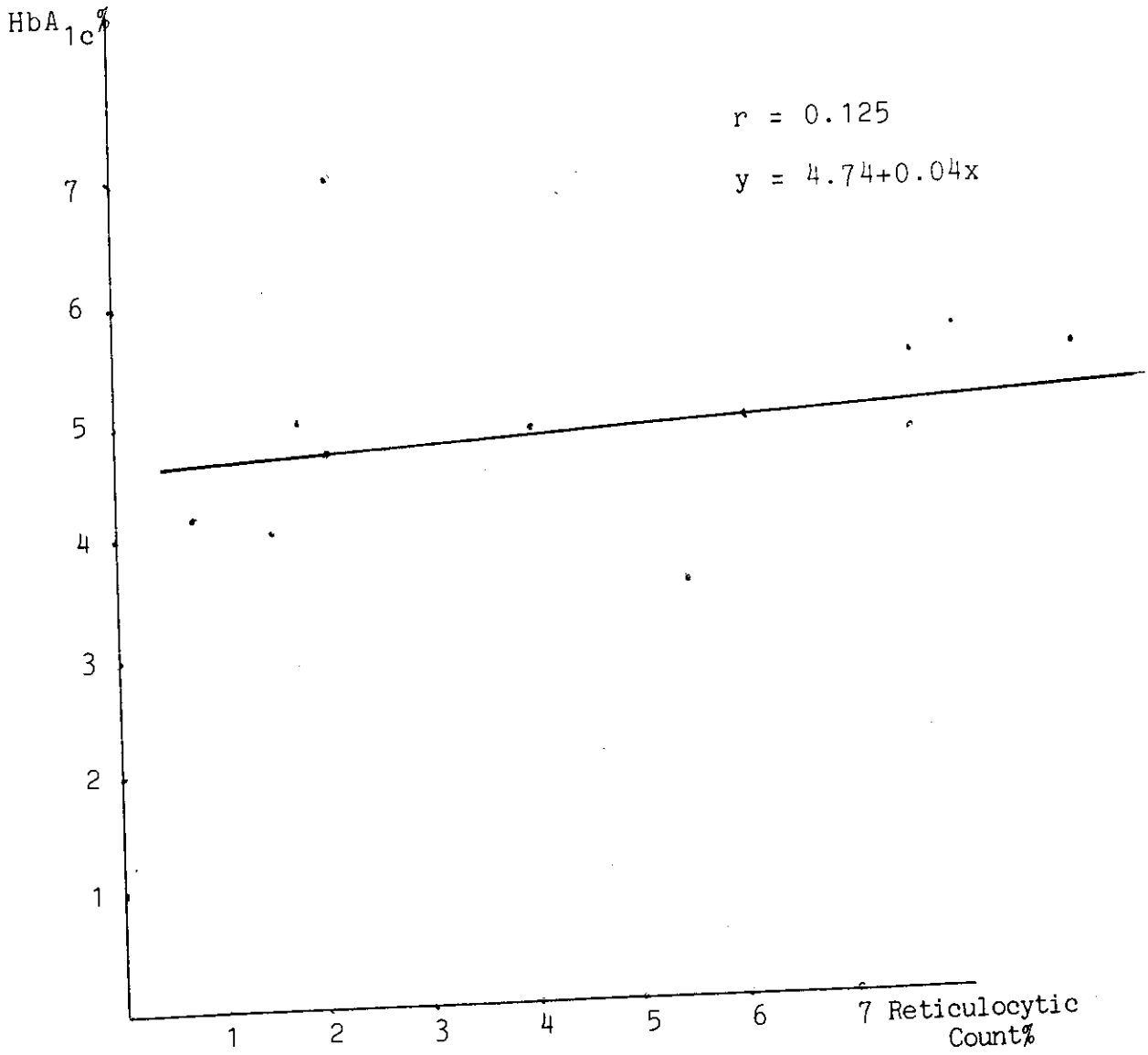

Fig. (5): Correlation between reticulocytic count and HBA_{1c} in G.6.PD.

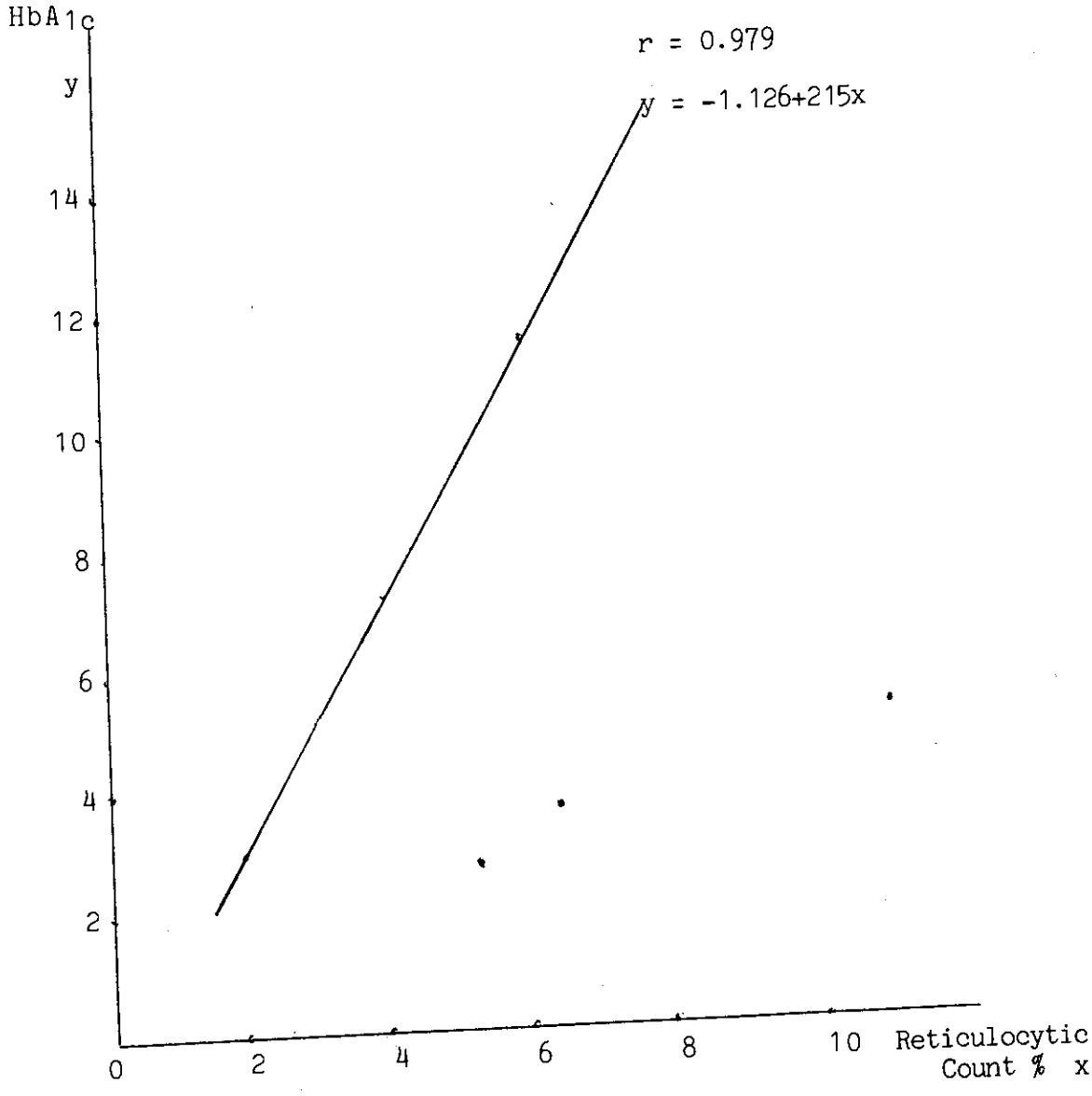

Fig. (6): Correlation between HbA_{1c} and reticulocytic count in immune haemolytic anaemia

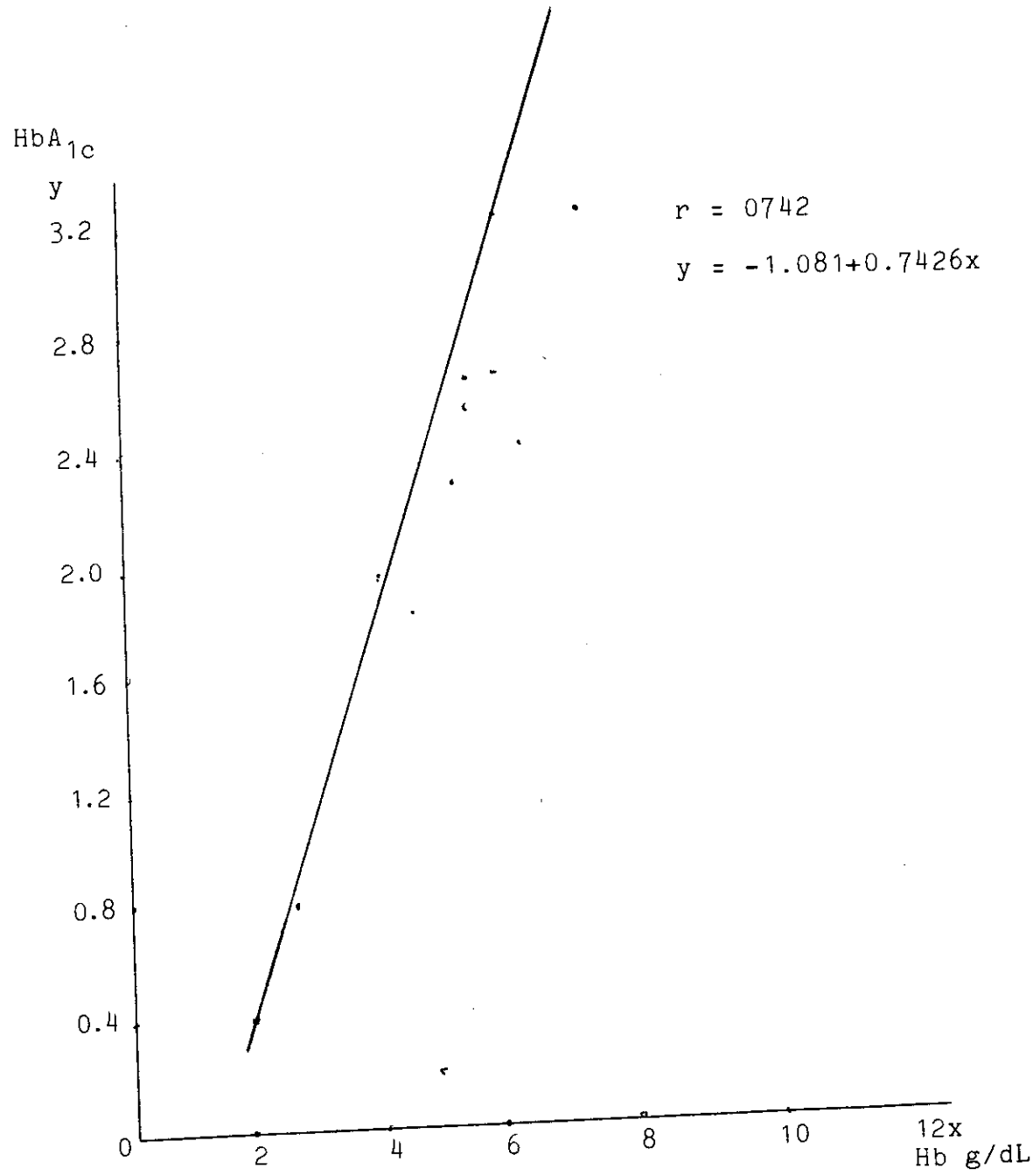

Fig. (7): Correlation between HbA_{1c} and total Hb in hypoplastic group.

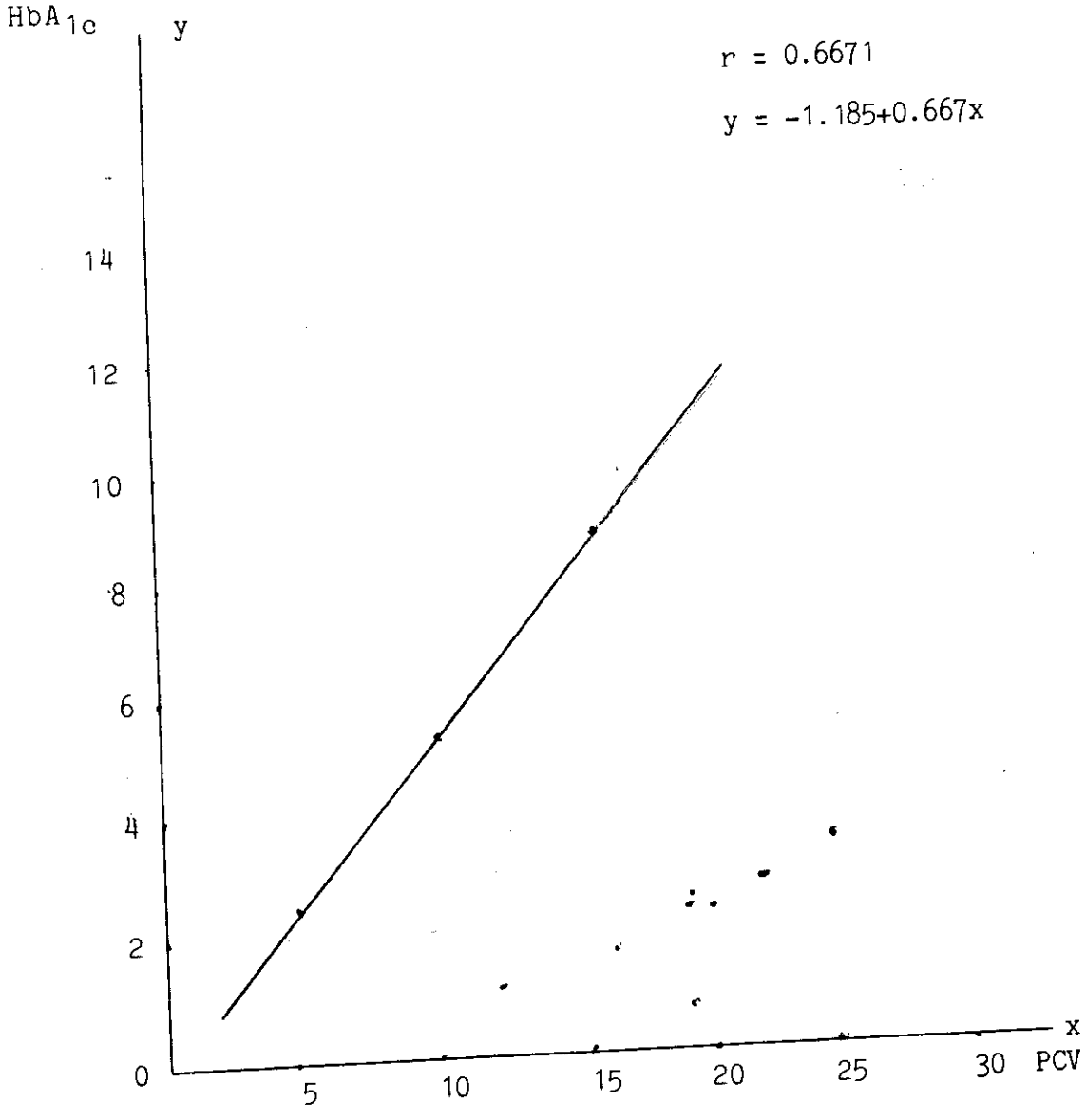

Fig. (8): Correlation between HbA_{1c} & PCV in hypoplastic anaemia group.

STATISTICAL METHODS

The statistical methods used in the analysis and the evaluation of the results in the present study, (Castle 1977, Christensen, 1977) are as follows:-

A) Descriptive Statistics:

1. The mean

It is the mesure of central tendency.

It is represented by the symbol $\bar{x}$ (called x-bar)

$$\bar{x} = \frac{\Sigma x}{N}$$

Where Σ is the sum

x is the individual variables

N is the number of values

2. The standard deviation (S.D.):

The standard deviation is a measure of variance of individual data around its arithmatic mean.

$$S.D. = \sqrt{\frac{(x)^2 - \frac{(x)^2}{N}}{N - 1}}$$

Where N = the number of cases

and x = the individual values

B) **Statistical Evaluation:**

Student t - test (t):

To test the significance of difference between the two means according to the following formula:-

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{SD_1^2}{N_1-1} + \frac{SD_2^2}{N_2-1}}}$$

Where,

$\bar{x}_1$ = mean of first group

$\bar{x}_2$ = mean of second group

SD_1 = standard deviation data in first group

SD_2 = standard deviation data in second group

N_1 = number of cases in first group

N_2 = number of cases in second group

The probability (p) value is obtained from special (t) distribution tables according to a certain degree of freedom (DF = $n_1 + n_2 - 2$).

The difference is considered significant if the (p) value is 0.05 or less. This means that the observed difference is real and not a matter of chance.

A probability of 0.001 or less indicates that the difference is highly significant.

If (p) value is more than 0.05, the difference is considered statistically insignificant.

C) **Measurement of Correlation:**

1. **The correlation coefficient (r):**

In order to find out whether there is a correlation between two parameters, the correlation coefficient (r) is calcualted by the following formula :-

$$r = \frac{\Sigma(x - \bar{x})\ (y - \bar{y})}{\sqrt{\Sigma(x - \bar{x})^2\ (y - \bar{y})^2}}$$

$$t = \frac{r\sqrt{n - 2}}{\sqrt{1 - r^2}}$$

P value (probability) is obtained from special tables where $P < 0.05$, this means that the test is significant.

2. **Linear regression analysis:**

For correlated variables regression equations were calcualted based on the general formula:-

$$y = a + b\,x$$

Where,

y = the variable on the vertical axis

x = the variable on the transverse axis

$$b = \frac{\Sigma(x - \bar{x})\,(y - \bar{y})}{\Sigma(x - \bar{x})^2}$$

$$a = y - b\,\bar{x}$$