CHAPTER III

RESULTS

The stability of coproporphyrin and delta-aminolevulinic acid in urine are shown in Table 2 and 3 respectively. Marked loss of CP was observed when storaged at room temperature without any preservative. Refrigeration or alkaline preservation could improve the stability of CP, but not completely. Delta-aminolevulinic acid was quite stable when storaged at 4°C in refrigerator.

Table 2

Stability of coproporphyrin in urine

No	Concentration of coproporphyrin (µg/l)*			
	immediately analysed	Storaged 24 hours at		
		room temp.	room temp. with Na_2CO_3	4°C
1	77.90	7.80	50.15	54.60
2	93.98	12.25	46.80	43.40
3	53.04	17.80	18.90	49.90

*average values of duplicate analyses

Table 3

Stability of delta-aminolevulinic acid in urine

No	Concentration of ALA in urine (mg/l)*		
	immediately analysed	Refrigerated at 4°C for	
		24 hours	48 hours
1	0.40	0.30	0.35
2	1.40	1.30	1.50
3	0.40	0.50	0.45
4	0.70	0.60	0.70
5	0.30	0.25	0.20

*average values of triplicate analyses

The recoveries of CP and ALA were studied and found that they were 98% (range 87-104%) and 97% (range 91-101%) respectively.

The reproducibilities of the methods used for lead, ALA and CP determinations were checked by analysing five individual specimens for five times. The mean standard deviations of the difference, calculated from the sets of five analyses, were 0.0066 ug/l, 0.2 mg/l and 4.73 ug/l, with the values of the coefficient of variation (CV) of 1.79%, 5.94% and 6.31% respectively.

The mean values, standard deviations and standard errors of urinary lead, ALA and CP of the population in exposed group and control group expressed in unit per volume of urine are shown in Table 4.

Table 4

The means, standard deviations and standard errors of urinary lead, ALA and CP of the population in exposed group and control group expressed in unit per volume of urine.

Group \ Test	PbU (ug/l)	ALAU (mg/l)	CPU (ug/l)
Exposed group (n=140)			
M	184.64	2.80	133.84
SD	161.91	4.09	299.35
SE	13.69	0.35	25.30
Control group (n=105)			
M	67.17	1.80	68.86
SD	25.61	1.81	45.74
SE	2.50	0.18	4.46
P	<0.0005	<0.01	<0.025

The levels of urinary lead in exposed group ranged from 36-1134 ug/l, with a mean of 184.64 ug/l, whereas those in control group were 31-177 ug/l, with an average of 67.17 ug/l.

The levels of urinary ALA in exposed group varied from 0.2-30.7 mg/l, with a mean of 2.8 mg/l, whereas those in control group were 0.3-7.0 mg/l, with a mean of 1.8 mg/l.

The levels of urinary CP in exposed group ranged from 0-2506.81 ug/l, with a mean of 133.84 ug/l, whereas those in control group were 11.14-280.60 ug/l, with a mean of 68.86 ug.l.

All three parameters showed significant differences between exposed group and control group ($p < 0.05$)

The mean values, standard deviations and standard errors for urinary lead, ALA and CP of the population in exposed group and control group expressed in unit per gram creatinine, and the means, standard deviations and standard errors of creatinine excretions in both groups are shown in Table 5.

Table 5

The means, standard deviations and standard errors for urinary lead, ALA and CP of the population in exposed group and control group expressed in unit per gram creatinine and the means, standard deviations and standard errors of creatinine excretions in both groups.

Group \ Test	PbU (ug/g.c#)	ALAU (mg/g.c)	CPU (ug/g.c)	Creatinine (mg%)
Exposed group (n=140)				
M	117.76	1.81	67.05	178.18
SD	96.15	3.62	113.95	85.68
SE	8.13	0.31	9.63	7.24
Control group (n=105)				
M	56.39	1.52	50.46	172.18
SD	58.39	2.82	54.42	94.20
SE	5.69	0.28	5.31	9.19
P	<0.0005	>0.05	>0.05	>0.05

#g.c = gram creatinine

The levels of PbU in exposed group ranged from 20.86-737.90 ug/g creatinine, with a mean of 117.76 ug/g creatinine, whereas those in control group were 12.47-457.38 ug/g creatinine, with a mean of 56.39 ug/g creatinine. There was a significant difference between these two groups.

The levels of urinary ALA in exposed group varied from 0.15-38.56 mg/g creatinine, with a mean of 1.81 mg/g creatinine, whereas those in control group were 0.25-26.61 mg/g creatinine, with a mean of 1.52 mg/g creatinine. It was not significantly different between these two groups.

For urinary CP, the levels in exposed group ranged from 0-821.74 ug/g creatinine, with a mean of 67.05 ug/g creatinine and the levels in control group varied from 6.94-370.10 ug/g creatinine, with a mean of 50.46 ug/g creatinine. There was no significant difference between these two groups.

Creatinine excretions in exposed group ranged from 526.36-20.87 mg%, with a mean of 178.18 mg%, whereas those in control group ranged from 468.35-24.05 mg%, with a mean of 172.18 mg%. There was no significant difference between these two groups.

The distribution of the three parameters of the population in exposed group and control group is presented in Figure II.

The mean values of the three parameters of exposed population classified into three groups according to durations of exposure are shown in Table 6.

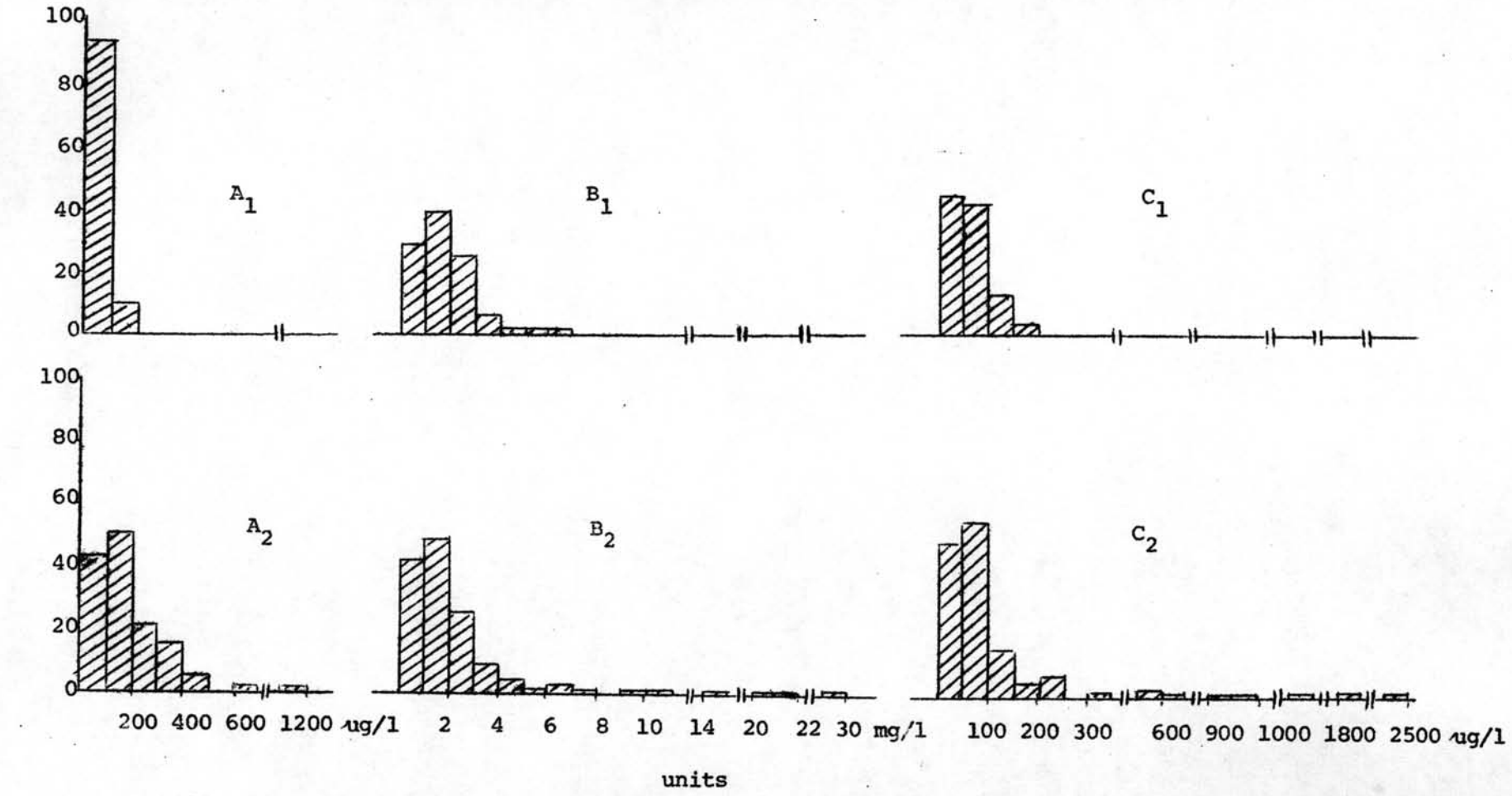

Fig. II Frequency distribution of urinary lead (A), δ-aminolevulinic acid (B) and coproporphyrin (C)

A_1, B_1, C_1 for control group

A_2, B_2, C_2 for exposed group.

Table 6

The mean values and standard deviations of urinary lead, ALA and CP of population in exposed group at different durations of exposure.

Test / Group	PbU (ug/l)	ALAU (mg/l)	CPU (ug/l)
Group A	110.03±38.97	1.72±0.81	65.27±40.74
Group B	161.03±67.28	1.93±1.16	66.33±41.46
Group C	211.65±147.03	1.71±1.76	128.11±260.58
p:			
A-B	< 0.005	> 0.05	> 0.05
A-C	< 0.005	> 0.05	> 0.05
B-C	< 0.05	> 0.05	> 0.05

Group A = 1-5 years of exposure

Group B = 6-10 years of exposure

Group C = more than 10 years of exposure.

Only urinary lead level showed significant differences at different durations of exposure ($p < 0.005$ and 0.05). The other two parameters showed no significant differences ($p > 0.05$).

Correlation coefficients (r) were computed between each pair of the three parameters and are shown in Table 7.

Table 7

Correlation coefficients between results of various analytical tests.

Test	Correlation coefficients (r)*		
	Total (n=245)	Exposed group (n=140)	Control group (n=105)
PbU (ug/l) vs ALAU (mg/l)	0.41	0.40	0.25**
PbU (ug/g.c#) vs ALAU (mg/g.c)	0.44	0.36	0.75
PbU (ug/l) vs CPU (ug/l)	0.54	0.54	0.36
PbU (ug/g.c) vs CPU (ug/g.c)	0.49	0.46	0.75
ALAU (mg/l) vs CPU (ug/l)	0.59	0.48	0.47
ALAU (mg/g.c) vs CPU (ug/g.c)	0.44	0.39	0.82

*All correlation coefficients were statistically significant values ($p < 0.001$, except** which had $p < 0.02$),

#g.c = gram creatinine.

In the exposed group, the correlation coefficients of those three parameters expressed in unit per volume of urine were similar to those which were expressed in unit per gram creatinine. However in the control group, the correlation coefficients expressed in unit per volume of urine were very much lower than those expressed in unit per gram creatinine.

The correlation coefficients of all parameters in the total population agreed well with the results obtained by Tola et al.[83] Urinary coproporphyrin displayed greater correlation with urinary lead than urinary delta-aminolevulinic acid.

The relationships of the three parameters in the total population were shown in Figure III, IV and V.

The correlations between the amounts expressed in unit per volume of urine and unit per gram creatinine of each parameter from exposed and control groups were also computed separately. The results are presented in Table 8. There were strong correlations in the exposed group. For ALAU, it was similar to Cramér & Selander's study.[21] In the control group, the correlations were very much lower than those in the exposed group.

Table 8

Correlations between the amounts expressed in unit per volume of urine and unit per gram creatinine of each parameter in exposed group and control group.

Test	Correlation coefficients (r)	
	Exposed group (n=140)	Control group (n=105)
PbU	0.69	0.39
ALAU	0.87	0.58
CPU	0.92	0.34

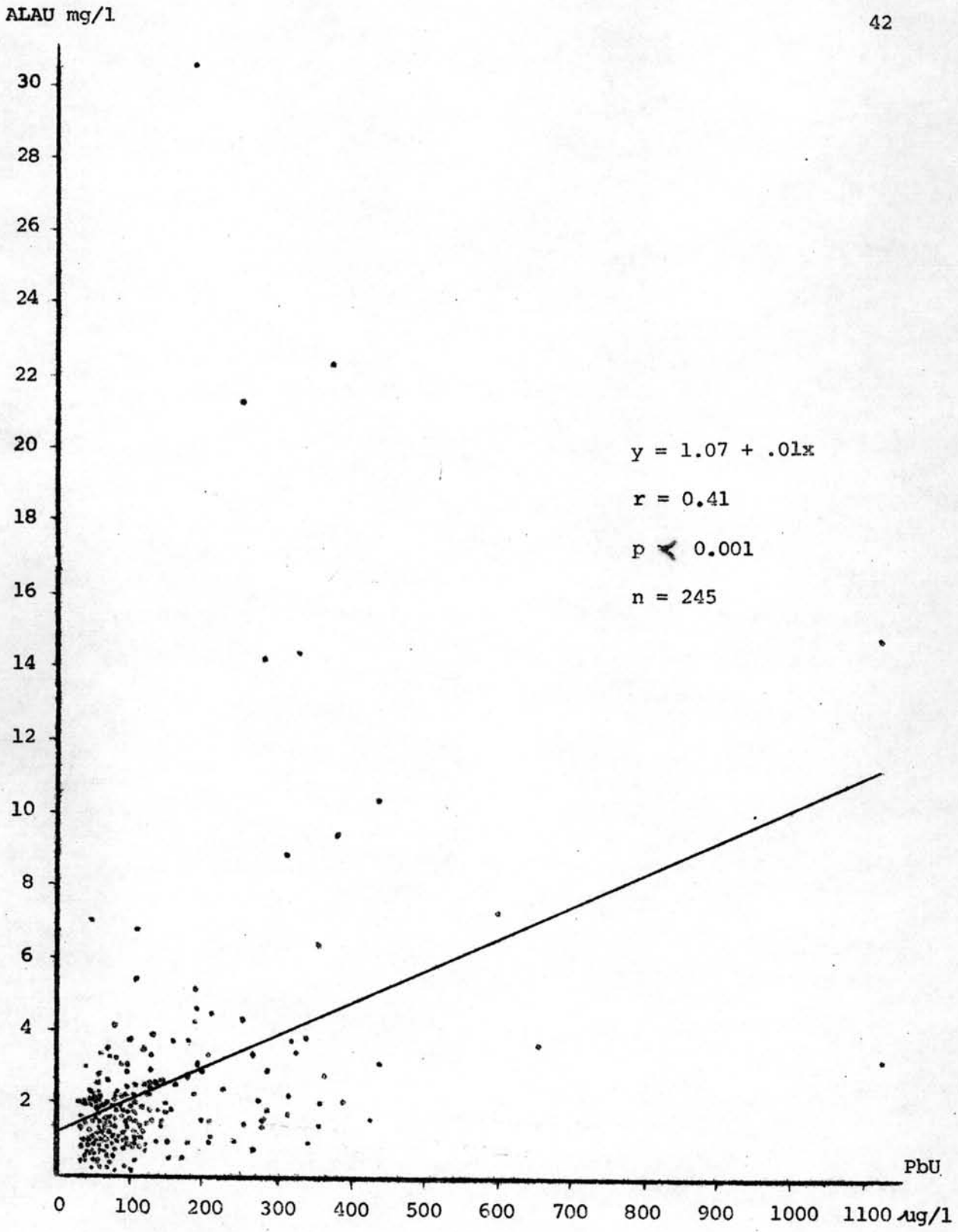

Fig. III The correlation of PbU and ALAU in the total population.

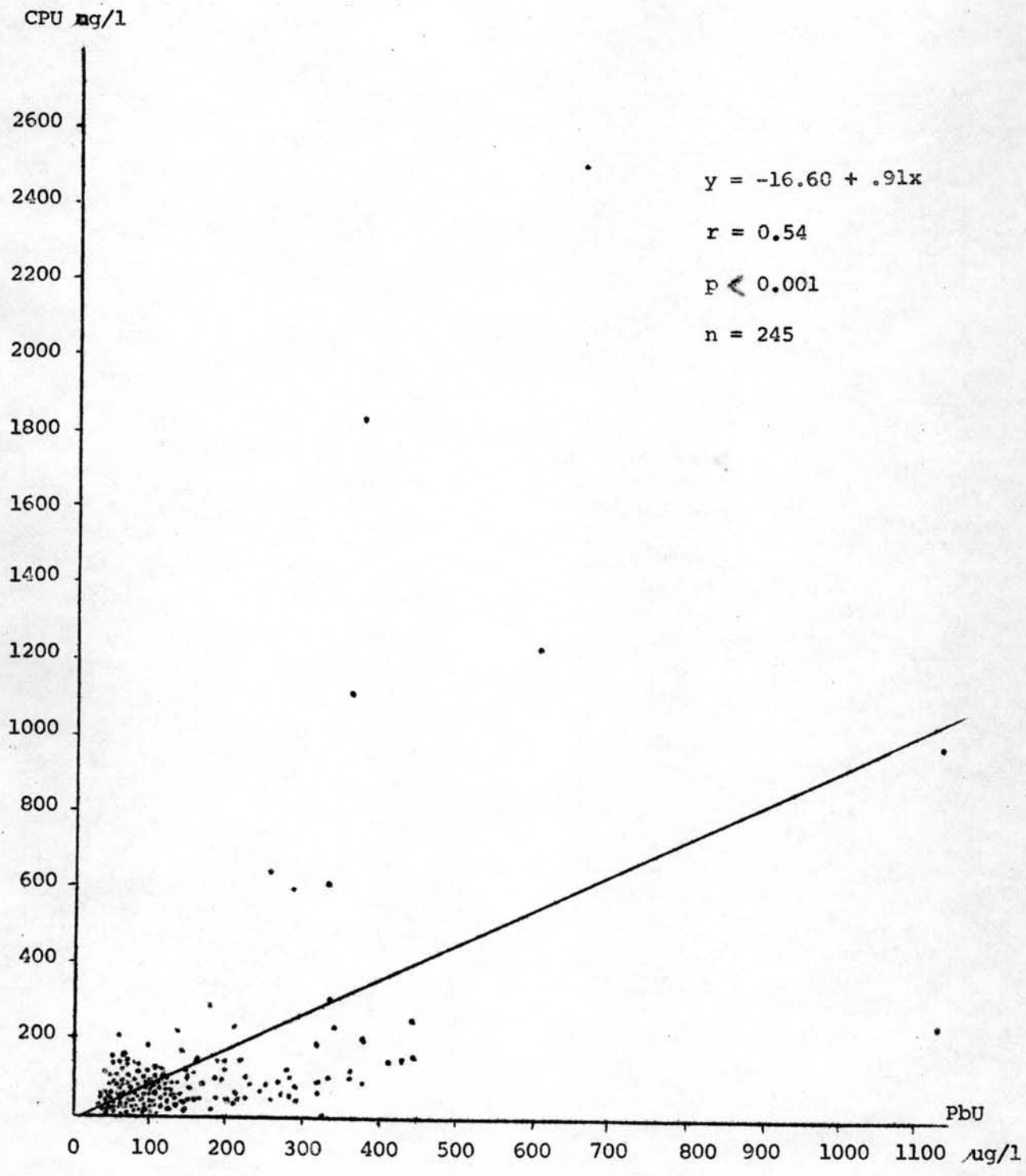

Fig. IV. The correlation of PbU and CPU in the total population.

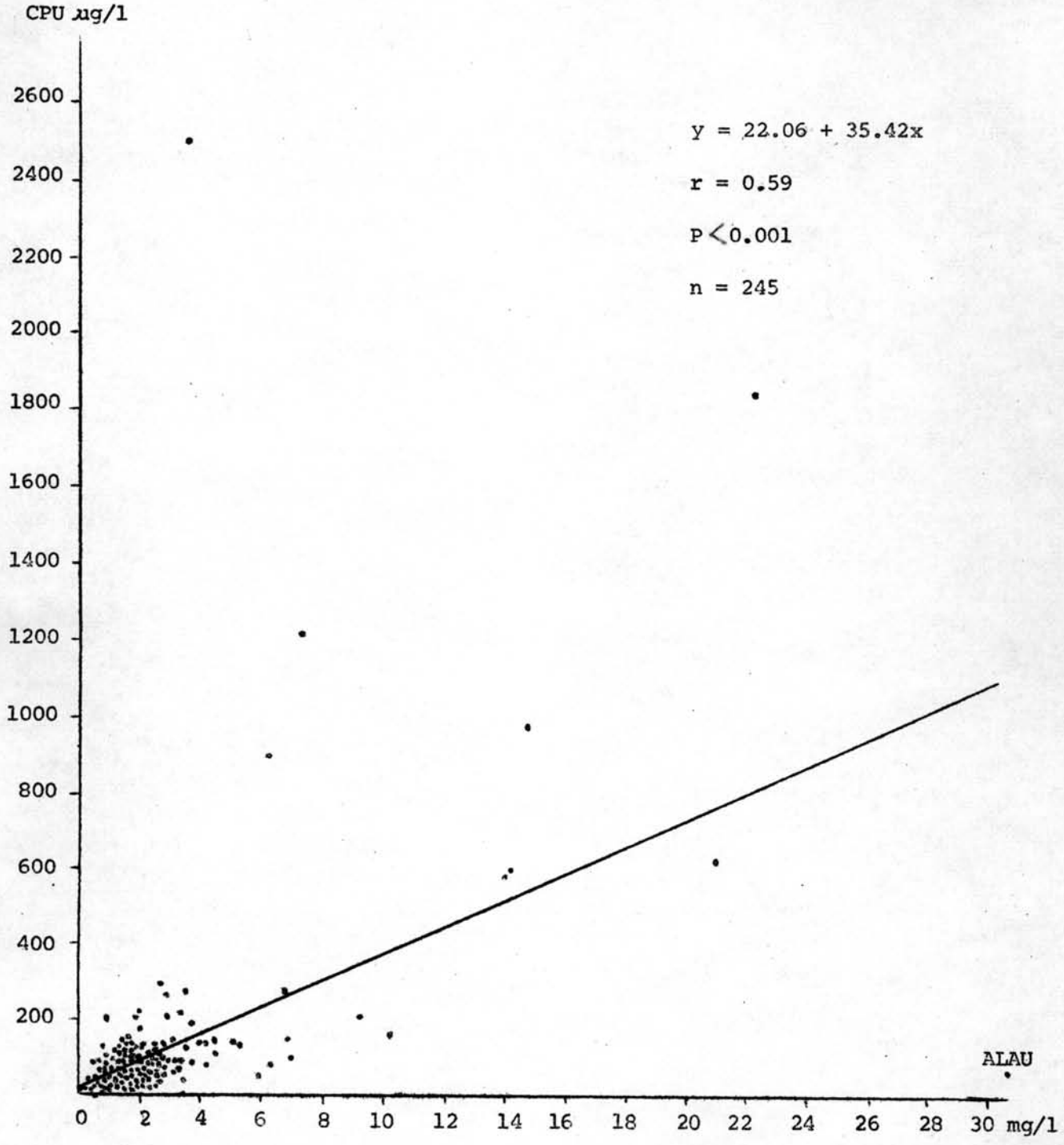

Fig. V. The correlation of ALAU and CPU in the total population.