

## RESULTS

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Results are tabulated and illustrated in tables 1-9 and figures 2-13

### (A) Non- smoker group (= control group):

#### (1) Before exposure to smoke:

Different haematological and haemorheological data are represented in tables (1) and (2).

#### (2) After exposure to smoke:

Data of members of this group are demonstrated in tables (3) and (4) .

### \* Statistical studying:

Comparison between the mean values of different parameters in non- smokers before exposure with their corresponding values after exposure revealed no significant alterations. i.e acute exposure to smoke has no significant change on haemorheological parameters measured.

### (B) Chronic smoker group:

#### (1) Before acute smoking:

Data of this group are represented in table (5) and (6)

#### (2) After acute smoking

Data of this group are represented in table (7) and (8).

**\*\* Statistical Studying:**

Comparison between the mean values of different parameters in non-smokers before exposure to smoke (control group) with their corresponding values in chronic smokers before acute smoking showed significant increases in Hb ( $P < 0.001$ ), RBCs ( $P < 0.001$ ), Hct ( $P < 0.001$ ), WBCs ( $P < 0.001$ ), ESR ( $P < 0.001$ ), relative blood and plasma viscosity ( $P < 0.001$ ) and fibrinogen concentration ( $P < 0.001$ ) in heavy chronic smokers. However, no significant changes could be detected in other parameters; MCV, osmotic fragility and different protein fractions. It is to be noted that the increase in blood and plasma viscosity of chronic smokers shown in this study is attributed to increase in both number, but not size, of RBCs and fibrinogen concentration.

It was also found that acute smoking has no significant effects on the haematological and haemorheological parameters investigated.

It could be concluded that acute smoking or acute exposure to smoke have no significant acute effects on blood viscosity determinants, at least in the dose and duration of smoking designed in this study. However, on the other hand, chronic smoking leads to remarkable significant alterations in blood and plasma viscosity determinants including RBCs count, WBCs count and fibrinogen concentration.

TABLE (1) HAEMATOLOGICAL AND HAEMORHEOLOGICAL DATA IN NON-SMOKERS.

NO.	AGE YEARS	Hb G/DL	RBC COUNT X10 <sup>6</sup> /CMM	HCT %	MCV $\mu$ S	ESR (MM)		WBC COUNT X10 <sup>9</sup> /L	OSMOTIC FRAGILITY		RELATIVE BLOOD VISCOSITY	RELATIVE PLASMA VISCOSITY
						1ST H	2ND H		START OF HEMOLYSIS	END OF HEMOLYSIS		
1	23	14.5	4.81	44	91.4	6	10	5.9	0.40	0.32	3.4	1.6
2	27	14.9	5.02	45	91.6	7	12	5.3	0.42	0.34	3.6	1.4
3	30	15.2	5.03	45	89.4	8	13	6.5	0.42	0.34	3.7	1.6
4	25	14.2	4.50	43	88.4	6	10	5.4	0.44	0.36	3.5	1.5
5	22	14.0	4.51	42	93.1	6	9	6.6	0.40	0.32	3.4	1.4
6	25	14.8	4.90	44	89.8	10	14	5.1	0.46	0.38	3.7	1.3
7	27	14.4	4.66	43	92.2	5	7	5.7	0.40	0.32	3.3	1.3
8	22	14.7	4.78	44	92.0	6	8	6.0	0.44	0.36	3.2	1.4
9	25	14.6	4.70	43	91.4	8	13	4.9	0.42	0.34	3.5	1.5
10	39	14.4	4.98	44	89.0	7	12	5.7	0.44	0.36	3.4	1.4
11	23	15.2	5.05	46	91.0	10	14	6.3	0.38	0.30	3.3	1.6
12	28	15.4	5.40	47	87.0	11	14	5.4	0.40	0.32	3.9	1.7
13	30	15.0	5.12	46	89.6	8	13	5.7	0.42	0.34	3.6	1.8
14	32	14.2	4.73	43	91.9	6	9	6.9	0.42	0.34	3.3	1.7
15	29	15.0	5.30	47	86.6	8	12	6.0	0.44	0.36	3.7	1.6
MEAN	27.00	14.71	4.87	44.31	90.23	7.51	11.33	5.82	0.42	0.34	3.53	1.45
S.D	5.1	0.43	0.27	1.40	2.10	1.77	2.31	0.57	0.02	0.02	0.22	0.29
S.E	1.34	0.11	0.07	0.36	0.54	0.46	0.59	0.51	0.005	0.005	0.06	0.07

Table (2) Different plasma protein fractions in non- smoker (gm/dl)

No	Total pl. proteins	Albumin	Total globulins	A/G ratio	Fibrinogen	$\gamma$ globulins
1	7.94	3.82	3.21	1.19	0.334	1.38
2	7.33	4.18	3.15	1.33	0.297	1.24
3	6.89	3.72	3.17	1.17	0.321	1.10
4	7.06	4.45	2.61	1.70	0.329	1.13
5	7.12	4.27	2.85	1.50	0.295	0.71
6	7.27	3.85	3.42	1.13	0.301	1.09
7	7.16	7.16	3.30	1.17	0.337	0.86
8	7.21	4.11	3.10	1.33	0.347	1.08
9	7.21	4.18	3.33	1.29	0.259	0.98
10	6.96	3.76	3.20	1.18	0.320	0.90
11	7.13	3.77	3.36	1.12	0.344	1.21
12	7.24	4.44	3.80	1.59	0.319	1.23
13	7.11	3.98	3.13	1.27	0.294	1.35
14	7.24	4.27	2.97	1.44	0.299	1.08
15	7.60	4.59	3.01	1.52	0.216	1.19
Mean	7.181	4.082	3.113	1.264	0.303	1.101
S.D	0.202	0.363	0.225	0.289	0.040	0.182
S.E	0.052	0.093	0.58	0.074	0.030	0.047

TABLE (3) EFFECT OF EXPOSURE TO CIGARETTE SMOKE ON SOME HAEMORHEOLOGICAL DATA IN NON-SMOKERS

NO.	AGE YEARS	Hb G/DL	RBCs COUNT X10 <sup>6</sup> /CMM	HCT %	MCV $\mu$ S	ESR (MM)		WBCs COUNT X10 <sup>9</sup> /L	OSMOTIC FRAGILITY		RELATIVE BLOOD VISCOSITY	RELATIVE PLASMA VISCOSITY
						1ST H	2ND H		START OF HEMOLYSIS	END OF HEMOLYSIS		
1	28	14.2	4.66	45	92.5	6	11	5.9	0.40	0.32	3.5	1.5
2	27	14.6	5.12	45	87.9	7	12	6.2	0.40	0.32	3.6	1.5
3	30	15.4	5.19	47	90.5	8	12	7.6	0.44	0.36	3.6	1.4
4	25	14.6	4.55	44	96.7	7	10	5.5	0.44	0.36	3.5	1.6
5	22	14.4	4.60	46	93.4	6	11	6.7	0.42	0.34	3.5	1.3
6	25	14.8	4.50	45	90.9	9	13	7.2	0.44	0.36	3.6	1.4
7	27	14.4	4.71	46	91.2	5	10	7.8	0.42	0.36	3.4	1.4
8	22	14.6	4.80	44	91.6	6	10	8.3	0.46	0.38	3.5	1.4
9	25	14.5	4.75	45	94.7	9	12	4.8	0.42	0.34	3.6	1.6
10	39	14.3	4.73	42	88.7	8	12	5.7	0.42	0.34	3.4	1.5
11	29	15.4	5.15	47	91.2	9	13	6.4	0.38	0.30	3.8	1.7
12	28	15.3	5.35	46	85.9	11	14	7.5	0.42	0.34	3.9	1.3
13	30	15.7	5.23	46	87.9	8	13	5.9	0.42	0.34	3.7	1.7
14	32	14.3	4.60	43	93.4	7	10	7.9	0.44	0.36	3.4	1.3
15	29	15.3	5.33	47	88.1	8	12	3.6	0.46	0.38	3.6	1.6
MEAN	27.00	14.82	4.95	44.83	90.91	7.62	11.79	6.79	0.42	0.34	3.56	1.54
S.D	5.10	0.42	0.31	1.55	2.92	1.55	1.29	1.14	0.02	0.02	0.20	0.18
S.E	1.34	0.11	0.08	0.40	0.75	0.40	0.33	0.621	0.006	0.006	0.04	0.05
"t"	-	0.775	0.701	0.967	0.796	0.160	0.561	1.213	-	-	0.429	1.047

Table (4) Effects of exposure to smoke of 2 cigarettes on different plasma protein fractions in non- smokers (gm/dl)

No	Total pl. proteins	Albumen	Total globulins	A/G ratio	Fibrinogen	$\gamma$ globulins
1	6.97	4.04	2.93	1.37	0.378	0.98
2	7.30	4.30	3.55	1.43	0.292	1.17
3	6.82	4.12	2.70	1.53	0.288	1.23
4	7.13	4.27	2.86	1.49	0.316	1.07
5	7.28	4.22	3.06	1.38	0.347	1.16
6	7.24	3.86	3.28	1.21	0.311	1.02
7	7.26	3.85	3.41	1.13	0.329	1.16
8	7.30	3.80	3.50	1.09	0.422	1.24
9	7.58	4.16	3.42	1.22	0.289	0.99
10	6.85	3.89	2.96	1.31	0.306	1.16
11	7.30	3.69	3.61	1.03	0.411	1.17
12	7.14	4.07	3.07	1.33	0.337	0.93
13	7.33	3.98	3.17	1.29	0.345	0.95
14	7.38	4.21	2.47	1.33	0.332	1.11
15	7.69	4.15	3.54	1.17	0.207	1.08
Mean	7.28	4.05	3.25	1.29	0.330	1.11
S.D	0.288	0.237	0.325	0.149	0.055	0.094
S.E	0.014	0.061	0.084	0.037	0.014	0.024
"t"	0.851	0.278	0.217	0.370	0.750	0.172

TABLE (5) HAEMATOLOGICAL AND HEMORHEOLOGICAL DATA OF HEAVY SMOKERS

NO.	AGE YEARS	HB G/DL	RBC# COUNT X10 <sup>6</sup> /CM <sup>3</sup>	HCT %	MCV $\mu$ S	ESR (MM)		WBC# COUNT X10 <sup>9</sup> /L	OSMOTIC FRAGILITY		RELATIVE BLOOD VISCOSITY	RELATIVE PLASMA VISCOSITY
						1ST H	2ND H		START OF HEMOLYSIS	END OF HEMOLYSIS		
1	29	15.3	5.44	47	87	9	13	6.3	0.42	0.34	4.0	1.9
2	27	15.6	5.62	48	88	12	14	8.1	0.38	0.30	4.2	2.1
3	31	15.2	5.19	46	90	13	15	6.9	0.44	0.36	3.9	1.8
4	28	15.5	5.27	47	90	11	17	7.2	0.42	0.34	3.9	1.9
5	25	15.0	5.33	46	87	12	14	7.4	0.44	0.36	4.0	2.0
6	24	15.8	5.63	48	86	11	15	7.5	0.42	0.34	4.3	2.2
7	33	14.8	5.49	47	87	10	13	7.9	0.42	0.34	3.8	1.7
8	27	15.0	5.20	46	87	12	15	10.4	0.44	0.36	3.9	1.9
9	24	15.8	5.59	48	93	13	16	8.4	0.40	0.32	4.3	2.2
10	29	15.1	4.95	46	93	12	17	7.6	0.44	0.36	3.9	2.0
11	32	15.9	5.50	49	90	10	15	8.3	0.42	0.34	4.5	2.4
12	30	15.7	5.38	48	91	15	13	7.4	0.42	0.34	3.0	2.0
13	25	15.8	5.63	49	88	13	17	7.3	0.40	0.32	4.5	2.2
14	35	14.9	4.40	47	87	12	19	9.2	0.38	0.30	3.7	1.8
15	29	15.8	5.54	48	87	14	19	8.8	0.44	0.36	4.3	2.1
MEAN	28.5	15.42	5.45	47.43	88.67	11.91	15.32	7.91	0.42	0.34	4.10	2.01
S.D	4.55	0.42	0.28	1.25	2.320	1.58	1.97	1.01	0.02	0.02	0.25	0.19
S.E	1.17	0.10	0.07	0.32	0.60	0.41	0.51	0.44	0.005	0.005	0.07	0.05
t*	-	4.765	5.813**	6.367	1.933	7.143	5.115	3.100	-	-	6.196***	6.211*

Where: \* Significant (P<0.05) \*\* Highly significant (P<0.01) \*\*\* Very highly significant (P<0.001)

Table (6) Plasma protein fractions in chronic smokers (gm/dl)

No.	Total pl. proteins	Albumen	Total globulins	A/G Ratio	Fibrinogen	δ Globulins
1	7.19	3.85	3.34	1.15	0.393	0.93
2	6.99	3.74	3.25	1.15	0.530	1.12
3	7.39	3.90	3.49	1.12	0.429	1.33
4	6.94	3.16	3.78	0.84	0.478	1.11
5	7.24	3.76	3.48	1.08	0.469	1.16
6	7.23	3.83	3.40	1.13	0.499	1.23
7	6.93	3.88	3.05	1.27	0.457	1.18
8	6.87	3.16	3.71	0.85	0.465	1.30
9	7.33	3.86	3.45	0.89	0.484	0.81
10	7.40	3.75	3.25	1.15	0.529	1.18
11	6.97	3.49	3.48	1.01	0.453	1.05
12	6.83	3.50	3.28	1.08	0.491	0.89
13	6.98	3.55	3.43	1.03	0.445	1.33
14	7.41	3.83	3.56	1.08	0.521	1.11
15	7.31	3.96	3.35	1.18	0.545	1.10
Mean	7.135	3.683	3.454	1.077	0.489	1.123
S.D	0.278	0.225	0.284	0.109	0.030	0.154
S.E	0.072	0.207	0.075	0.028	0.007	0.039
"t"	0.581	1.403	0.586	1.900	5.813***	0.344

Where: \*\*\* Very highly significant (P < 0.001)

TABLE (7) HAEMATOLOGICAL AND HEMORHEOLOGICAL DATA OF HEAVY SMOKERS AFTER ACUTE SMOKING

NO.	AGE YEARS	Hb G/DL	RBCs COUNT X105/CMM	HCT %	MCV $\mu$ 3	ESR (MM)		HBCs COUNT X10 9/L	OSMOTIC FRAGILITY		RELATIVE BLOOD VISCOSITY	RELATIVE PLASMA VISCOSITY
						1ST H	2ND H		START OF HEMOLYSIS	END OF HEMOLYSIS		
1	29	15.2	5.33	47	89	11	14	6.5	0.42	0.34	3.8	1.8
2	27	15.8	5.49	48	89	12	15	8.0	0.38	0.30	4.2	2.1
3	31	15.3	5.43	48	88	12	16	6.8	0.42	0.34	3.8	1.7
4	28	15.6	5.37	47	89	11	17	7.4	0.44	0.36	3.9	1.9
5	25	15.2	5.12	46	90	12	14	7.5	0.44	0.35	3.8	1.8
6	24	15.8	5.71	49	80	11	16	8.0	0.42	0.34	4.2	2.1
7	33	14.9	5.03	46	91	10	13	10.6	0.44	0.36	3.6	1.5
8	27	15.1	4.98	45	90	11	16	8.5	0.42	0.34	3.9	1.9
9	24	15.8	5.63	49	90	12	15	7.7	0.38	0.30	4.1	2.0
10	29	15.3	5.22	47	88	12	16	8.4	0.46	0.36	3.9	2.0
11	32	15.7	5.60	48	90	11	15	7.4	0.42	0.34	4.5	2.3
12	30	15.6	5.48	48	88	14	19	7.2	0.44	0.36	3.9	1.8
13	25	15.8	5.41	48	89	14	17	9.1	0.40	0.32	4.3	1.7
14	35	15.1	5.02	45	92	13	18	8.9	0.40	0.32	3.6	2.0
15	29	15.7	5.53	48	87	13	19	8.7	0.44	0.35	4.1	1.9
MEAN	28.51	15.54	5.33	47.50	89.29	11.92	16.13	8.04	0.42	0.34	3.97	1.91
S.D	4.55	0.31	0.32	1.05	4.49	1.15	1.73	1.04	0.02	0.02	0.25	0.20
S.E	1.17	0.98	0.08	0.27	0.38	0.30	0.45	0.27	0.006	0.006	0.07	0.05
t <sup>n</sup>	-	0.122	1.132	0.167	0.873	0.020	1.197	0.252	-	-	1.313	1.408

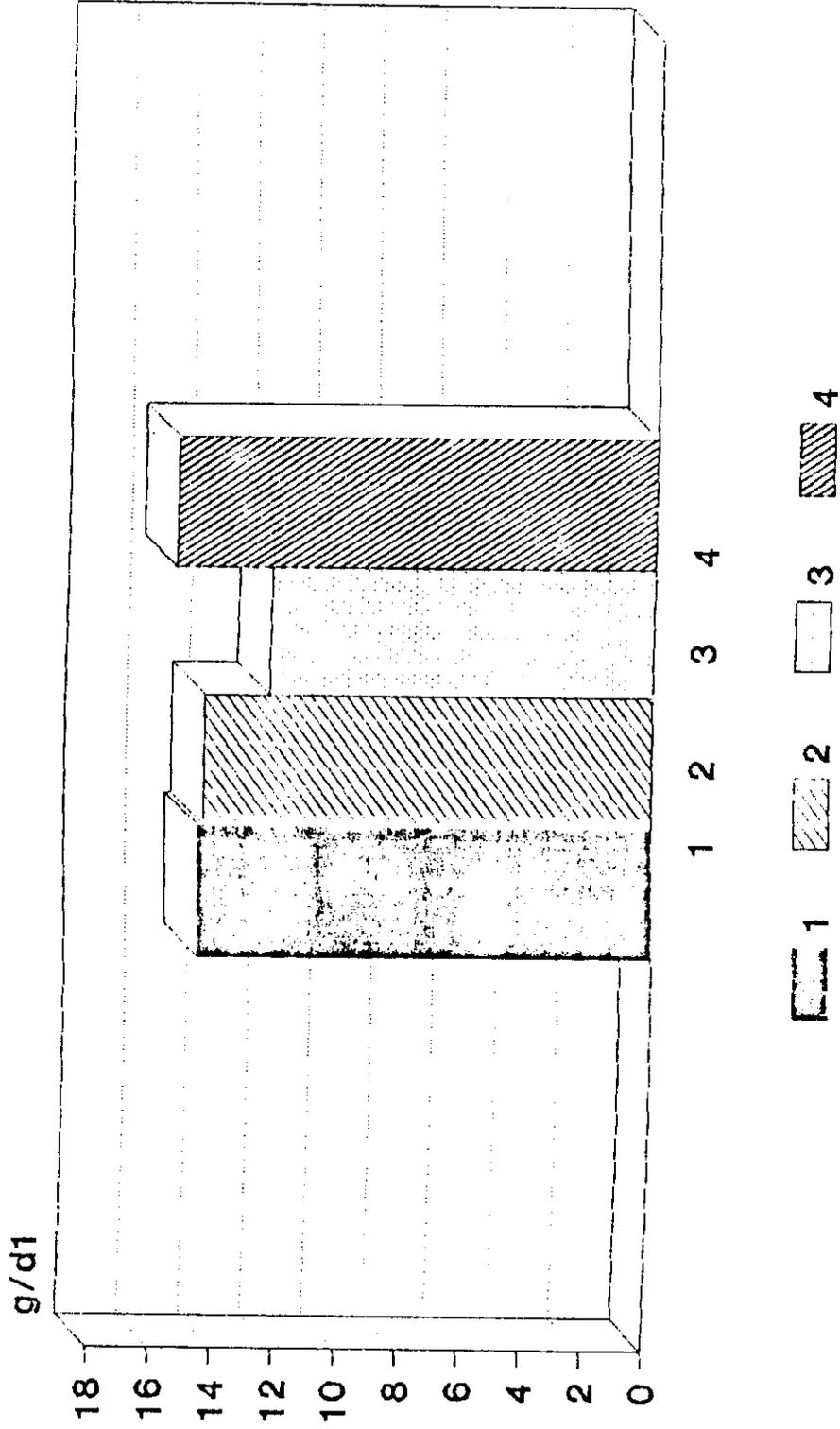
Table (8) Effect of acute smoking on different plasma protein fractions in chronic smokers (gm/dl).

No	Total pl. proteins	Albumen	Total globulins	A/G Ratio	Fibrinogen	ζ Globulins
1	7.23	3.76	3.47	1.08	0.490	1.37
2	6.99	3.22	3.77	1.85	0.525	1.33
3	7.39	3.70	3.70	1.00	0.449	0.46
4	6.94	3.61	3.33	1.08	0.468	0.97
5	7.24	3.91	3.33	1.174	0.490	1.09
6	7.30	3.94	3.36	1.170	0.527	1.17
7	6.93	3.60	3.33	1.08	0.529	1.18
8	6.85	3.56	3.29	1.08	0.513	1.30
9	7.44	3.94	3.50	1.13	0.498	1.41
10	7.35	3.54	3.81	0.93	0.490	1.25
11	6.90	3.66	3.24	1.13	0.470	1.17
12	6.88	3.72	3.16	1.18	0.512	0.83
13	7.03	3.66	3.37	1.09	0.479	1.33
14	7.31	3.36	3.95	1.85	0.238	1.38
15	7.33	3.96	3.37	1.18	0.555	1.03
Mean	7.141	3.675	3.474	1.063	0.502	1.182
S.D	0.213	0.213	0.233	0.102	0.029	0.177
S.E	0.050	0.055	0.060	0.026	0.007	0.046
"t"	0.147	0.036	0.200	0.118	0.929	0.923

NO	ITEM	GROUP A (NON-SMOKERS) (N:15)				GROUP B (CHRONIC SMOKERS) (N:15)			
		BEFORE EXPOSURE		AFTER EXPOSURE		BEFORE SMOKING		AFTER SMOKING	
		MEAN ± S.E	MEAN ± S.E	"t"	"t"	MEAN ± S.E	MEAN ± S.E	"t"	"t"
1	AGE (YEARS)	27.00 ± 1.34	27.00 ± 1.34	--	--	28.5 ± 1.17	28.5 ± 1.17	--	--
2	Hb (G/DL)	14.71 ± 0.11	14.82 ± 0.09	0.775	0.775	12.42 ± 0.10	15.54 ± 0.98	0.122	0.122
3	RBCs COUNT (X106/CMM)	4.87 ± 0.07	4.95 ± 0.09	0.701	0.701	5.45 ± 0.07	5.33 ± 0.08	1.132	1.132
4	HCT (%)	44.81 ± 0.26	44.83 ± 0.40	0.987	0.987	47.43 ± 0.32	47.50 ± 0.27	0.157	0.157
5	MCV (u 3)	90.23 ± 0.54	90.91 ± 0.75	0.738	0.738	89.67 ± 0.60	99.29 ± 0.33	0.873	0.873
6	ESR (MM): 1ST HOUR 2ND HOUR	7.51 ± 0.45 11.33 ± 0.59	7.62 ± 0.40 11.73 ± 0.40	0.180 0.561	0.180 0.561	11.91 ± 0.41 15.32 ± 0.51	11.92 ± 0.30 16.12 ± 0.45	0.020 1.191	0.020 1.191
7	WBCs COUNT (X109/L)	5.82 ± 0.51	6.79 ± 0.62	1.213	1.213	7.91 ± 0.44	8.04 ± 0.27	0.252	0.252
8	OSMOTIC FRAGILITY START OF HEM END OF HEM	0.42 ± 0.005 0.34 ± 0.005	0.42 ± 0.005 0.34 ± 0.005	--	--	0.42 ± 0.005 0.34 ± 0.005	0.42 ± 0.005 0.34 ± 0.005	--	--
9	RELATIVE PL. VISCOSITY	3.53 ± 0.05	3.56 ± 0.04	0.429	0.429	4.10 ± 0.07	3.97 ± 0.07	1.313	1.313
10	RELATIVE PL. VISCOSITY	1.45 ± 0.07	1.54 ± 0.05	1.047	1.047	2.01 ± 0.05	1.91 ± 0.05	1.408	1.408
11	TOTAL PL. PROTEINS (G/DL)	7.16 ± 0.05	7.28 ± 0.02	1.851	1.851	7.12 ± 0.07	7.14 ± 0.05	0.147	0.147
12	ALBUMIN (G/DL)	4.08 ± 0.09	4.05 ± 0.05	0.278	0.278	3.63 ± 0.27	3.67 ± 0.05	0.036	0.036
13	TOTAL GLOBULINS (G/DL)	3.11 ± 0.58	3.23 ± 0.23	0.217	0.217	3.45 ± 0.08	3.47 ± 0.05	0.200	0.200
14	A/G RATIO	1.26 ± 0.07	1.29 ± 0.04	0.370	0.370	1.07 ± 0.08	1.06 ± 0.03	0.118	0.118
15	FISBANDSEN (G/DL)	0.303 ± 0.03	0.330 ± 0.02	0.750	0.750	0.463 ± 0.01	0.502 ± 0.01	0.929	0.929
16	σ GLOBULINS (G/DL)	1.10 ± 0.05	1.11 ± 0.03	0.172	0.172	1.123 ± 0.04	1.162 ± 0.05	0.922	0.922

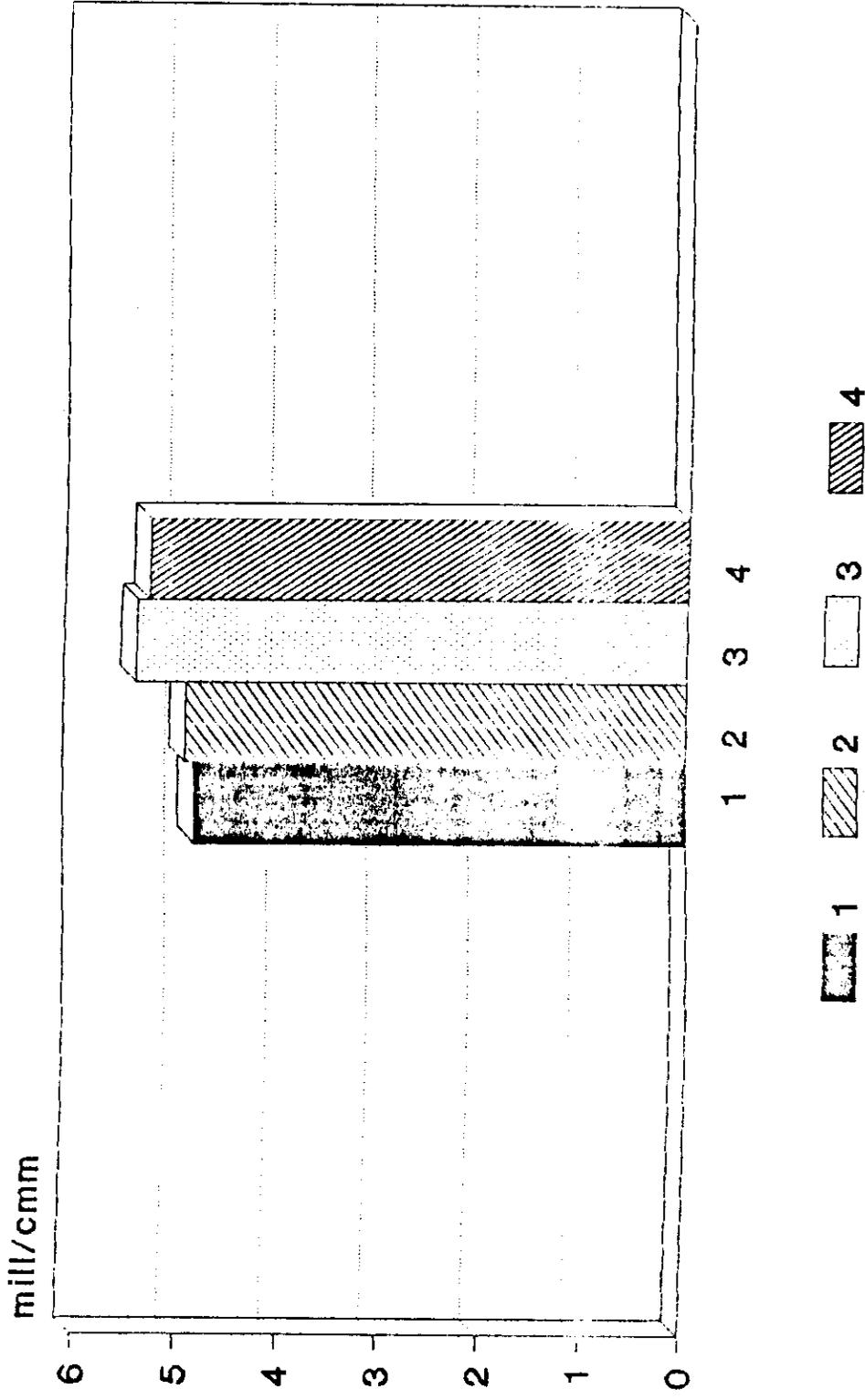
WHERE: \* SIGNIFICANT (P<0.05) \*\* HIGHLY SIGNIFICANT (P<0.01) \*\*\* VERY HIGHLY SIGNIFICANT (P<0.001)

Fig.(2): Hb concentration of different groups



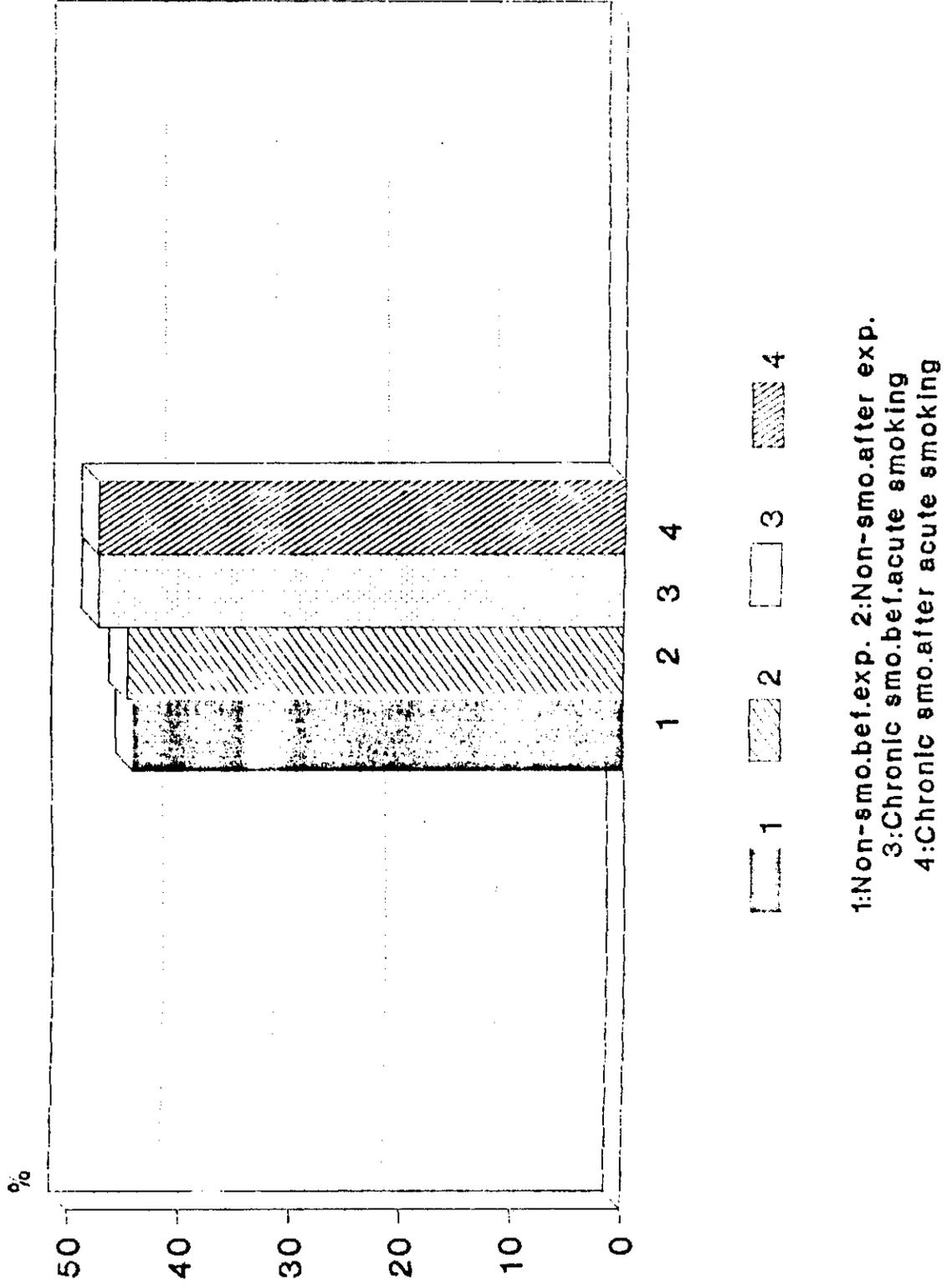
1:Non-smo bef.exp. 2:Non-smo after exp.  
3:Chronic smo bef. acute smoking  
4:Chronic smo after acute smoking

Fig.(3): R.B.Cs count in different group



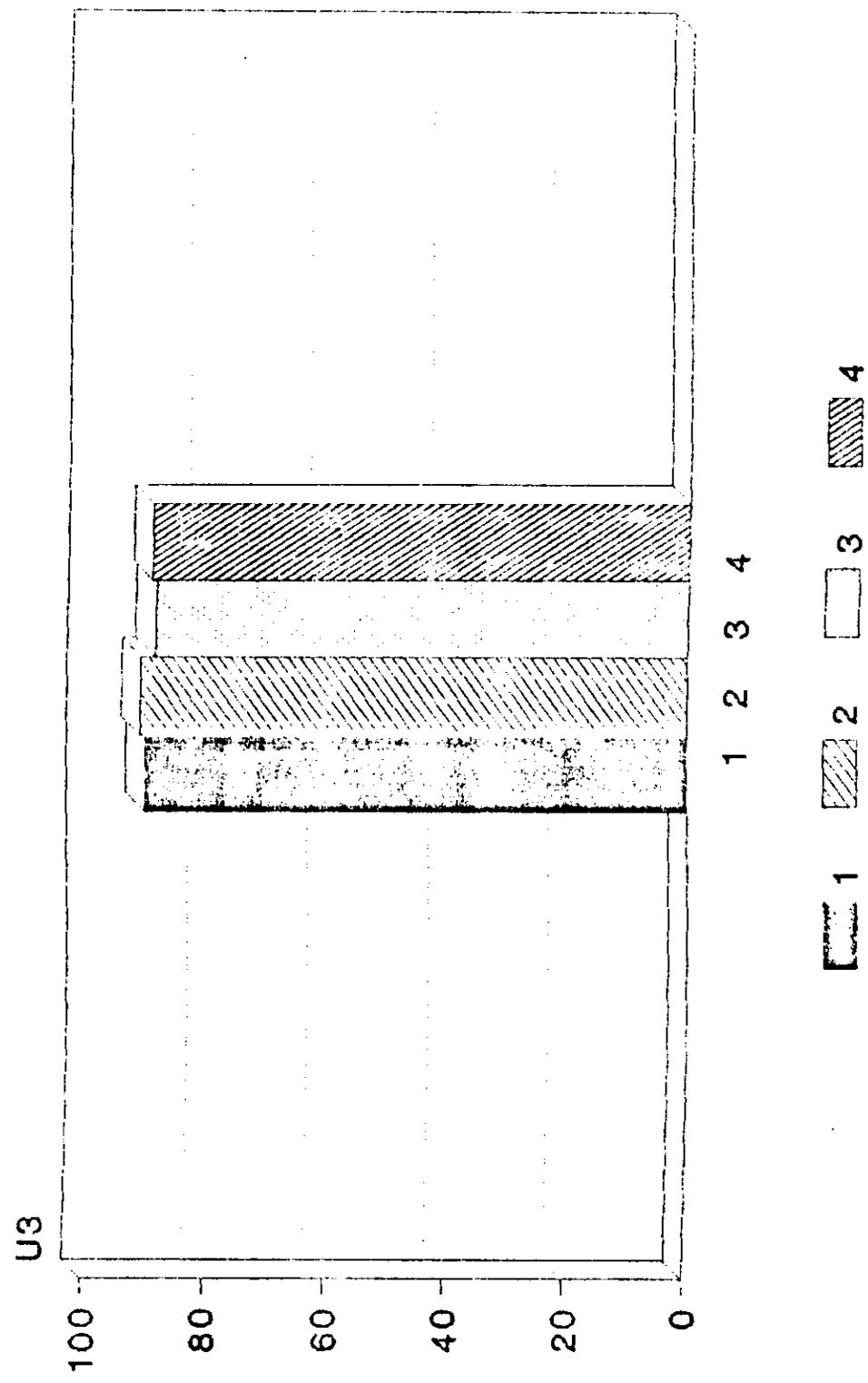
1:Non-smo.bef.exp. 2:Non-smo.after exp.  
3:Chronic smo.bef.acute smoking  
4:Chronic smo.after acute smoking

Fig.(4): Hct of different groups.



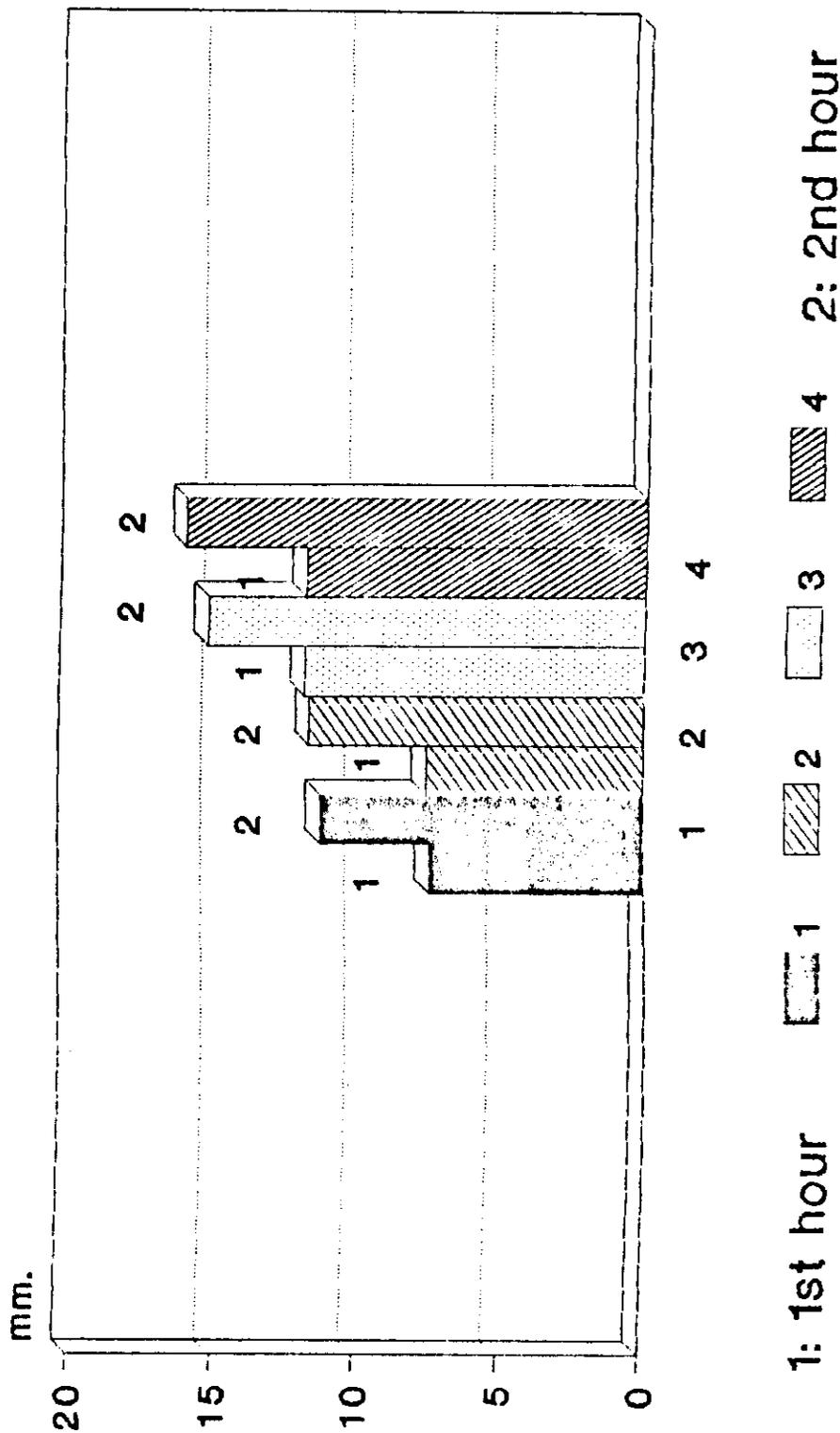
1: Non-smo. bef. exp. 2: Non-smo. after exp.  
3: Chronic smo. bef. acute smoking  
4: Chronic smo. after acute smoking

Fig. (5): MCV in different groups.



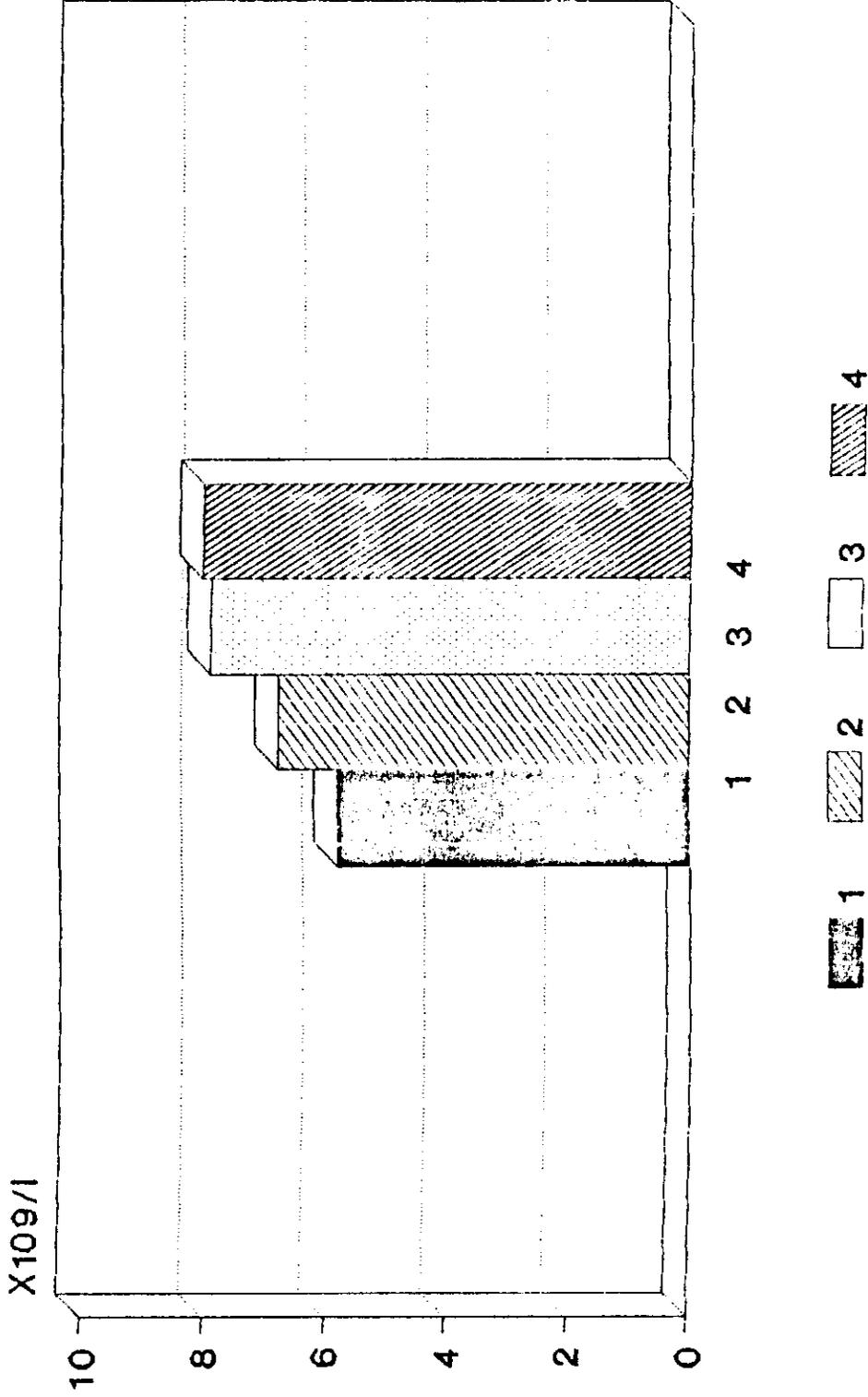
1:Non-smo.bef. exp. 2:Non-smo after exp.  
3:Chronic smo.bef. acute smoking  
4:Chronic smo after acute smoking

Fig. (6): ESR after 1st and 2nd hours  
in all groups.



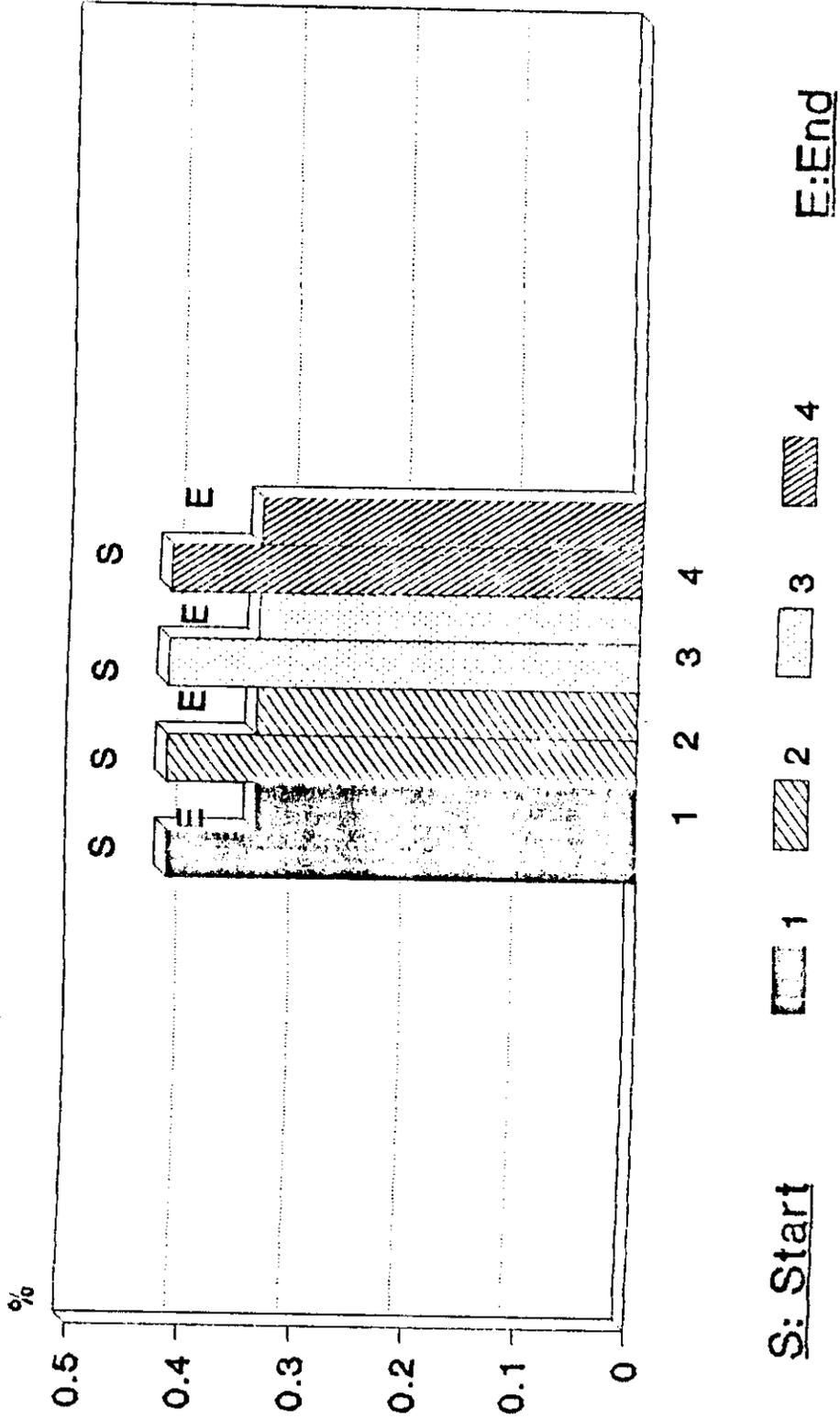
1: Non-smo. bef. exp. 2: Non-smo. after exp.  
3: Chronic smo. bef. acute smoking  
4: Chronic smo. after acute smoking

Fig. (7): WBCs count in different groups



1:Non-smo.bef. exp. 2:Non-smo.after exp.  
3:Chronic smo.bef. acute smoking  
4:Chronic smo after acute smoking

Fig. (8): Osmotic fragility test in all groups (start and end of hemolysis)



S: Start

1

2

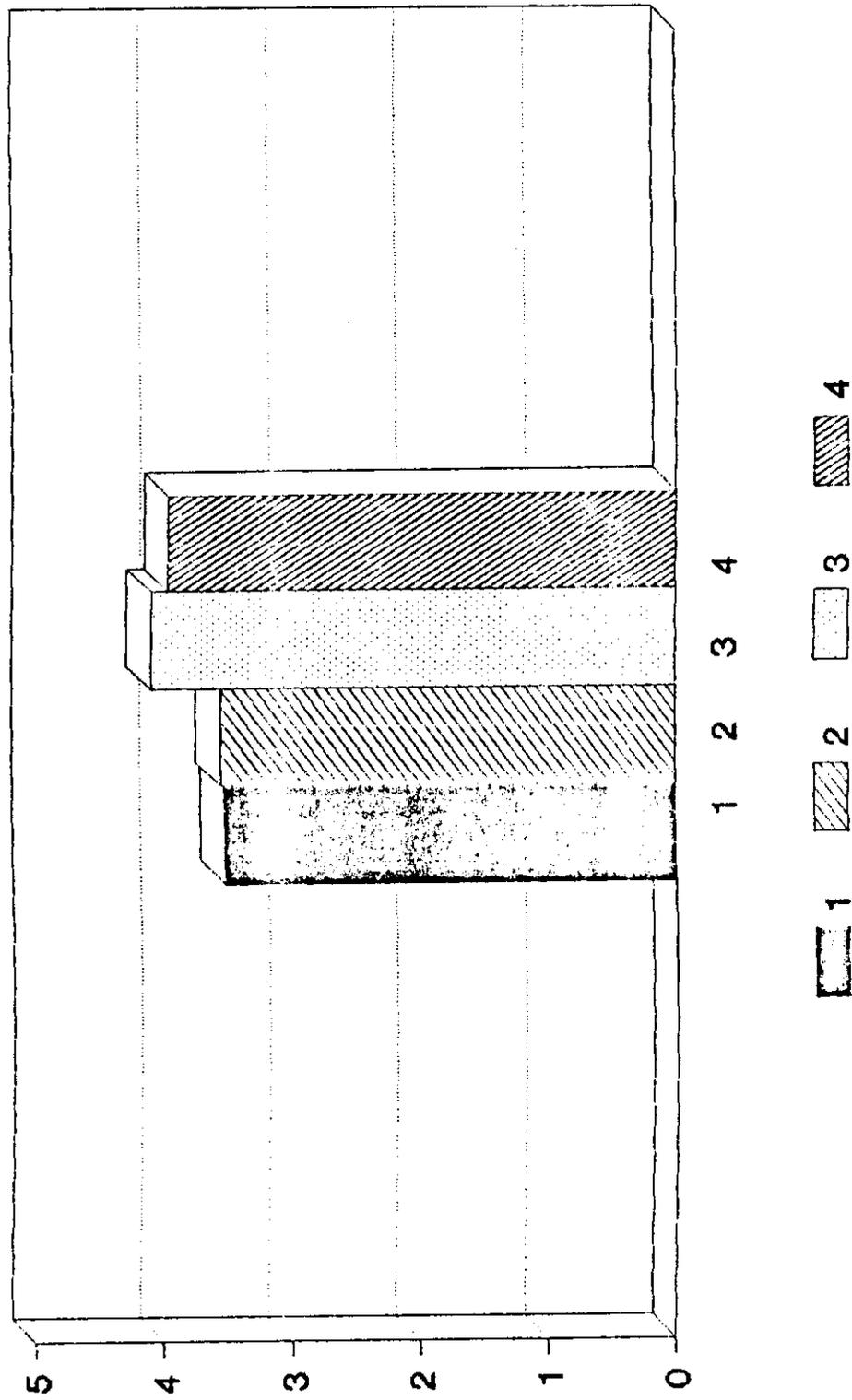
3

4

E: End

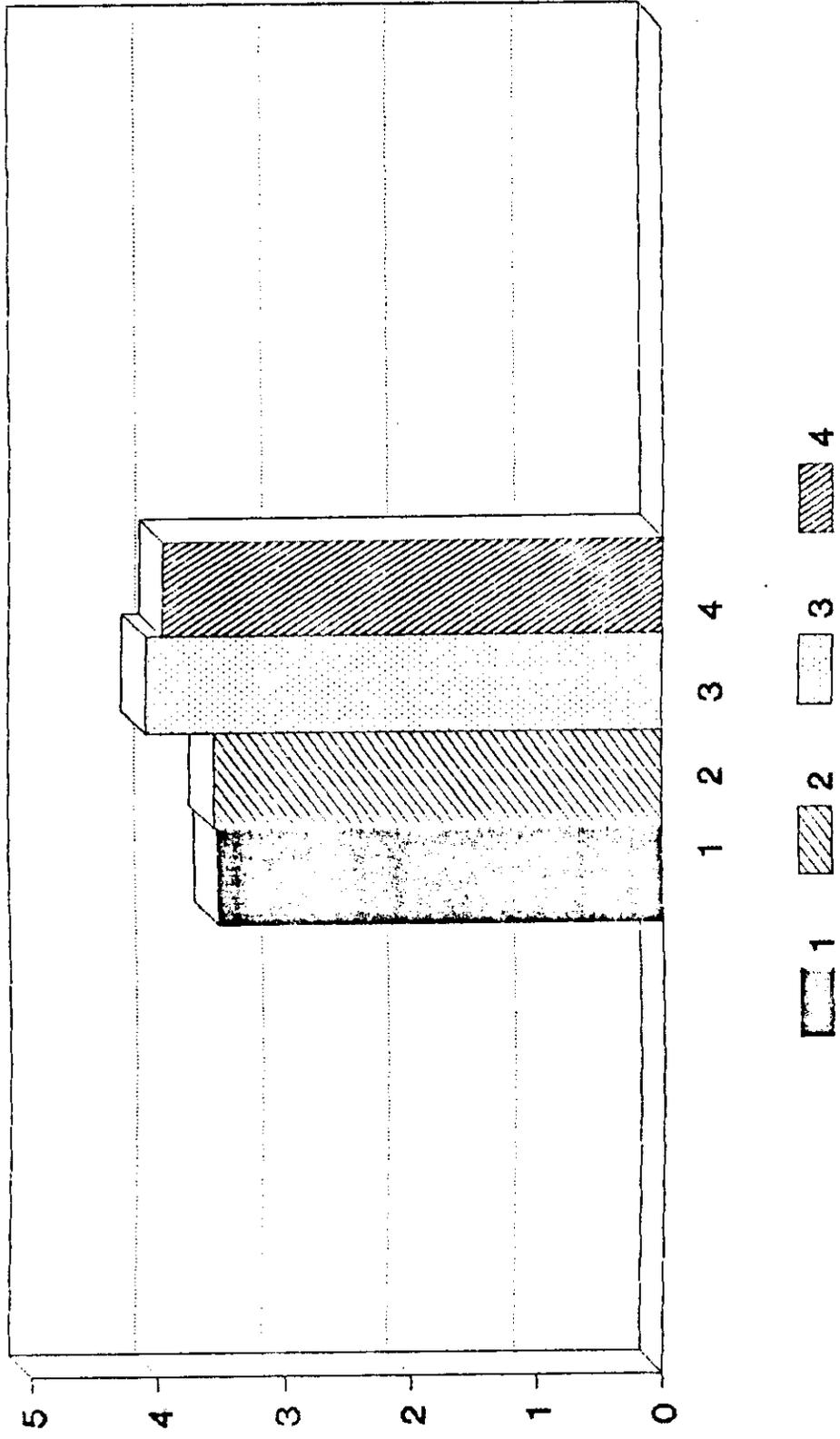
- 1: Non-smo. bef. exp
- 2: Non-smo. after exp.
- 3: Chronic smo. bef. acute smoking
- 4: Chronic smo. after acute smoking

Fig. (9): Blood viscosity in all groups



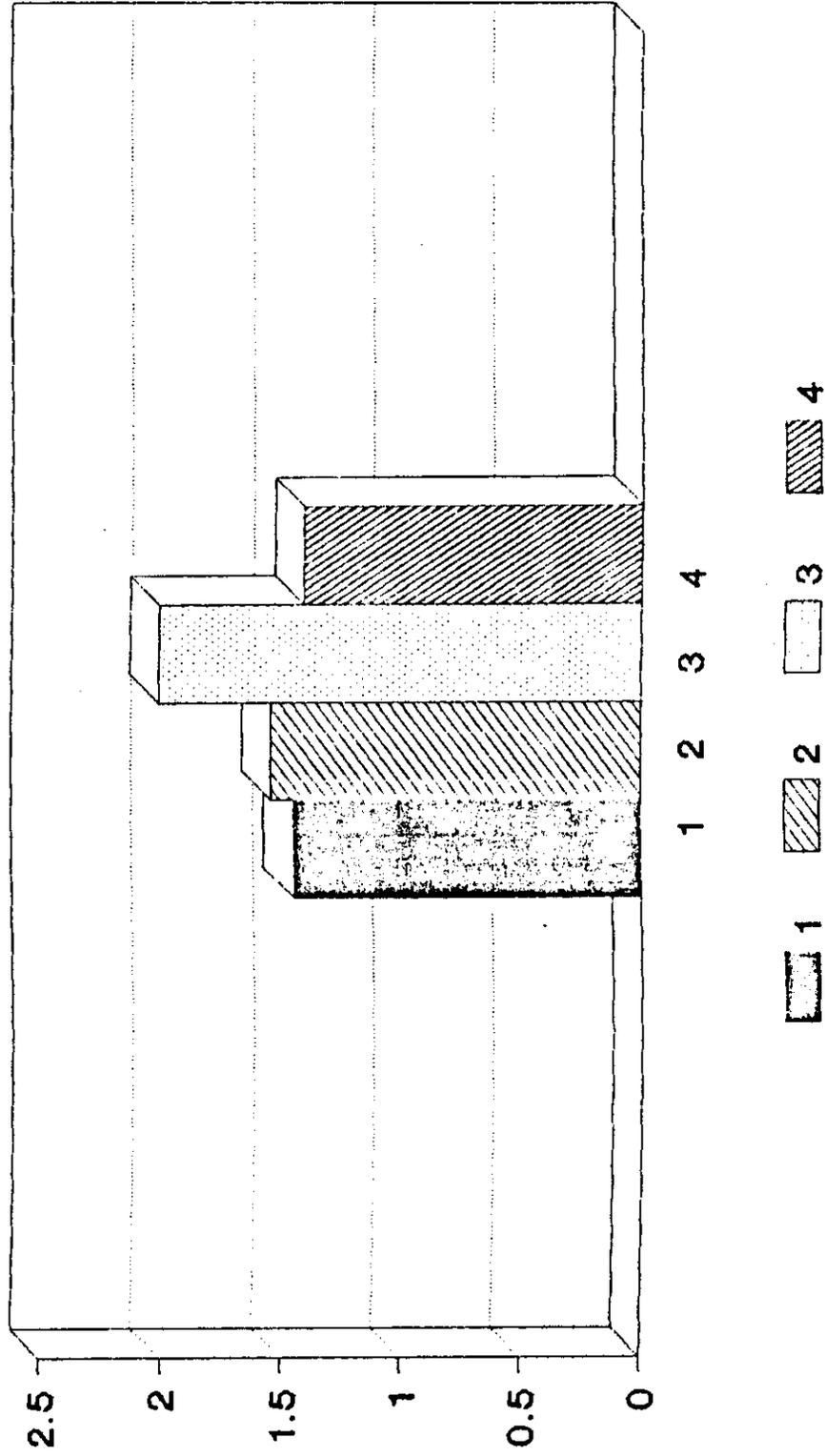
1: Non-smo. bef. exp. 2: Non-smo. after exp.  
3: Chronic smo. bef. acute smoking  
4: Chronic smo. after acute

Fig. (9): Blood viscosity in all groups



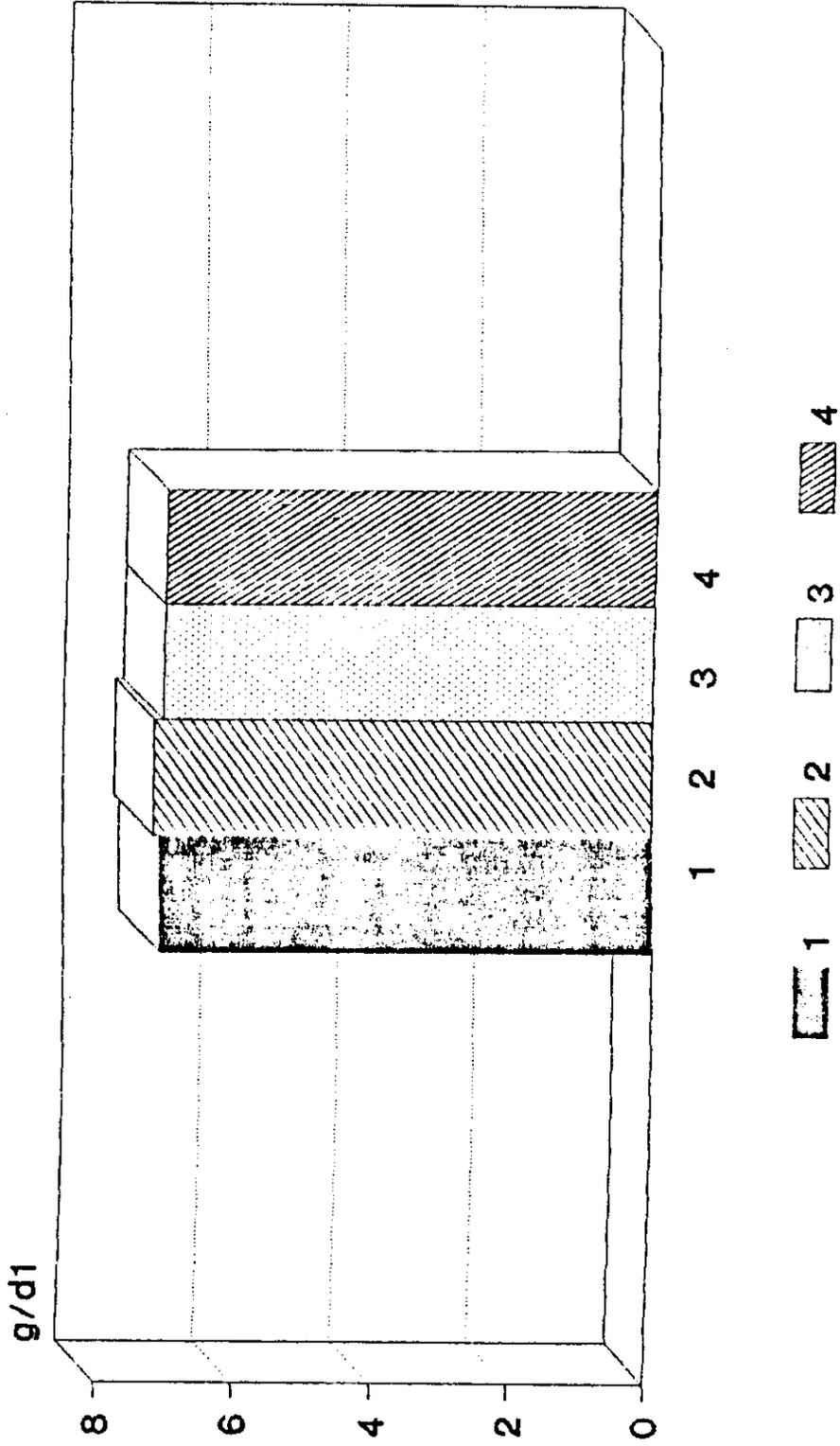
1: Non-smo. bef. exp. 2: Non-smo. after exp.  
3: Chronic smo. bef. acute smoking  
4: Chronic smo. after acute

Fig. (10): Plasma viscosity in all groups.



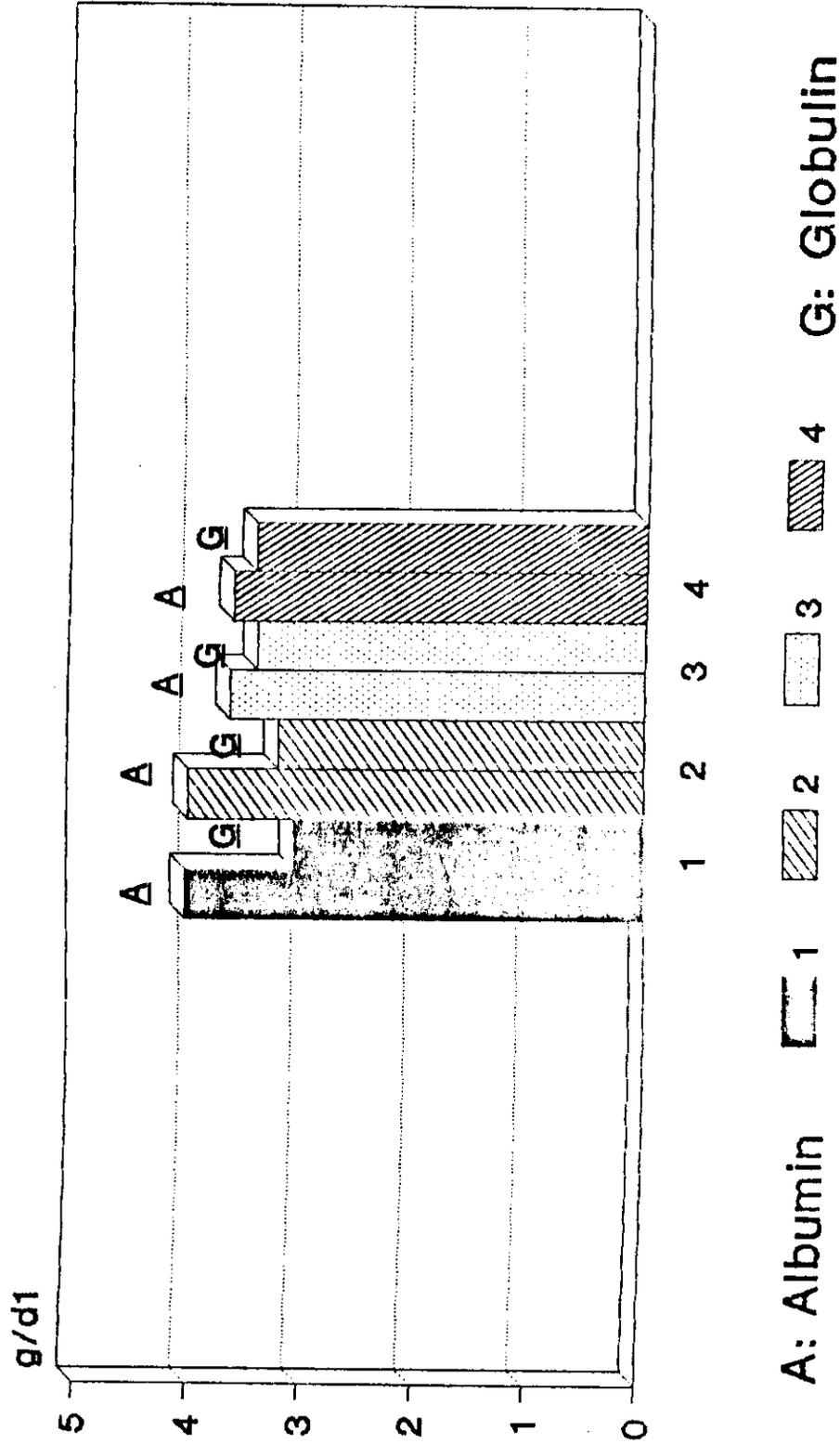
1:Non-smo.bef.exp. 2:Non-smo after exp.  
3:Chronic smo.bef. acute smoking  
4:Chronic smo.after acute smoking

Fig.(11):Total plasma protein concentrations in all groups.



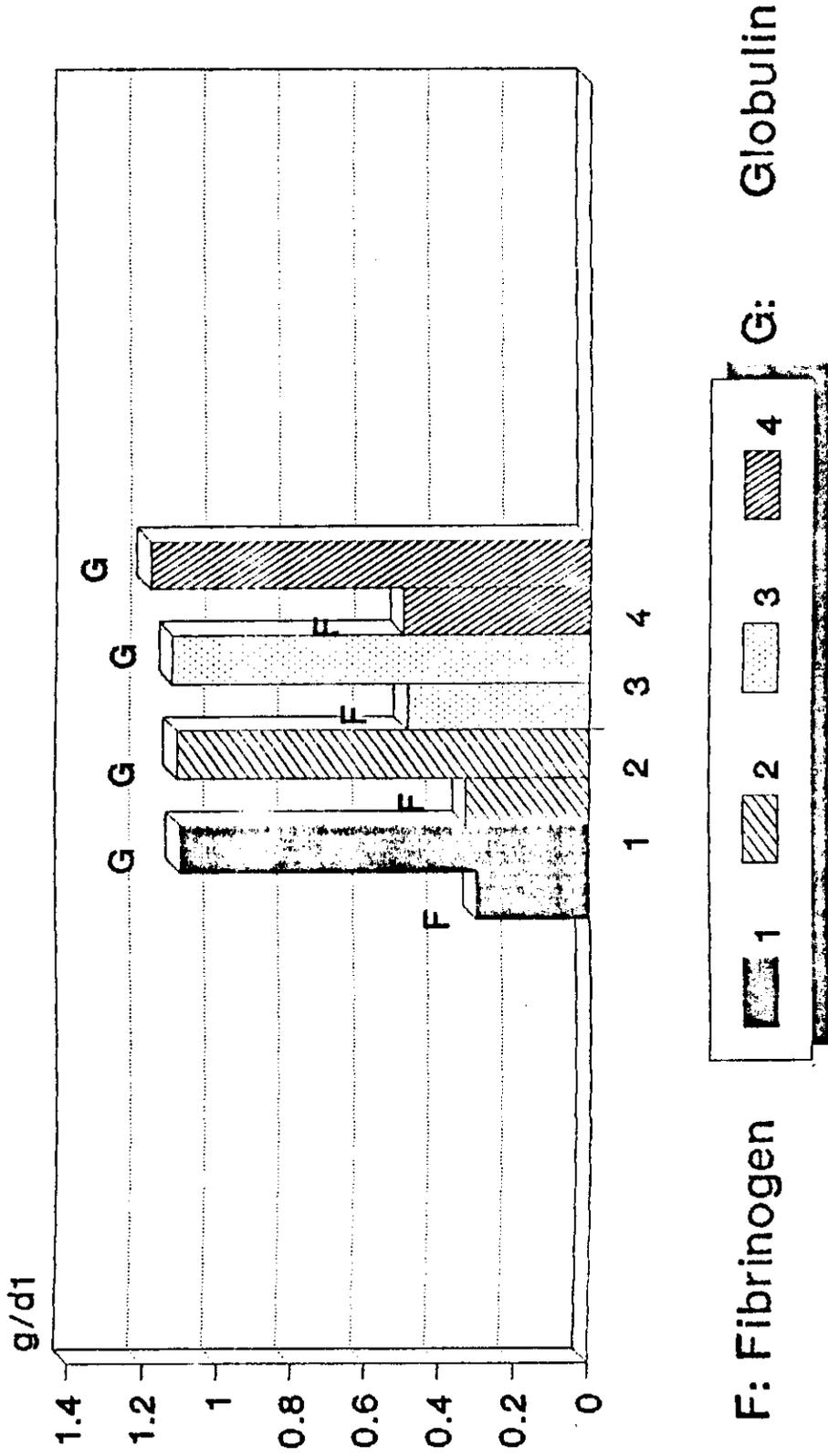
1:Non-smo.bef.exp. 2:Non-smo after exp.  
3:Chronic smo.bef. acute smoking  
4:Chronic smo. after acute smoking

Fig. (12): Albumin and total globulin concentrations in all groups.



1: Non-smoker. 2: Non-smoker after exp.  
3: Chronic-smoker before acute smoking  
4: Chronic-smoker after acute smoking

Fig. (13): Fibrinogen and globulin concentrations in all groups.



1: Non-smo. bef. exp. 2: Non-smo after exp.  
3: Chronic smo. bef. acute smoking  
4: Chronic smo. after acute