RESULTS

The results are summarized in tables (1 - 17) and illustrated in figures (1 - 22) as follows.

1. Socio-ecnomic, clinical and anthropometric findings in the malnourished (KWO, marasmic-KWO and marasmus) and in the control children.

2. Laboratory findings of:

   - Serum albumin
   - Serum protein
   - Serum aldosterone
   - Serum renin activity

in both the malnourished (KWO, marasmic-KWO and marasmus) and the control children.

1. Socio-economic, clinical, and anthropometric findings:

Table 1: shows the total number, age and sex of the malnourished children. The total number is 51 (19 males and 32) females).

Table 2: shows the precipitating diseases and the underlying socio-economic pattern of the cases. It is noticed that, gastroenteritis and measles were the most frequent precipitating diseases. Poverty, illiteracy, large family size and ignorance of the food values, were the underlying factors.

Table 3: shows the clinical picture and anthropometric measurements of marasmic children, all of them show muscle wasting, loss of subcutaneous fat with signs of vitamins deficiencies. The mean value of the weight was 5.7 kg $\pm$ 0.68 and of the mid-arm circumference 9.79 cm $\pm$ 1.71, both were reduced and of high statistical significance

P value < 0.005 for both. The mean value of the length and head circumference were 71.3 cm $\pm$ 3.91 and 45.87 cm $\pm$ 3.1 both were statistically insignificant $P > 0.05$ for both.

Table 4: shows the clinical picture and anthropometric measurements in marasmic-kwashiorkor children: all of them show apathy or irritability, oedema, skin and hair changes and signs of vitamin deficiency. Most of them show varying degree of hepatomegaly. The mean value of the weight, length and mid-arm circumference were 6 kg $\pm$ 0.72, 62.7 cm $\pm$ 3.4 and 10.03 cm $\pm$ 1.98 respectively, all were reduced and of high statistical significance $P < 0.005$, $P < 0.05$ and $P < 0.005$ respectively. The mean value of the head circumference was 45.96 cm $\pm$ 2.3 which was statistically insignificant $p > 0.05$.

Table 5: shows the clinical picture and anthropometric findings in kwashiorkor children, all of them show varying degree of oedema, hepatomegaly, skin and hair changes, signs of vitamin deficiencies in addition to apathy or irritability. The mean value of the weight and mid-arm circumference were 7.26 kg $\pm$ 0.78 and 10.46 cm $\pm$ 1.8 both were reduced and of high statistical significance

$P < 0.005$ for both. The mean value of the length and head circumference were 70.47 cm ± 4.4 and 45.98 cm ± 3.26 this was statistically significant for the length $P < 0.05$ and statistically insignificant for the head circumference $P > 0.05$.

Table 6: shows the anthropometric measurements of the control children. The mean value of the weight was 10.7 kg ± 1.54, of the length 74.7 cm ± 2.32, of the head circumference 46.25 cm ± 2.1 and of the mid-arm circumference 14.89 cm ± 1.89.

The percentage of the weight/age length/age as related to the local standards of Abbassy were 109.8 % ± 8.57 and 98.1 % ± 2.38 respectively. This is illustrated in figure (1 and 2).

As regards the percentiles 20 % were on the 25th percentile for the weight/age, 40 % were on the 75th percentile, 30 % on the 90th percentile and 10 % on the 97th percentile (Fig. 3). As regards the length/age 30 % were on the 25th percentile and 70 % were on the 50th percentily (Fig. 5).

Table 7: shows some anthropometric measurements of the marasmic children in relation to Abbassy et al. (1972). The percentage

of weight/age and length/age were 59.2 % $\pm$ 3.9 and 93.6 % $\pm$ 2.52 respectively.

As regards the percentiles in relation to the local standards of "Abbassy"; all of them were below the third percentile for weight/age (Fig. 3).

As regards length/age 13 % were on the third percentile, 34.8 % were on the the tenth percentile, 47.8 % were on the 25^{th} percentile and only 4.4 % fits for the 50^{th} percentile (Fig. 5).

Table 8: shows some anthropometric measurements of the marasmic-kwashiorkor children in relation to Abbassy et al. (1972). The percentage of weight/age and length/age were 62.7 % $\pm$ 3.4 and 93.6 % $\pm$ 3.3 respectively.

All of them were below the 3^{rd} percentile for the weight/age (Fig. 3), 15.4 % were on the 3^{rd} percentile for the length/age, and 53.8 % were on the 10^{th} percentile, 23.1 on the 25^{th} percentile, and only 7.7 % were on the 50^{th} percentile (Fig. 6).

Table 9: shows some anthropometric measurements of kwashiorkor children in relation to "Abbassy". The percentage of weight/age and length/age were 75.6 $\pm$ 4.47 and 70.47 $\pm$ 4.2 respectively. 33.3 % were below the 3^{rd} percentile

for weight/age, 13.3 % on the 3^{rd} percentile and 53.4 % on the 10^{th} percentile (Fig. 4). As regards length/age 40 % were on the 3^{rd} percentile, 20 % on the 10^{th} percentile, 26.7 % on the 25^{th} percentile and 13.3 % fits for the 50^{th} percentile (Fig. 7).

2. Laboratory findings:

Table 10: shows the laboratory findings in the control children. The means of serum proteins and serum albumin were 7.04 gm/100 ml $\pm$ 0.44 and 4.83 gm/100 ml $\pm$ 0.73 respectively. Serum globulins was 2.21 gm/100 ml $\pm$ 0.49, the A/G ratio was 2.2 $\pm$ 0.49. The means of serum sodium and potassium were 139.6 m Eq/L. $\pm$ 3.93 and 3.83 m Eq/L. $\pm$ 0.65 respectively. Serum aldosterone and serum renin activity were 13.54 ng/dl $\pm$ 4.04 and 1.3 ng/ml/h. $\pm$ 0.27 respectively.

Table 11: shows the laboratory findings in marasmic children. The means of serum proteins and albumin were 6.87 gm/100 ml $\pm$ 0.49 and 4.63 gm/100 ml $\pm$ 0.31 respectively which were statistically insignificant, P values were > 0.4 and > 0.2 respectively.

The mean value of serum globulins was 2.27 gm/100 ml $\pm$ 0.42 and the A/G ratio was 2.1 $\pm$ 0.49, both were statistically insignificant, the P values were $>$ 0.7 and $>$ 0.5 for both.

The mean value of serum Na^+ and serum K^+ were 142.9 m Eq/L. $\pm$ 7.04 and 4.15 m Eq/L. $\pm$ 0.47, both were statistically insignificant, P $>$ 0.1 and $>$ 0.05 respectively. The mean value of serum aldosterone and serum renin activity were 14.4 ng/dl $\pm$ 2.54 and 1.54 ng/ml/h. $\pm$ 0.43, both were statistically insignificant, P $>$ 0.5 and $>$ 0.1 respectively.

Table 12: shows the laboratory findings in marasmic-kwashiorkor. The mean value of serum proteins and serum albumin were 4.9 gm/100 ml $\pm$ 0.55 and 2.41 gm/100 ml $\pm$ 0.43, both were of high statistical significance, the P value was $<$ 0.0005 for both.

The mean value of serum globulin and A/G ratio were 2.49 gm/100 ml $\pm$ 0.45 and 0.99 $\pm$ 0.26 respectively. The P values were $>$ 0.1 and $<$ 0.005 respectively which were of high statistical significance for the A/G ratio only.

The mean value of serum Na^+ and serum K^+ were 135.77 m Eq/L. $\pm$ 6.79 and 3.65 m Eq/L. $\pm$ 0.49 respectively.

The P values were > 0.1 and > 0.3 both were statistically insignificant. The meran value of serum aldosterone and serum renin activity were 15.69 ng/dl $\pm$ 2.67 and 2.008 ng/ml/h $\pm$ 0.37 respectively. The P values were > 0.15 and < 0.005 denoting high statistical significance as regards serum renin activity.

Table 13: shows the laboratory findings in kwashiorkor children the mean value of serum proteins and serum albumin were 4.7 gm/100 ml $\pm$ 0.87 and 2.39 gm/100 ml $\pm$ 0.54 respectively, both were of high statistical significance, the P values of both were < 0.001 and < 0.005.

The mean value of serum globulin was 2.31 gm/100 ml $\pm$ 0.46 which was statistically insignificant, $P > 0.8$, the A/G ratio was 0.9 $\pm$ 0.19 which was of high statistical significance, $P < 0.001$.

The mean value of serum Na^+ and serum K^+ were 131.13 m Eq/L $\pm$ 5.32 and 3.5 m Eq/L $\pm$ 0.37 respectively, both were statistically insignificant, the P values were > 0.1 and > 0.5 respectively.

The mean value of serum aldosterone and serum renin activity were 20.38 ng/100 ml $\pm$ 3.26 and 2.62 ng/ml/h $\pm$ 0.49 respectively, both were of high statistical significance, the P values were < 0.005 for each.

Table 14: shows a comparison between serum proteins in the malnourished (KWO, marasmic-KWO and marasmus) and the control children. This is also demonstrated in Fig. (8).

Table 15: shows a comparison between serum albumin in the malnourished (KWO, marasmic-KWO, and marasmus) and the control children. This is also illustrated in Fig. (9).

Table 16: shows a comparison between serum electrolytes (serum Na^+ and serum K^+) in the malnourished (KWO, marasmic-KWO, and marasmus) and the control children. This is also illustrated in Fig. (10 and 11).

Table 17: shows a comparison between serum aldosterone and serum renin activity in the malnourished (KWO, marasmic-KWO, and marasmus) and the control children. This is also illustrated in Fig. (12 and 13).

Figure 14: A histogram showing the relationship between the degree of oedema and serum aldosterone in both KWO and marasmic-KWO children.

Figure 15: A histogram showing the relationship between the degree of oedema and serum renin activity in KWO and marasmic-KWO children.

Figure 16: A histogram showing the relationship between the degree of oedema and serum aldosterone in KWO and marasmic-KWO cases.

Figure 17: A graphic representation of serum aldosterone and the degree of oedema in KWO cases, there is a positive correlation coefficient $r = 0.99$, $P < 0.001$

Figure 18: A graphic representation of serum renin activity and the degree of oedema in KWO cases, there is a positive correlation coefficient $r = 0.84$, $P < 0.001$

Figure 19: A graphic representation of the relationship between serum aldosterone and the degree of oedema in marasmic-KWO cases, there is a positive correlation coefficient. $r = 0.9$, $P < 0.001$

Figure 20: A graphic representation of the relationship between serum renin activity and the degree of oedema in marasmic-KWO cases, there is a positive correlation coefficient $r = 0.82$, $P < 0.001$

Figure 21: A graphic representation of the relationship between serum aldosterone and hepatomegaly in KWO cases, there is a +ve correlation coefficient $r = 0.82$, $P < 0.001$

Figure 22: A graphic representation of the relationship between serum aldosterone and hepatomegaly in marasmic-KWO cases, there is a positive correlation coefficient $r = 0.132$, $P < 0.5$

Table (1): Total number, age and sex of malnourished children (KWO, marasmic-KWO and marasmus)

Age in months	KWO		Marasmic-KWO		Marasmic	
	M	F	M	F	M	F
12 - 15	2	3	1	3	2	6
16 - 18	1	4	-	4	2	2
19 - 21	1	-	3	-	2	3
22 - 24	1	3	1	1	3	3
Total number	5	10	5	8	9	14

- Total number of the malnourished children = 51 (19 males, 32 females).

- Total number of the malnourished children = 51 (15 KWO, 13 Marasmic-KWO, 23 Marasmus)

Table (2): Precipitating diseases and socio-economic pattern of the cases

	No. of cases
* Pricipitating diseases:	
- Gastro-interitis	33
- Measles	13
- Respiratory tract infections	5
* Socio-economic pattern:	
- Poverty	41
- Illiteracy of the parents	45
- Large family size	45
- Ignorance of food values	45

Table (3): Clinical picture and anthropometric measurements of marasmic children

Serial No.	Age in months	Sex	Weight in kgm	Length in cm	Head circ. in cm	Mid arm circ. in cm	Muscle wasting	Loss of S.C. fat	Signs of vitamins defficiency
1	12	F	5.0	67.0	44.0	9.0	+++	++	+
2	13	M	5.3	65.0	44.5	9.5	+++	++	+
3	15	F	5.5	68.0	44.8	9.5	+++	++	+
4	18	M	6.0	72.0	46.0	10.0	+++	++	+
5	24	F	6.5	75.0	46.4	10.5	+++	++	+
6	20	M	5.8	73.0	46.5	10.2	+++	++	+
7	22	M	6.0	70.0	46.8	10.3	+++	++	+
8	24	F	6.2	74.0	47.0	9.2	+++	++	+
9	12	F	4.5	70.0	44.2	9.8	+++	++	+
10	17	F	5.0	72.0	45.7	9.8	+++	++	+
11	19	F	5.5	71.0	45.8	10.0	+++	++	+
12	22	M	6.7	76	47.6	10.2	+++	++	+
13	18	M	7.0	73.0	46.9	10.2	++	++	+
14	21	F	6.0	71.0	47.0	9.3	++	++	+

Table (3) (Cont'd)

Serial No.	Age in months	Sex	Weight in kg	Length in cm	Head circ. in cm	Mid arm circ. in cm	Muscle wasting	Loss of S.C. fat	Signs of vitamins defficiency
15	12	F	5.0	66.0	46.0	9.4	+++	++	+
16		F	4.5	69.0	44.0	9.6	+++	++	+
17				70.0	45.2	9.8	+++	++	+
18	20.0	M	6.0	75.0	46.8	10.2	+++	++	+
19	24	M	6.5	77.0	47.5	10.4	+++	++	+
20	22	F	6.4	74.0	46.0	9.8	+++	++	+
21	20	F	6.0	72.0	46.0	9.8	+++	++	+
22	15	M	5.8	69.0	45.8	9.5	+++	++	+
23	12	F	5.2	68.0	44.8	9.2	+++	++	+
$\bar{x}$			5.7	71.3	45.87	9.79			
S.E. $\pm$			0.021	0.89	0.98	0.23			
S.D. $\pm$			0.68	3.91	3.1	1.71			
P			$P < 0.005$	$P > 0.05$	$P > 0.05$	$P < 0.005$			

Table (4): Clinical picture and anthropometric measurements in marasmic-kwashiorkor children

Serial No.	Age in months	Sex	Weight in kg	Length in cm	Head circ. in cm	Mid-arm circ. in cm	Apathy	Irrita-bility	Skin & hair changes	Signs of vitamins dif.	Oedema	Hepato megaly
1	12	F	5.0	66.0	44.0	9.0	-	+	+++	+	++++	++
2	18	F	5.5	70.0	45.5	9.5	+	-	+	+	+++	+
3	20	M	6.2	74.0	47.0	10.0	+	-	+	+	++	-
4	18	F	6.0	70.0	45.8	9.5	+	-	+	+	+++	++
5	24	M	7.5	75.0	47.5	10.5	-	+	+	+	++	++
6	24	F	6.8	68.0	46.0	10.0	-	+	+	+	+	+
7	20	M	6.8	72.0	46.5	10.5	+	-	+	+	+	+
8	20	M	6.0	74.0	46.8	11.0	+	-	+	+	++	-
9	18	F	5.5	67.0	46.0	9.5	+	-	+	+	++	-
10	12	F	5.2	69.0	45.0	9.0	+	-	+	+	++	-
11	13	F	5.5	6.9	45.0	9.5	+	-	+	+	+++	++
12	16	F	6.0	68.0	45.5	10.5	+	-	+	+	+++	++
13	15	M	6.2	72.0	46.0	11.0	+	-	+	+	++	+
$\bar{x}$			6.0	62.7	45.96	10.03						
S.E. $\pm$			0.12	0.943	0.81	0.72						
S.D. $\pm$			0.721	3.4	2.3	1.98						
P			<0.005	<0.05	>0.05	<0.005						

Table (5): Clinical picture and anthropometric measurements in kwashiorkor children

Serial No.	Age in months	Sex	Weight in kg	Length in cm	Head circ. in cm	Mid arm circ. in cm	Apathy	Irrita-bility	Oedema	Skin & hair changes	Signs of vitamins dif.	Hepato-megaly
1	12	M	6.9	70.0	45.5	11.0	+	-	++++	+++	+	+++
2	14	F	6.3	71.0	44.5	10.5	+	-	++++	+++	+	++
3	18	F	7.5	72.0	45.5	11.2	+	-	+++	++	+	+
4	13	F	6.8	62.0	44.8	10.5	-	+	++	+	+	+
5	15	M	6.5	66.0	45.8	11.0	-	+	+++	++	+	++
6	18	M	7.1	71.0	46.5	11.5	+	-	++	+	+	+
7	22	F	8.2	70.0	46.0	11	+	-	+++	+	+	++
8	20	M	8.5	76.0	47.0	11.2	-	+	++	+	+	+
9	18	F	6.5	66.0	46.0	9.5	+	-	++	+++	+	++
10	15	F	6.6	68.0	45.0	9.8	+	-	++	+	+	++
11	24	F	8.3	76.0	47.0	9.5	+	-	+++	++	+	+
12	24	F	7.7	72.0	46.5	9.2	+	-	++++	+++	+	+++
13	16	F	6.8	71.0	45.6	10.2	+	-	++++	+++	+	+++
14	23	M	8.5	78.0	48.0	11.0	+	-	++	+	+	+
15	17	F	6.7	68.0	46.0	10.0	+	-	++++	+++	+	+++
$\bar{x}$			7.26	70.47	45.98	10.46						
S.E. $\pm$			0.203	1.17	0.78	0.711						
S.D. $\pm$			0.78	4.4	3.26	1.8						
P			<0.005	<0.005	>0.05	<0.005						

Table (6): Anthropometric measurements of the control children in ralation to ABBASSY et al. (1972)

Serial No.	Age in months	Sex	Weight in kg	% Weight per age	Length in cm	% Length per age	Percentiles Weight	Percentiles Length	Head circ. in cm	Mid-arm circ. in cm
1	16	F	8.5	93	74.0	100	25	50	45.8	14.8
2	18	M	10.5	105	76.0	99	75	50	45.9	14.8
3	20	M	12.2	116	78.0	98	90	50	45.7	15.5
4	24	F	13.2	123	75.0	93	97	25	47.0	16.4
5	12	F	9.3	114	70.0	99	75	50	44.6	13.8
6	18	M	10.8	107	74.0	96	75	25	46.5	15.2
7	22	M	12.5	110	76.0	96	90	25	47.5	15.4
8	14	F	10.0	115	72.0	100	90	50	46.0	13.8
9	18	F	10.8	113	75.6	100	75	50	46.0	14.8
10	19	F	9.2	96	76.4	100	225	50	45.7	14.4
$\bar{x}$			10.7	109.8	74.7	98.1	71.7	42.5	46.25	14.89
S.E. ±			0.487	2.71	0.73	0.75	8.2	3.818	0.67	0.32
S.D. ±			1.54	8.57	2.32	2.30	25.9	12.08	2.1	1.89

Table (7): Some Anthropometric measurements of marasmic children in relation to Abbassy et al. (1972)

Serial No.	Age in months	Sex	Weight in kgm	% weight per age	Length in cm	% length per age	Percentile Wt.	Percentile Length
1	12	F	5	61	67	94	below 3	25
2	13	M	5.3	60	6.5	89	" 3	3
3	15	F	5.5	62	68	93	" 3	10
4	18	M	6	60	72	94	" 3	10
5	24	F	6.5	61	75	92	" 3	10
6	20	M	5.8	55	73	92	" 3	10
7	22	M	6	56	70	88	" 3	3
8	24	F	6.2	58	74	92	" 3	10
9	12	F	4.5	55	70	99	" 3	50
10	17	F	5	53	72	94	" 3	25
11	19	F	5.5	57	71	93	" 3	10
12	22	M	6.7	62	76	96	" 3	25
13	18	M	7	70	73	95	" 3	25
14	21	F	6	59	71	91	" 3	3
15	12	F	5	61	66	91	" 3	25
16	14	F	4.5	51	69	96	" 3	25
17	18	F	5.5	58	72	95	" 3	25
18	20	M	6	57	75	96	" 3	25
19	24	M	6.5	59	77	95	" 3	25

Table (7) (Cont'd)

Serial No.	Age in months	Sex	Weight in kgm	% weight per age	Length in cm	% length per age	Percentila Wt.	Percentila Length
20	22	F	6.4	62	74	95	below 3	25
21	20	F	6	59	72	94	" 3	10
22	15	M	5.8	61	69	92	" 3	10
23	12	F	5.2	64	68	96	" 3	25
$\bar{x}$	18	9M	5.7	59.2	71.3	93.6	below 3	18
S.E. $\pm$	0.869	14F	0.02	0.81	0.67	0.526	-	2.33
S.D. $\pm$	4.17		0.68	3.9	3.23	2.52	-	11.2

Table (8): Some Anthropometric measurements of marasmic-Kwashiorkor children in relation to Abbassy et al. (1972)

Serial No.	Age in months	Sex	Weight in kgm	% weight per age	Length in cm	% length per age	Percentile Wt.	Percentile Length
1	12	F	5	61	66	93	below 3	10
2	18	F	5.5	58	70	93	" 3	10
3	20	M	6.2	60	74	95	" 3	25
4	18	F	6	63	70	93	" 3	10
5	24	M	7.5	68	75	92	" 3	10
6	24	F	6.8	63	68	85	" 3	3
7	20	M	6.8	65	72	92	" 3	10
8	20	M	6.0	58	74	95	" 3	10
9	18	F	5.5	58	67	89	" 3	3
10	12	F	5.2	64	69	97	" 3	50
11	13	F	5.3	66	69	96	" 3	25
12	16	F	6	66	68	92	" 3	10
13	15	M	6.2	65	72	96	" 3	25
$\bar{x}$	17.7	4M	6	62.7	70.3	93.6	below 3	15.5
S.E. ±	1.111	9M	0.2	0.943	0.80	0.916	-	3.075
S.D. ±	4.00		0.721	3.40	2.870	3.302	-	11.91

Table (9): Some anthropometric measurements of Kwashiorkor children in relation to Abbassy et al. (1972)

Serial No.	Age in months	Sex	Weight in kgm	% weight per age	Length in cm	% length per age	Percentile Wt.	Percentile Length
1	12	M	6.9	78	70	96	10	25
2	14	F	6.3	74	71	99	3	50
3	18	F	7.5	79	72	95	10	25
4	13	F	6.8	83	62	88	10	3
5	15	M	6.5	68	66	88	below 3	3
6	18	M	7.1	71	71	92	" 3	10
7	22	F	8.2	78	70	89	10	3
8	20	M	85	82	78	97	10	25
9	18	F	65	68	66	87	3	3
10	15	F	6.6	75	68	93	10	10
11	24	F	8.3	77	76	95	below 3	10
12	24	F	7.7	72	72	90	" 3	3
13	16	F	6.8	76	71	96	10	25
14	23	M	8.5	78	78	88	10	50
15	17	F	6.7	75	68	91	below 3	3
$\bar{x}$	17.93		7.26	75.6	70.47	92.9	6.7	35.5
S.E. $\pm$	0.984		0.203	1.15	1.086	1.02	0.93	6.6
S.D. $\pm$	3.81		0.788	4.47	4.207	3.95	3.6	25.56

Table (10): Laboratory findings in the control children

Serial No.	Age in months	Sex	S. Protein gm/100 ml	S. Albumin gm/100 ml	S. Globulin gm/100 ml	A/G	S. Na^+ nEq/L	S. K^+ nEq/L	S. Aldosterone ng/dl	S.R.A. ng/ml/h
1	16	F	7	5.1	1.9	2.68	140	4.3	14.3	1.5
2	18	M	6.6	4.2	2.4	1.75	138	4.2	6.7	1.1
3	20	M	69	4.6	2.3	2.0	145	3.5	12.9	0.9
4	24	F	7.4	5.2	2.2	2.36	144	3.5	10.8	1.2
5	12	F	7.4	5.2	2.2	2.36	138	3.8	19.7	1.5
6	18	M	7.6	5	2.6	1.9	137	3.6	17.4	1.3
7	22	M	6.2	4.2	2.0	2.1	135	3.2	18.5	0.9
8	14	F	6.7	4.8	1.9	2.5	140	3.5	16.8	1.3
9	18	F	7.4	5	2.4	2.1	141	42	15.4	1.6
10	19	F	7.2	5	2.2	2.27	138	4.5	13.9	1.7
$\bar{x}$			7.04	4.83	2.21	2.207	139.6	3.83	13.54	1.3
S.E. $\pm$			0.14	0.231	0.156	0.156	1.245	0.206	1.278	0.088
S.D. $\pm$			0.442	0.732	0.495	0.495	3.938	0.652	4.042	0.279

Tabler (11): Laboratory findings in marasmic children

Serial No.	Age in months	Sex	S. Protein gm/100 ml	S. Albumin gm/100 ml	S. Globulin gm/100 ml	A/G	S. Na^+ m Eq/L	S. K^+ m Eq/L	S. Aldosterone ng/dl	S.R.A. ng/ml/h
1	12	F	7.1	5.0	2.1	2.38	145	4.2	12.3	1.3
2	13	M	7.0	5.0	2.0	2.5	145	4.2	8.5	1.6
3	15	F	7.3	5.1	2.2	2.32	147	4.4	11.9	1.1
4	18	M	5.6	4.4	1.2	3.66	135	3.8	17.4	0.9
5	24	F	7.3	5.0	2.3	2.17	144	3.6	16.8	1.4
6	20	M	6.6	4.7	1.9	2.47	139	4.5	18.9	1.6
7	22	M	6.9	4.6	2.3	2.0	148	3.4	12.7	0.9
8	24	F	6.8	4.5	2.3	1.95	133	3.8	14.3	0.85
9	12	F	7.5	4.0	3.5	1.14	147	4.6	13.6	1.1
10	17	F	7.2	5.0	2.2	2.27	148	4.1	14.1	1.7
11	19	F	7.0	4.8	2.2	2.18	130	4.9	15.4	0.84
12	22	M	7.3	5.0	2.3	2.17	135	3.5	13.6	2.1
13	18	M	7.2	4.9	2.3	2.13	148	4.5	18.1	1.7
14	21	F	6.8	4.8	2.0	2.4	142	3.9	14.5	1.9
15	12	F	6.3	4.6	1.7	2.7	144	4.8	11.8	2.3
16	14	F	7.0	5.0	2.0	2.5	145	4.0	10.4	1.6
17	18	F	7.4	4.7	2.7	1.7	145	4.2	12.8	1.8
18	20	M	5.8	4.3	1.5	2.86	147	4.9	17.3	1.7
19	24	M	6.7	4.2	2.5	1.68	139	3.9	14.8	1.7

Table (11) (Cont'd)

Serial No.	Age in months	Sex	S. Protein gm/100 ml	S. Albumin gm/100 ml	S. Globulin gm/100 ml	A/G	S. Na^+ mEq/L	S. K^+ mEq/L	S. Aldosterone ng/dl	S.R.A. ng/ml/h
20	22	F	6.3	4.0	2.3	1.73	135	4.1	15.7	1.5
21	20	F	6.7	4.2	2.5	1.68	133	4.0	16.3	1.8
22	15	M	7.3	4.5	2.8	1.6	147	3.8	16.8	2.3
23	12	F	6.9	4.4	2.5	1.76	146	4.4	13.4	1.9
$\bar{x}$			6.87	4.63	2.27	2.101	142.9	4.15	14.4	1.547
S.E.			0.102	0.066	0.089	0.103	2.16	0.088	0.53	0.09
S.D.			0.49	0.316	0.42	0.498	7.048	0.47	2.54	0.43
P			>0.40	>0.20	>0.7	>0.5	>0.1	>0.05	>0.5	>0.1

Table (12): Laboratory findings inmarasmic-Kwashiorkor children

Serial No.	Age in months	Sex	S. Protein gm/100 ml	S. Albumin gm/100 ml	S. Globulin gm/100 ml	A/G	S. Na^+ mEq/L	S. K^+ mEq/L	S. Aldosterone ng/dl	S.R.A. ng/ml/h
1	12	F	5.2	2.6	2.6	1	142	3.5	18.5	2.8
2	13	F	5.3	2.7	2.6	1.03	144	3.6	16.3	1.9
3	20	M	5.5	3.0	2.5	1.2	141	3.5	15.7	2.4
4	18	F	4.5	2.2	2.3	0.95	145	3.2	11.8	1.7
5	24	M	4.4	2.4	2.0	1.2	144	4.2	17.5	1.8
6	24	F	4.8	3.0	1.8	1.66	131	4.0	10.4	1.6
7	20	M	4.6	2.5	2.1	1.19	130	2.2	13.2	2.1
8	20	M	4.0	1.6	2.4	0.66	128	3.8	16.1	2.3
9	18	F	5.6	2.7	2.9	0.93	137	4.1	15.6	1.8
10	12	F	3.8	1.7	2.1	0.81	124	4.3	18.5	1.4
11	13	F	4.8	2.2	2.6	0.84	128	3.3	19.7	1.9
12	16	F	5.5	2.5	3.0	0.83	132	4.0	15.8	2.3
13	15	M	3.8	2.3	3.5	0.65	134	3.8	14.9	2.1
$\bar{x}$			4.9	2.415	2.493	0.999	135.77	3.65	15.692	2.008
S.E. $\pm$			0.153	0.119	0.126	0.074	1.88	0.138	0.741	0.105
S.D. $\pm$			0.553	0.43	0.455	0.260	6.79	0.498	2.672	0.377
P			$<0.0005^{***}$	$<0.0005^{***}$	<0.1	$<0.0005^{***}$	>0.10	>0.3	>0.15	$<0.005^{**}$

Table (13): Laboratory findings in Kwashiorkor children

Serial No.	Age in months	Sex	S. Protein gm/100 ml	S. Albumin gm/100 ml	S. Globulin gm/100 ml	A/G	S. Na^+ mEq/L	S. K^+ mEq/L	S. Aldosterone ng/dl	S.R.A. ng/ml/h
1	12	M	3.5	1.8	1.7	1.06	135	3.5	19.5	3.1
2	14	F	3.5	1.6	1.9	0.84	125	3.1	20.4	2.8
3	18	F	5.2	2.8	2.4	1.16	130	3.4	21.9	2.4
4	13	F	5.8	3.1	2.7	1.15	124	2.8	18.9	1.9
5	15	M	4.3	2.5	1.8	1.34	128	17.3	2.6	
6	18	M	4.8	2.2	2.6	0.84	131	3.2	21.0	1.8
7	22	F	5.5	3.0	2.5	1.2	130	2.9	22.4	1.9
8	20	M	5.3	2.6	2.7	0.96	135	3.7	17.3	3.6
9	18	F	5.8	2.8	3.0	0.93	139	4.3	19.5	2.8
10	15	F	3.1	1.7	1.4	1.21	131	4.5	16.9	2.7
11	24	F	5.2	3.1	2.1	1.47	138	3.5	20.4	3.1
12	24	F	5.2	2.5	2.7	0.92	121	4.0	25.3	2.9
13	16	F	4.0	1.7	2.3	0.74	125	4.2	29.1	2.5
14	23	M	5.4	2.6	2.8	0.93	140	4.1	18.5	2.7
15	17	F	4.0	1.8	2.2	0.81	135	3.5	17.3	2.5
$\bar{x}$			4.707	2.397	2.31	0.902	131.13	3.507	20.38	2.62
S.E. $\pm$			0.225	0.140	0.119	0.051	1.375	0.095	0.859	0.127
S.D. $\pm$			0.874	0.544	0.462	0.196	5.324	0.37	3.26	0.490
P			<0.001***	<0.005***	>0.80	<0.001***	>0.10	>0.50	<0.005***	<0.005***

Table (14): Serum protein (gm/100 ml) in malnourished (KWO, marasmic-Kwashiorkor and marasmus) and control children

Serial No.	KWO	Marasmic-KWO	Marasmus	Control
1	3.5	5.2	7.1	7
2	3.5	5.3	7.0	6.6
3	5.2	5.5	7.3	6.9
4	5.8	4.5	5.6	7.4
5	4.3	4.4	7.3	7.4
6	4.8	4.8	6.6	7.6
7	5.5	4.6	6.6	6.2
8	5.3	4	6.8	6.7
9	5.8	5.6	7.5	7.4
10	3.1	3.8	7.2	7.2
11	5.2	4.8	7.0	
12	5.2	5.5	7.3	
13	4	3.8	7.2	
14	5.4		6.8	
15	4		6.3	
16			7.0	
17			7.4	
18			5.8	
19			6.7	

Table (14) (Cont'd)

Serial No.	KWO	Marasmic-KWO	Marasmus	Control
20			6.3	
21			6.7	
22			7.3	
23			6.9	
$\bar{x}$	4.7	4.908	6.87	4.04
S.E. $\pm$	0.226	0.042	0.021	0.140
S.D. $\pm$	0.874	0.153	0.102	0.4427

Table (15): Serum albumin (gm/100 ml) in malnourished (KWO, marasmic-KWO and marasmic) and control children

Serial No.	KWO	Marasmic-KWO	Marasmus	Control
1	1.8	2.6	5	5.1
2	1.6	2.7	5	4.2
3	2.8	3	5.1	4.6
4	3.1	2.2	4.4	5.2
5	2.5	2.4	5	5.2
6	2.2	3	4.7	5
7	3	2.5	4.6	4.2
8	2.6	1.6	4.5	4.8
9	2.8	2.7	4.0	5
10	1.7	1.7	5	5
11	3.1	2.2	4.8	
12	2.5	2.5	5.8	
13	1.7	2.3	5	
14	2.6		4.9	
15	1.8		4.8	
16			4.6	
17			5	
18			4.7	
19			4.3	

Table (15) (Cont'd)

Serial No.	KWO	Marasmic-KWO	Marasmus	Control
20			4	
21			4.2	
22			4.5	
23			4.4	
$\bar{x}$	2.387	2.415	4.709	4.83
S.E. $\pm$	0.122	0.118	0.085	0.119
S.D. $\pm$	0.47	0.426	0.407	0.377

Table (16): Serum electrolytes (Na^+ & K^+ mEq/100 ml) of malnourished (KWO, marasmic-KWO and marasmic) and control children

Serial No.	KWO		Marasmic-KWO		Marasmus		Control	
	S. Na^+	S. K^+	S. Na^+	S. K^+	S. Na^+	S. K^+	S. Na^+	S. K^+
1	135	3.5	142	3.5	145	4.2	140	4.3
2	125	3.1	144	3.6	145	4.2	138	4.2
3	130	3.4	141	3.5	147	4.4	145	3.5
4	124	2.8	145	3.2	135	3.8	144	3.5
5	128	2.7	144	4.2	144	3.6	138	3.8
6	131	3.2	131	4	139	4.5	137	3.6
7	130	2.9	130	2.2	148	3.4	135	3.2
8	135	3.7	128	3.8	133	3.8	140	3.5
9	139	4.3	137	4.1	147	4.6	141	4.2
10	131	4.5	124	4.3	148	4.1	138	4.5
11	138	3.5	128	3.3	130	4.9		
12	121	4.0	132	4.0	135	3.5		
13	125	4.2	134	3.8	148	4.5		
14	140	4.1			142	3.9		
15	135	3.3			144	4.8		
16					145	4.0		
17					145	4.2		
18					147	4.9		
19					139	3.9		

Table (16) (Cont'd)

Serial No.	KWO S. Na^+	KWO S. K^+	Marasmic-KWO S. Na^+	Marasmic-KWO S. K^+	Marasmus S. Na^+	Marasmus S. K^+	Control S. Na^+	Control S. K^+
20					135	4.1		
21					133	4.0		
22					147	3.8		
23					146	4.4		
$\bar{x}$	131.13	3.507	135.77	3.654	142.9	4.15	139.6	3.83
S.E. $\pm$	0.355	0.025	0.526	0.0380	0.450	0.018	1.2450	0.206
S.D. $\pm$	1.375	0.0958	1.883	0.138	2.16	0.088	3.938	0.652

Table (17): Serum aldosterone (ng/dl) and Renin activity (ng/ml/h) in malnourished (KWO, marasmic-KWO and marasmic) and control children

Serial No.	KWO		Marasmic-KWO		Marasmus		Control	
	S. Ald.	S.R.A.	S. Ald.	S.R.A.	S. Ald.	S.R.A.	S. Ald.	S.A.R.
1	19.5	3.1	18.5	2.8	12.3	1.3	14.3	1.5
2	20.4	2.8	16.3	1.9	8.5	1.6	6.7	1.1
3	21.9	2.4	15.7	2.4	11.9	1.1	12.9	0.9
4	18.9	1.9	11.8	1.7	17.4	0.9	10.8	1.2
4	17.3	2.6	17.5	1.8	16.8	1.4	19.7	1.5
6	21.0	1.8	10.4	1.6	18.9	1.6	17.4	1.3
7	22.4	1.9	13.2	2.1	12.7	0.9	18.5	0.9
8	17.3	3.6	16.1	2.3	14.3	0.85	16.8	1.3
9	19.5	2.8	15.6	1.8	13.6	1.1	15.4	1.6
10	16.9	2.7	18.5	1.4	14.1	1.7	13.9	1.7
11	20.4	3.1	19.7	1.9	15.4	0.84		
12	25.3	2.9	15.8	2.3	13.6	2.1		
13	29.1	2.5	14.9	2.1	18.1	1.7		
14	18.5	2.7			14.5	1.9		
15	17.3	2.5			11.8	2.3		
16					10.4	1.6		
17					12.8	1.8		
18					17.3	1.7		
19					14.8	1.7		

Table (17) (Cont'd)

Serial No.	KWO S. Ald.	KWO S.R.A.	Marasmis-KWO S. Ald.	Marasmis-KWO S.R.A.	Marasmus S. Ald.	Marasmus S.R.A.	Control S. Ald.	Control S.R.A.
20					15.7	1.5		
21					16	1.8		
22					16.8	2.3		
23					13.4	1.9		
$\bar{x}$	20.38	2.62	15.692	2.008	14.409	1.547	13.54	1.3
S.E. $\pm$	0.222	0.032	0.154	0.029	0.110	0.079	0.404	0.0278
S.D. $\pm$	0.859	0.127	0.741	0.105	0.53	0.091	1.278	0.088

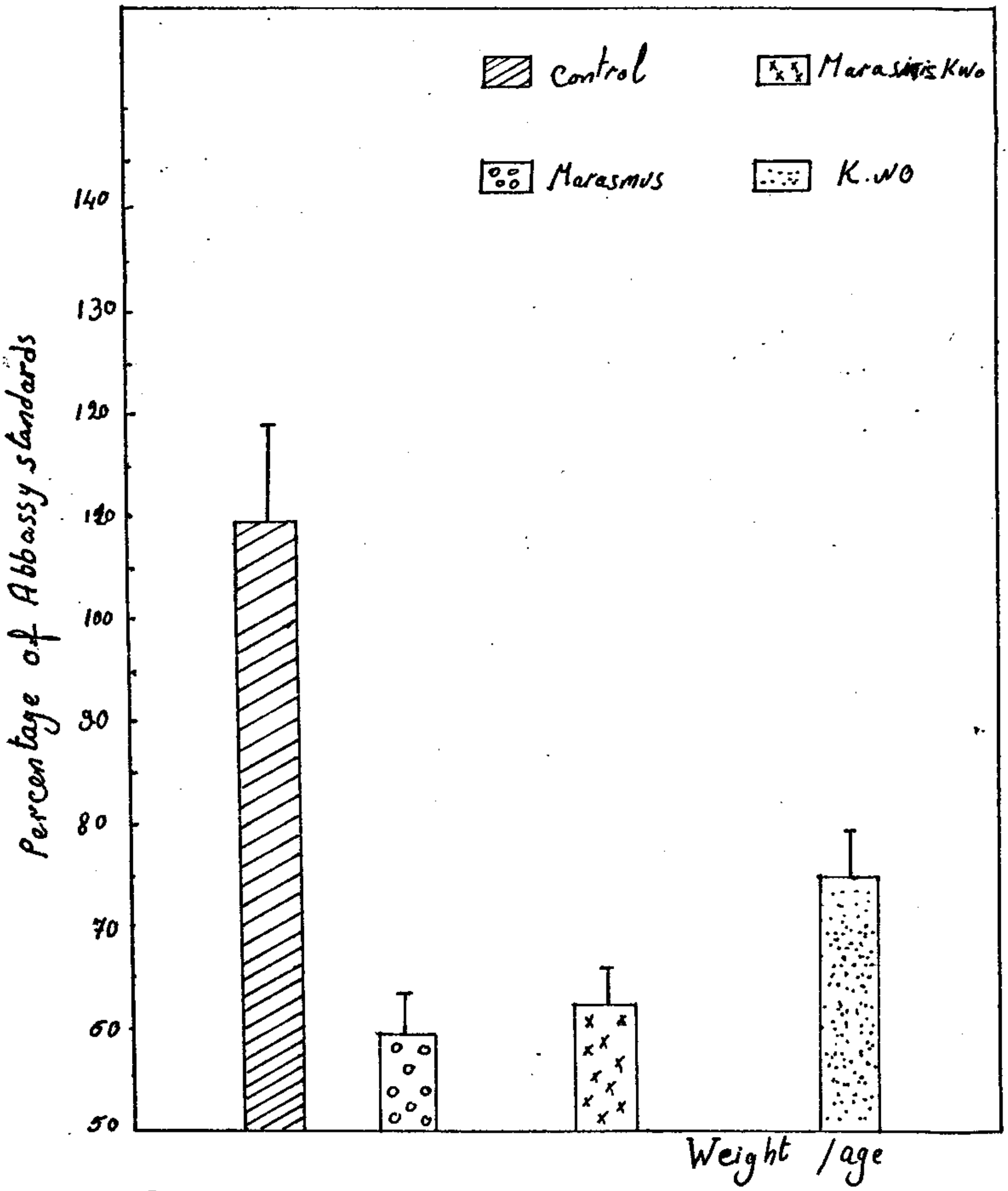

Fig. (1) Histogram showing anthropometric measurements: weight/age (mean ± S.D). relative to The Abbassy standards in KWO, Marasmic - KWO, marasmus and normal children.

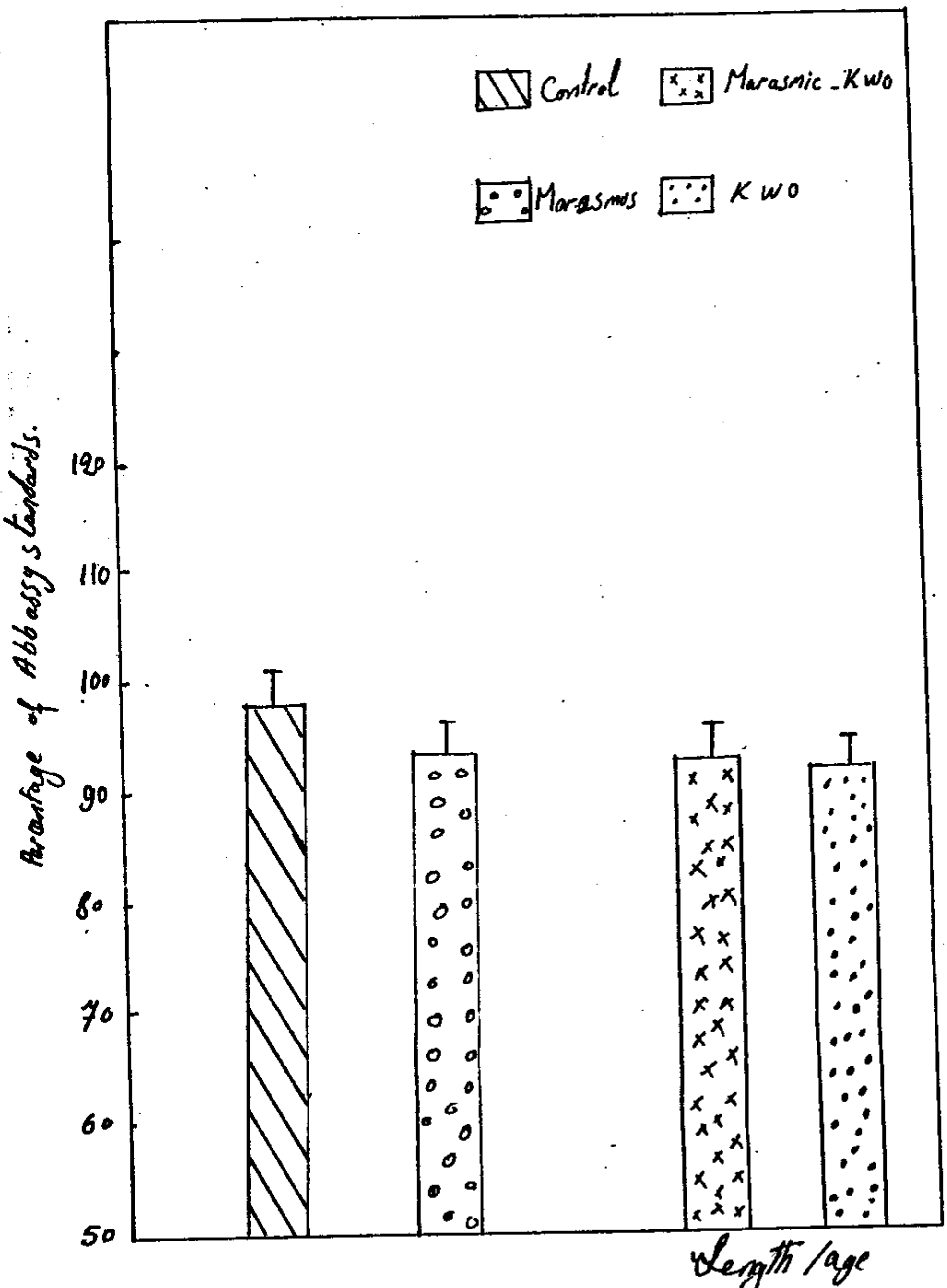

Fig (2): Histogram showing anthropometric measurement: length /age (mean ± SD) relative to Abbassy standards in Kwo, Marasmic - Kwo, marasmus and normal children.

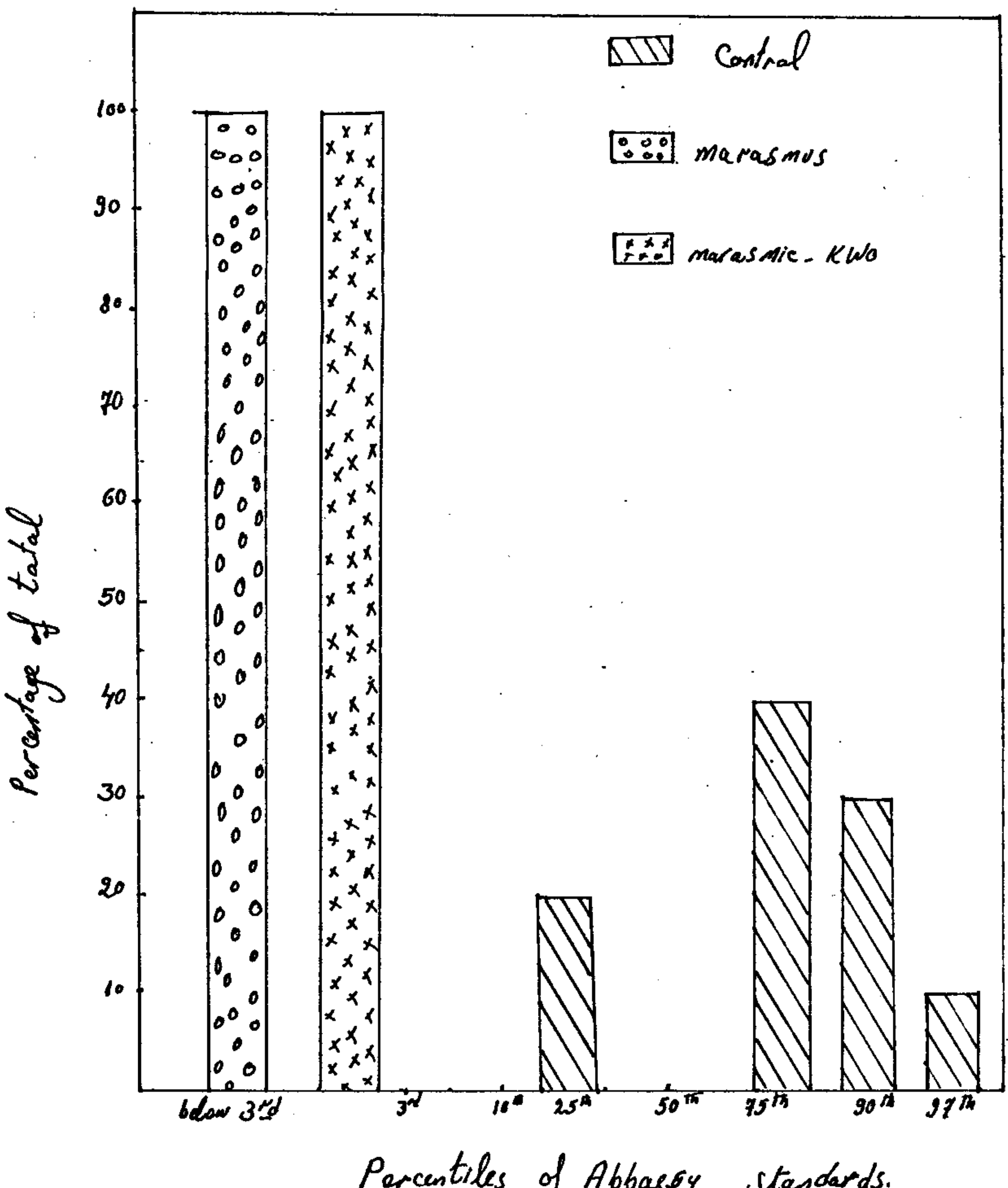

Fig (3) : Histogram showing pecentiles of weight in relation of Abbassy standard in marasmus, marasmic - K wo and normal children

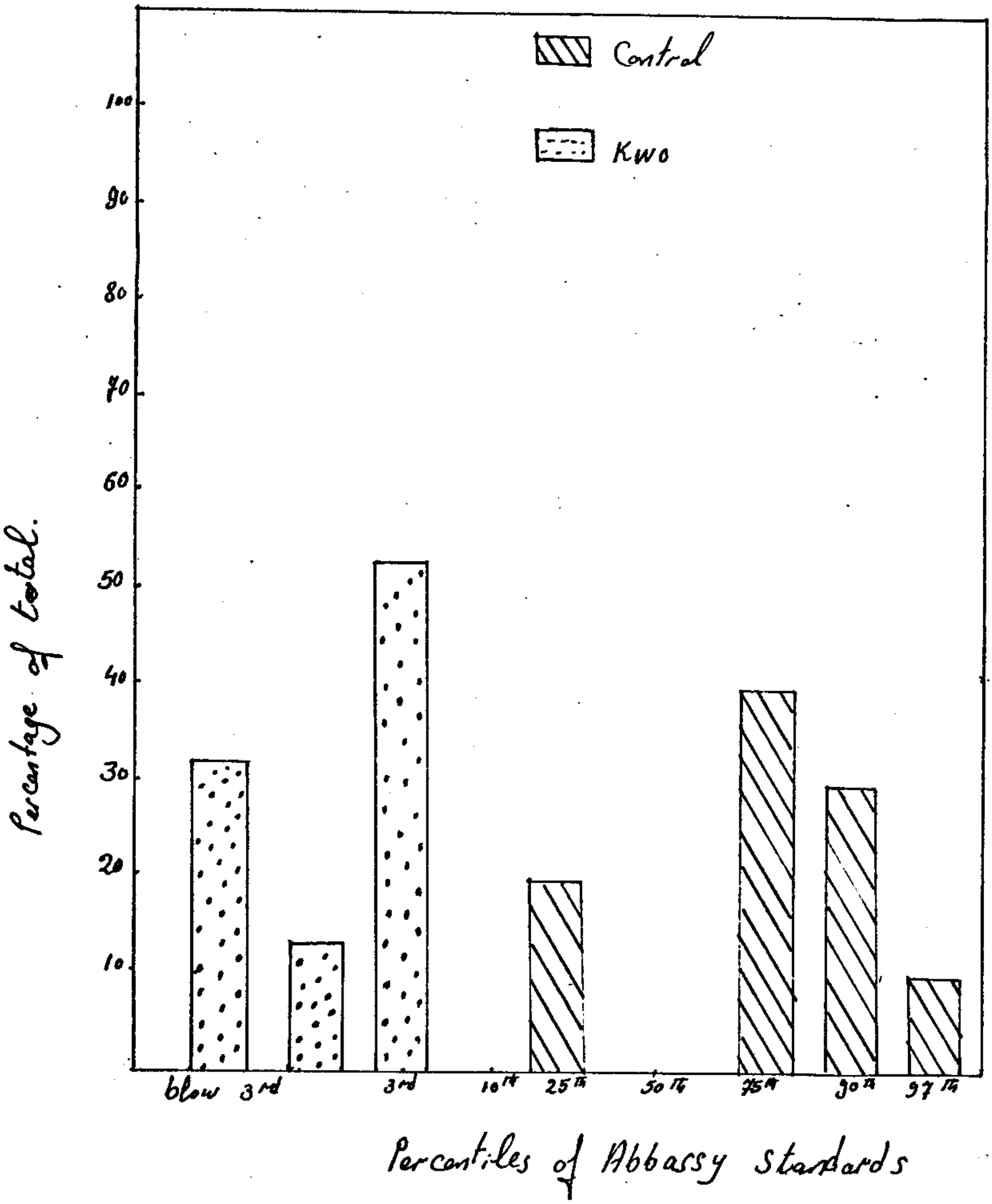

Fig (4) : Histogram showing percentiles of weight in relation of Abbassy standards in KWO and normal children.

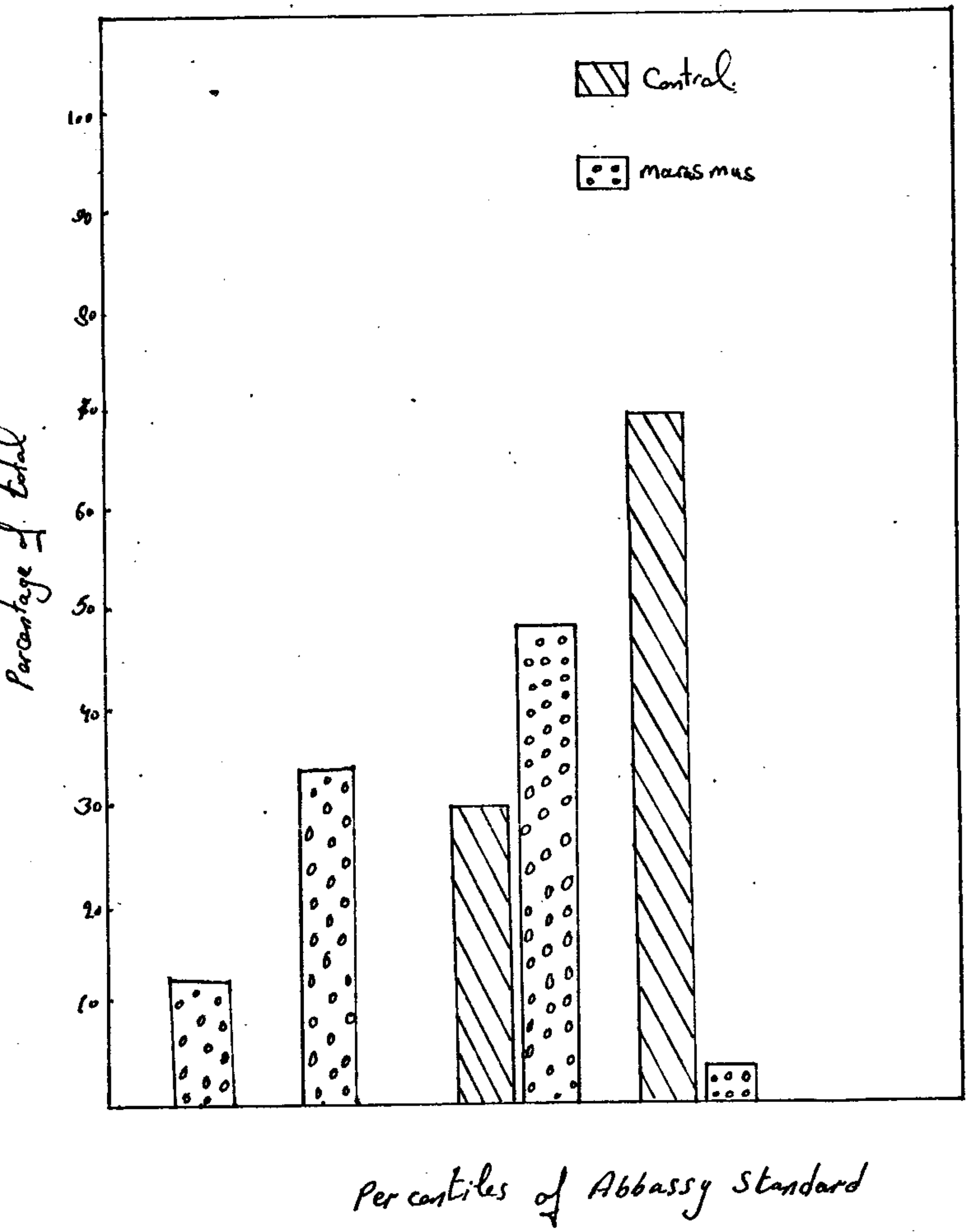

Fig (5) : Histogram showing percentiles of length in relation of Abbassy standards in marasmus and normal children

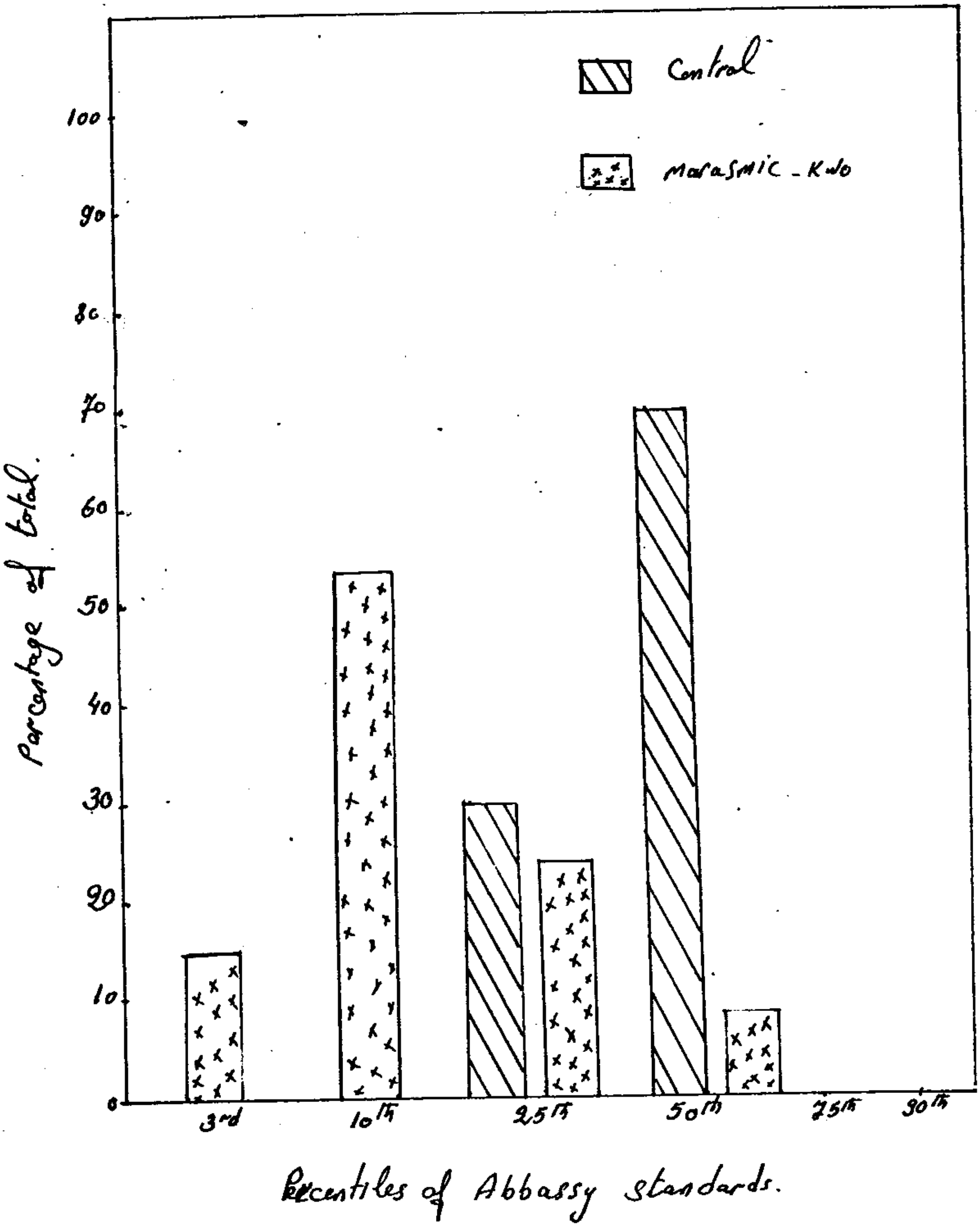

Fig (6) : Histogram showing percentiles of length in relation of Abbassy standards in marsmic - KWO and normal children.

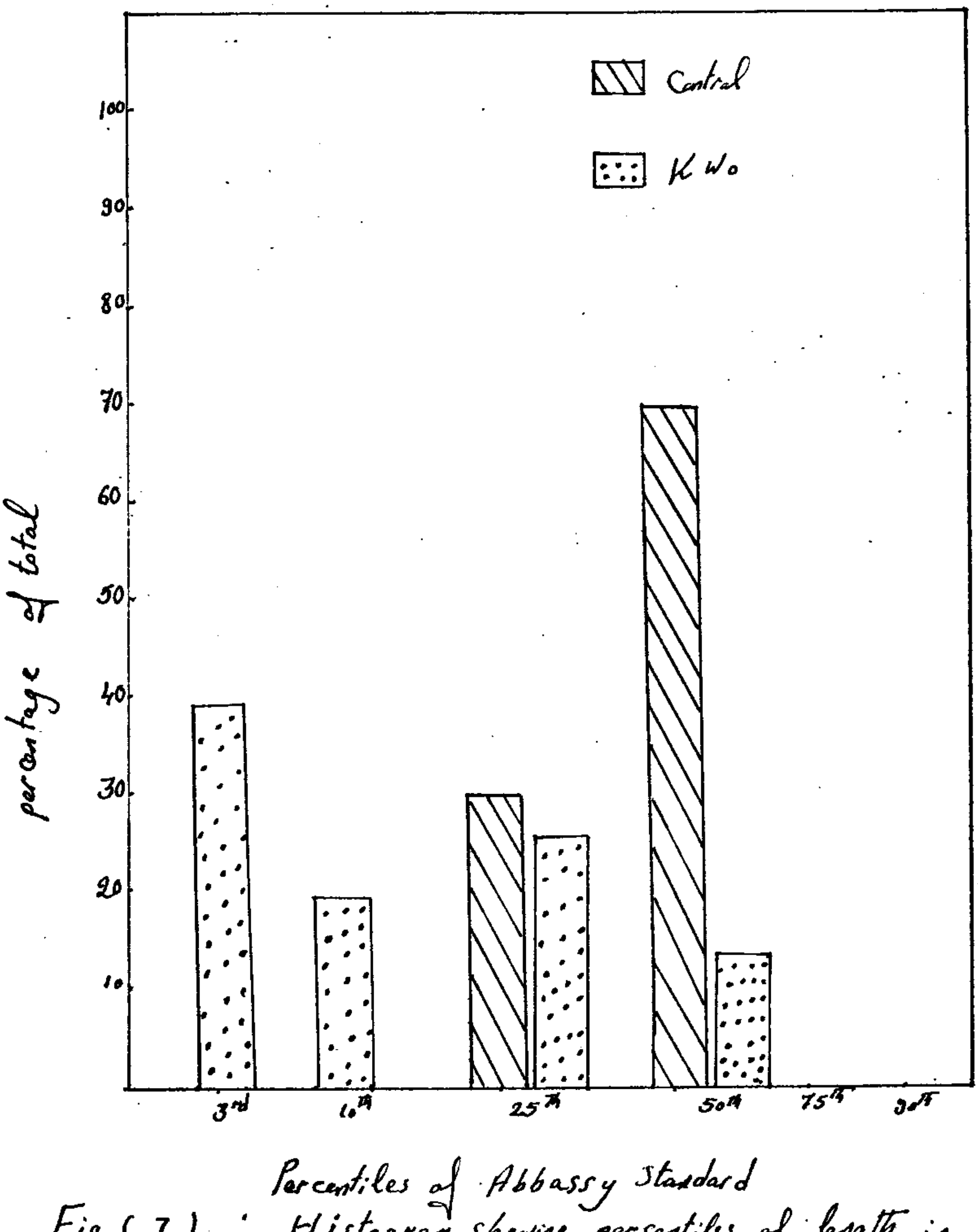

Fig (7) : Histogram showing percentiles of length in relation of Abbassy Standards in KWO and normal children.

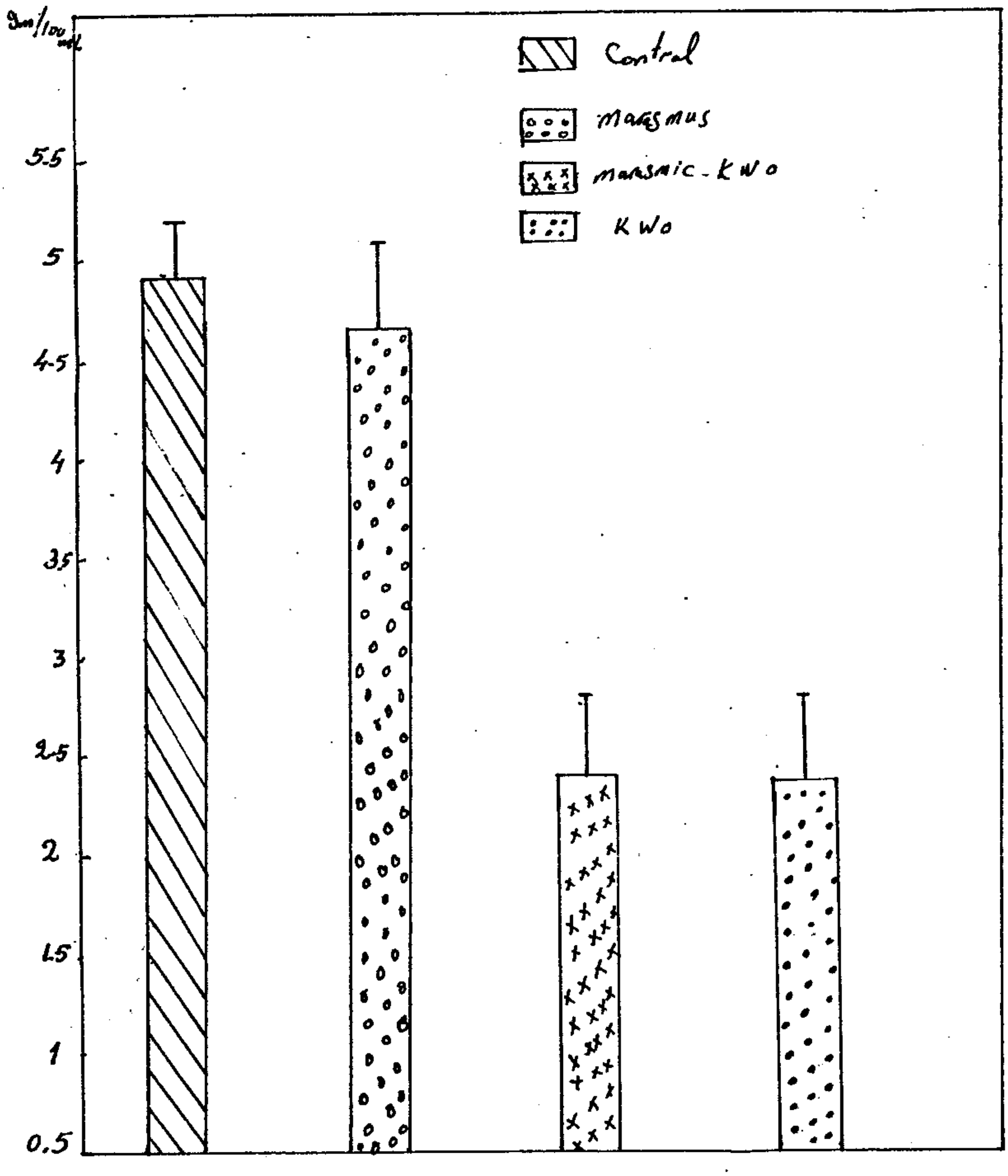

Fig (8) : Histogram showing serum albumin concentration (mean ± SD) in malnourished (KWo, marasmic - KWo and marasmus) and control children.

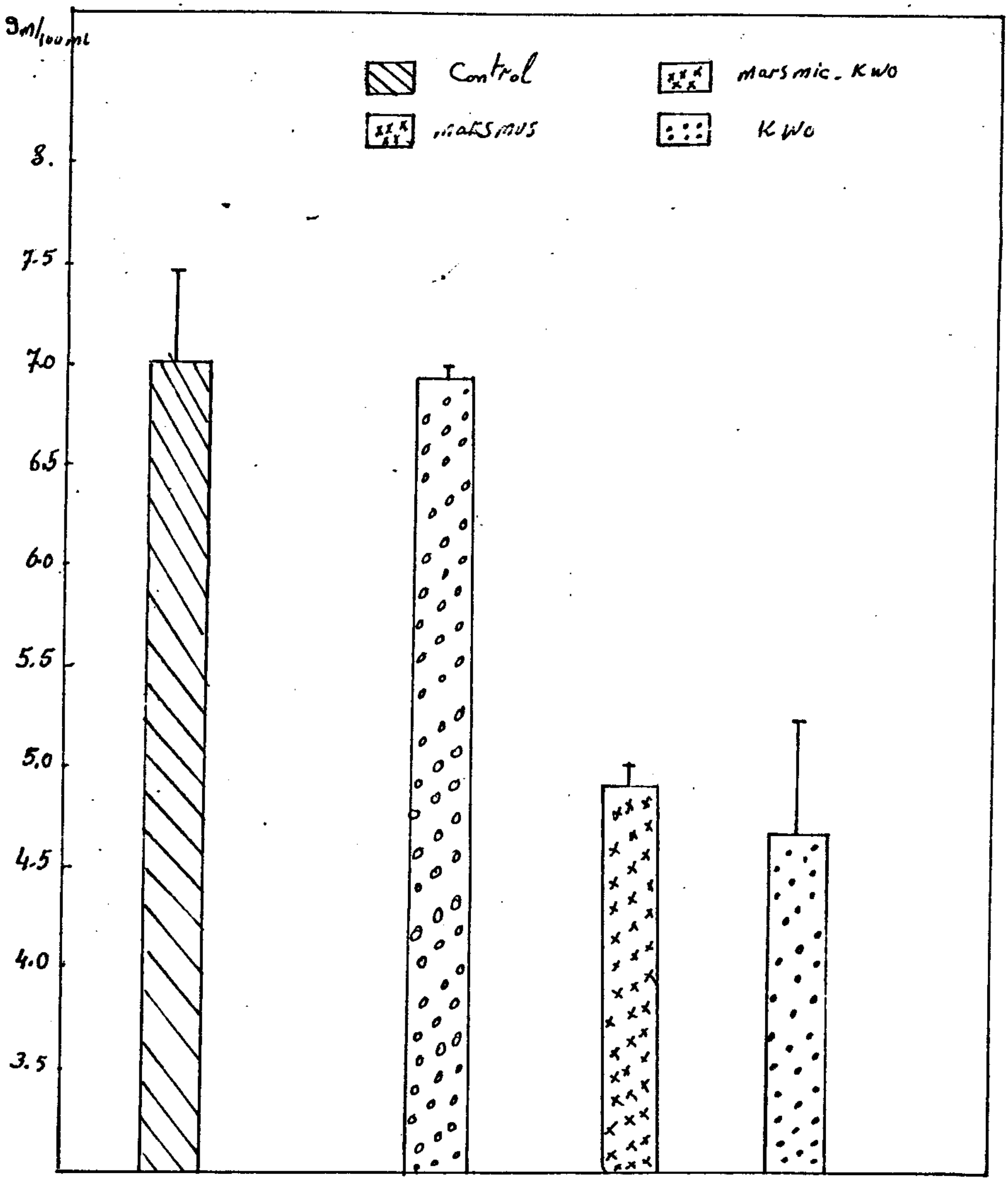

Fig (9): Histogram showing serum protein concentration (mean ± S.D) in malnourished (KWo, marasmic-KWo and marsmus) and Control children.

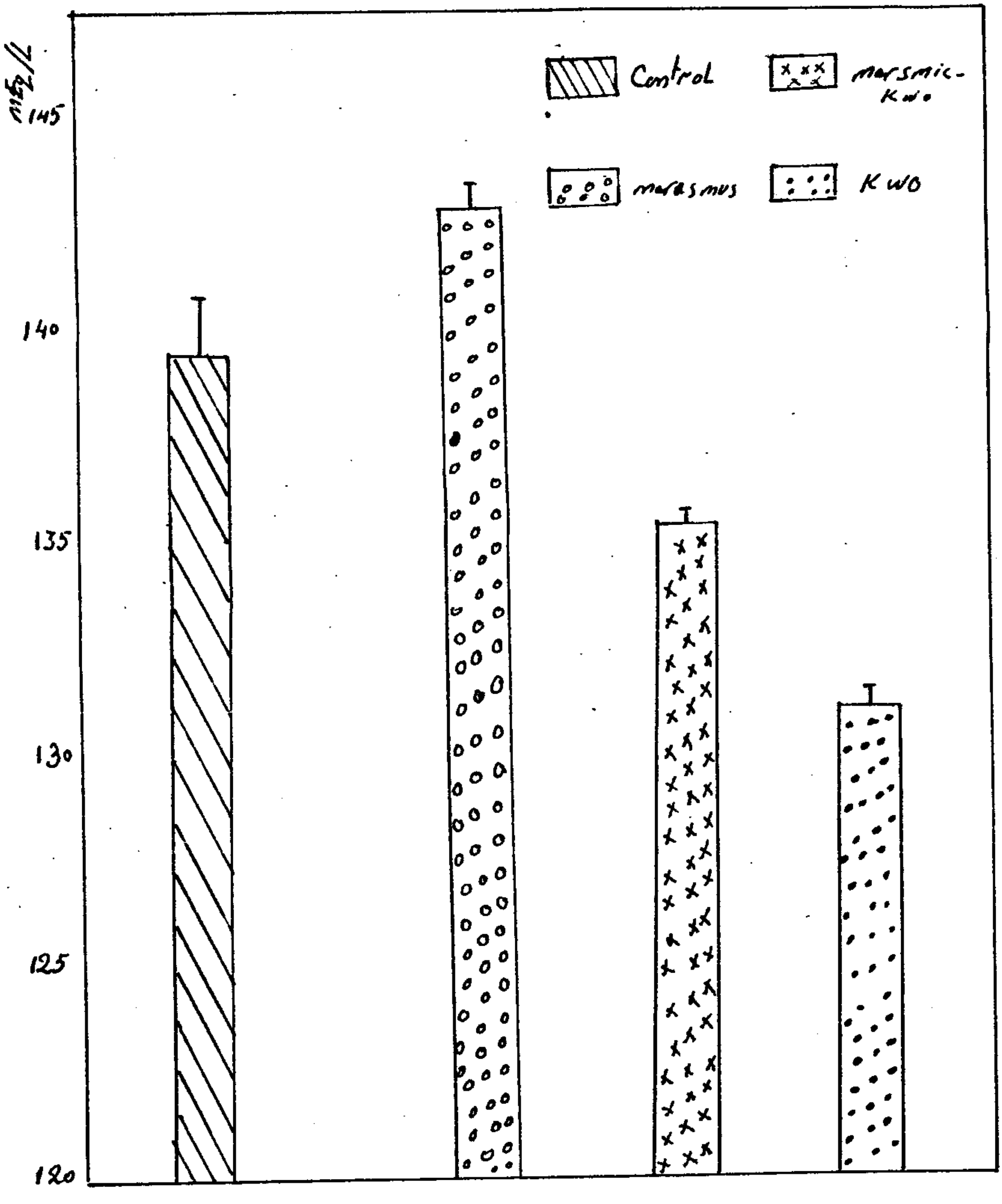

Fig (10) Histogram Showing Serum Na^+ Concentration mEq /L (mean ± SD) malnourished (KWO, marasmic-KWO, and marasmus) and the Control children.

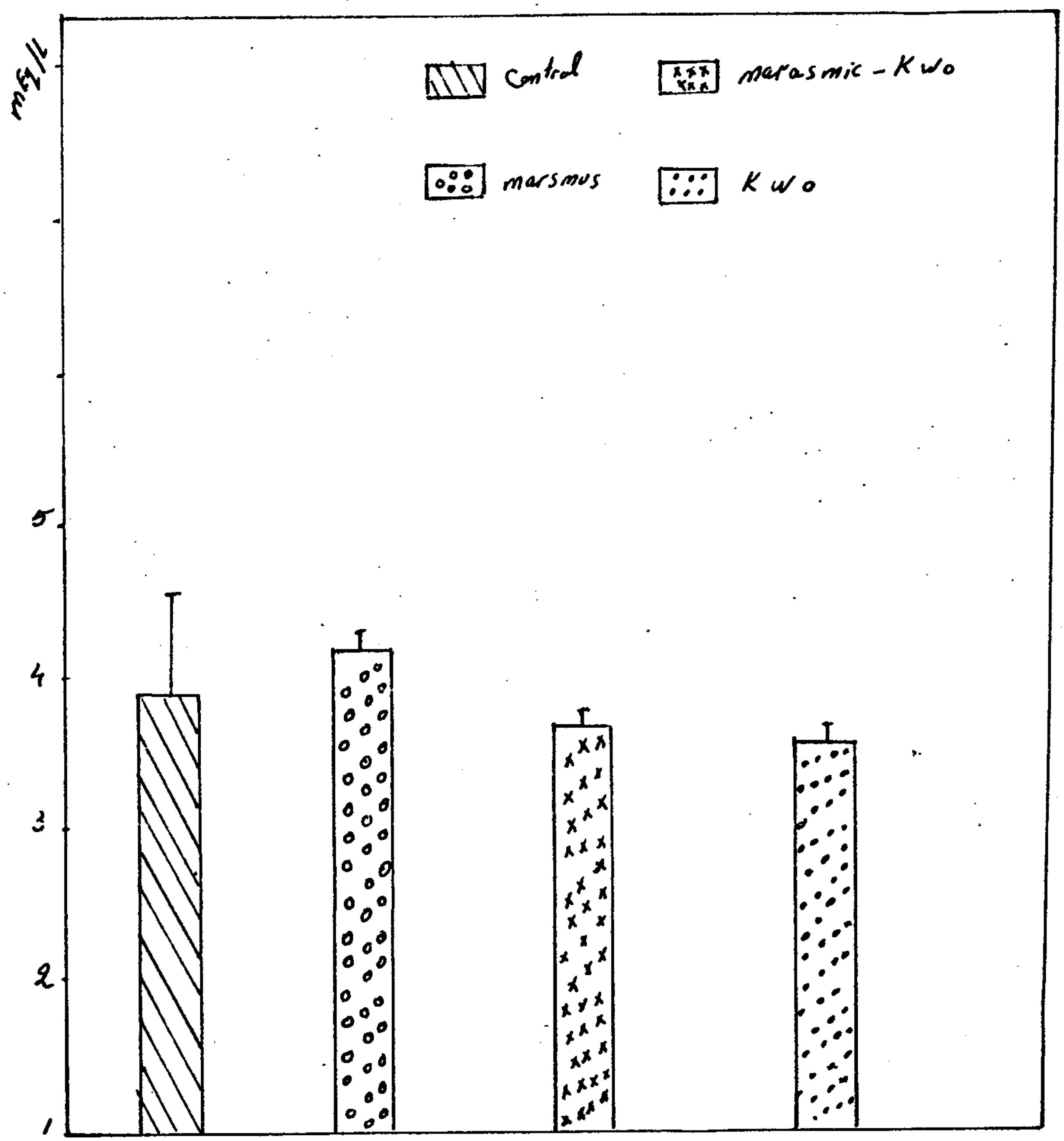

Fig (11): Histogram showing serum K^+ concentration mEq/L (mean ± SD) in malnourished (Kwo, marasmic-Kwo and marsamus) and the control children.

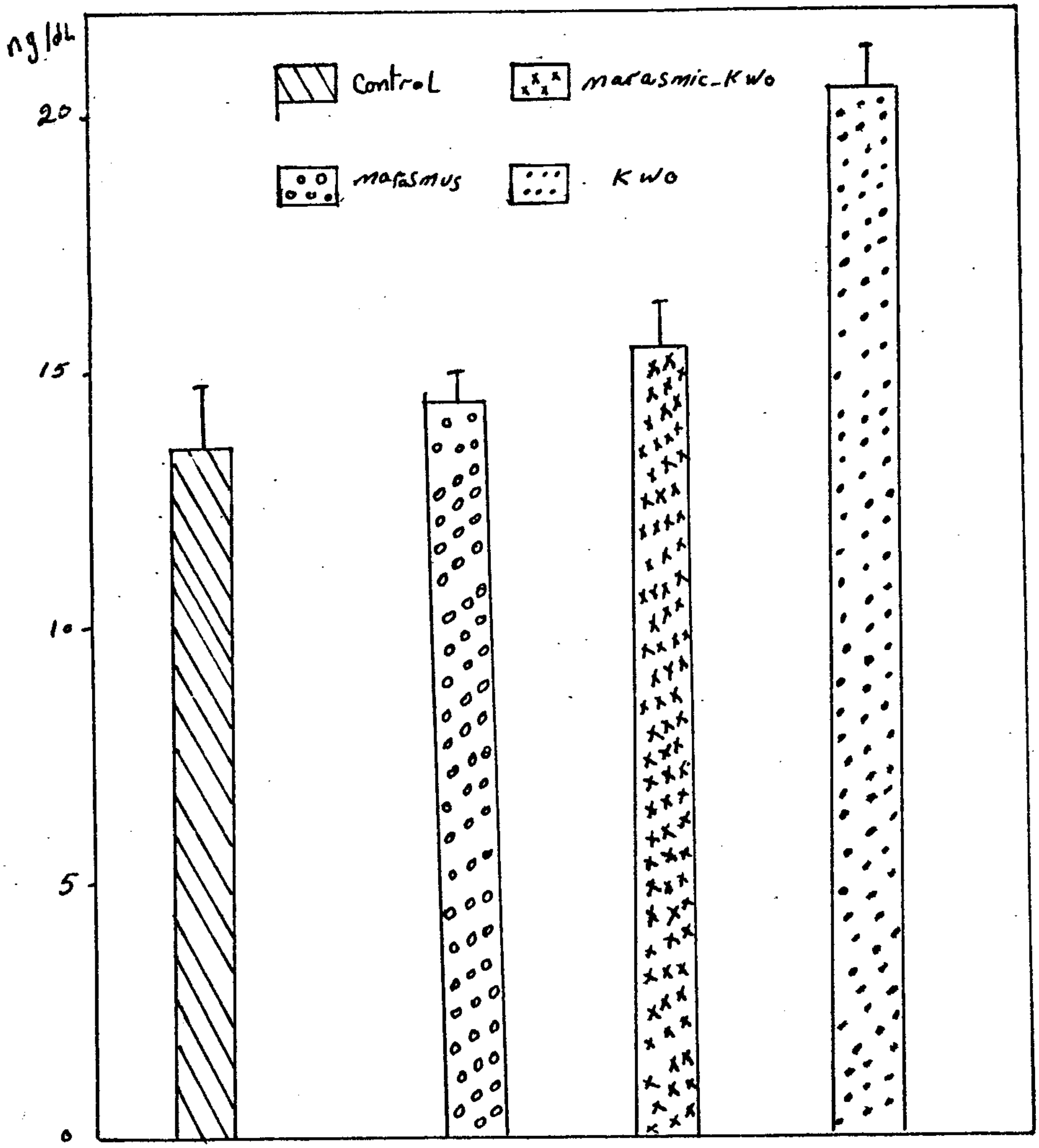

Fig (12): Histogram showing serum aldosterone Concentration (ng/dL) (mean ± SD) in malnourished (KWO, marasmic-KWO and marasmus) and The Control children.

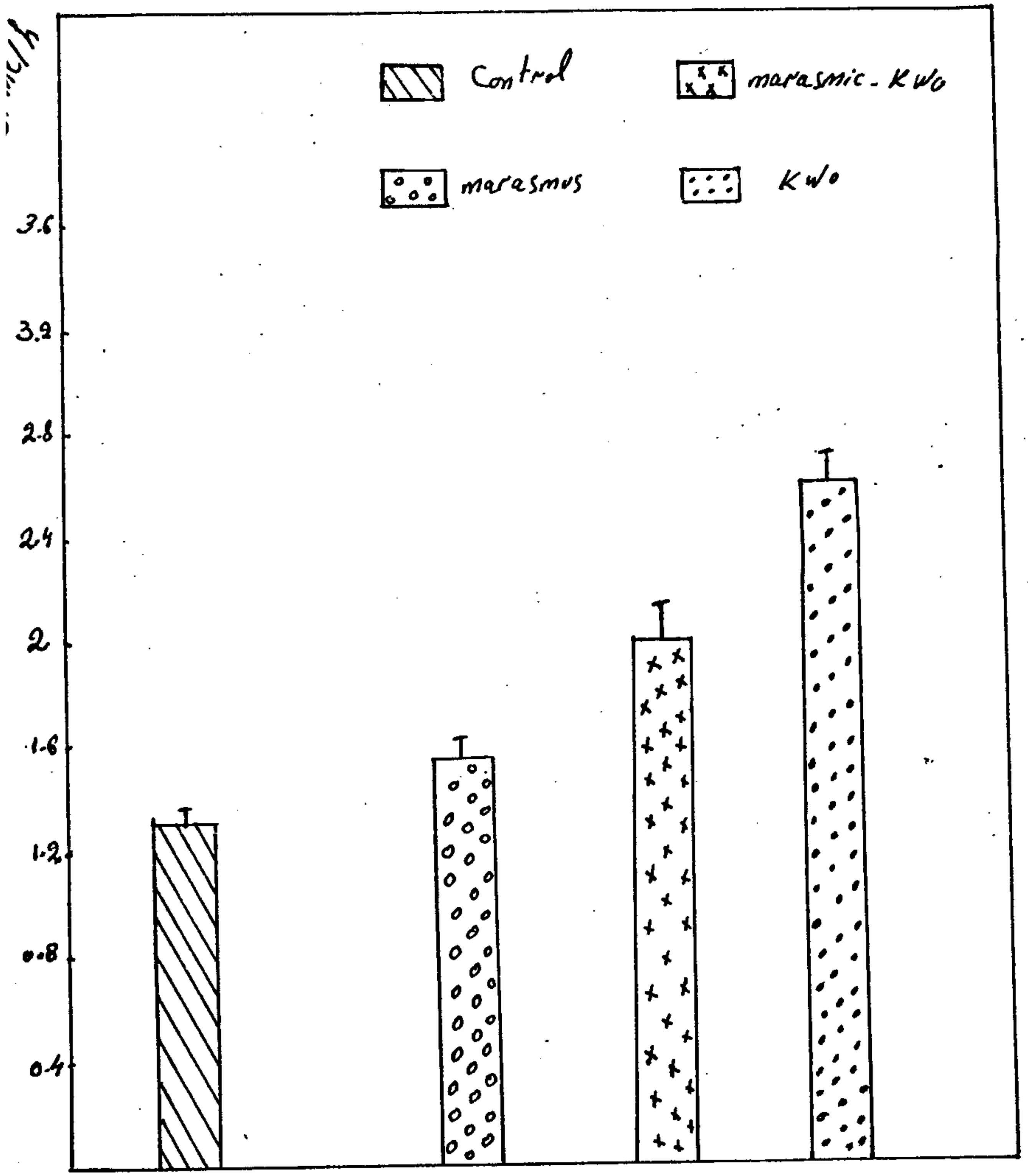

Fig (13): Histogram showing Renin activity (ng/ml/h) mean±SD in malnourished (KWO, marasmic-Kwo and marasmus) and the control children.

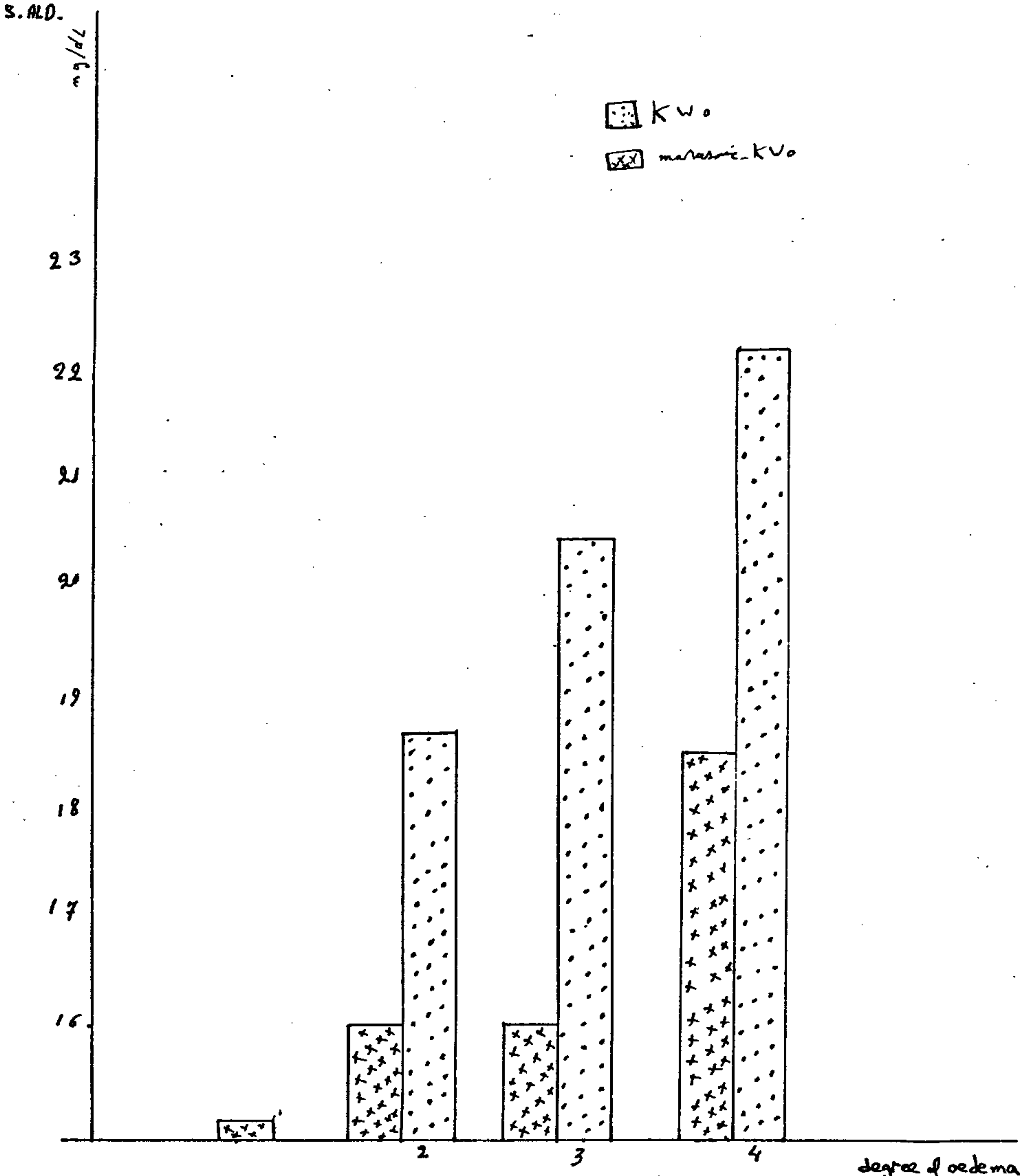

Fig (14): Showing the relationship bettwean The degree of oedema and S.aldosterone in KWO. + marasmic_KWO.

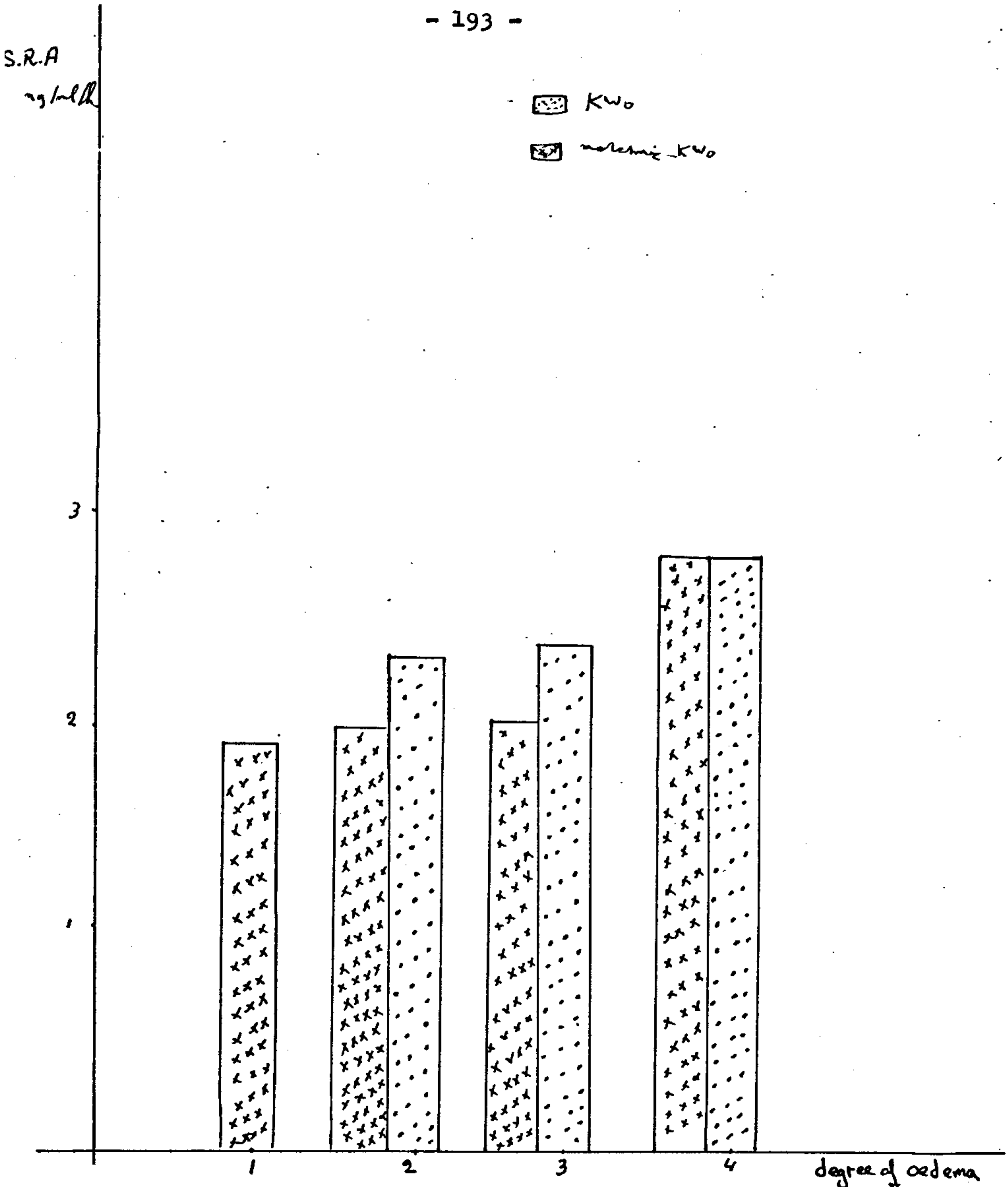

Fig (15) : showing The relation between the degree of oedema + S.R.A in KWo and marasmic - KWo

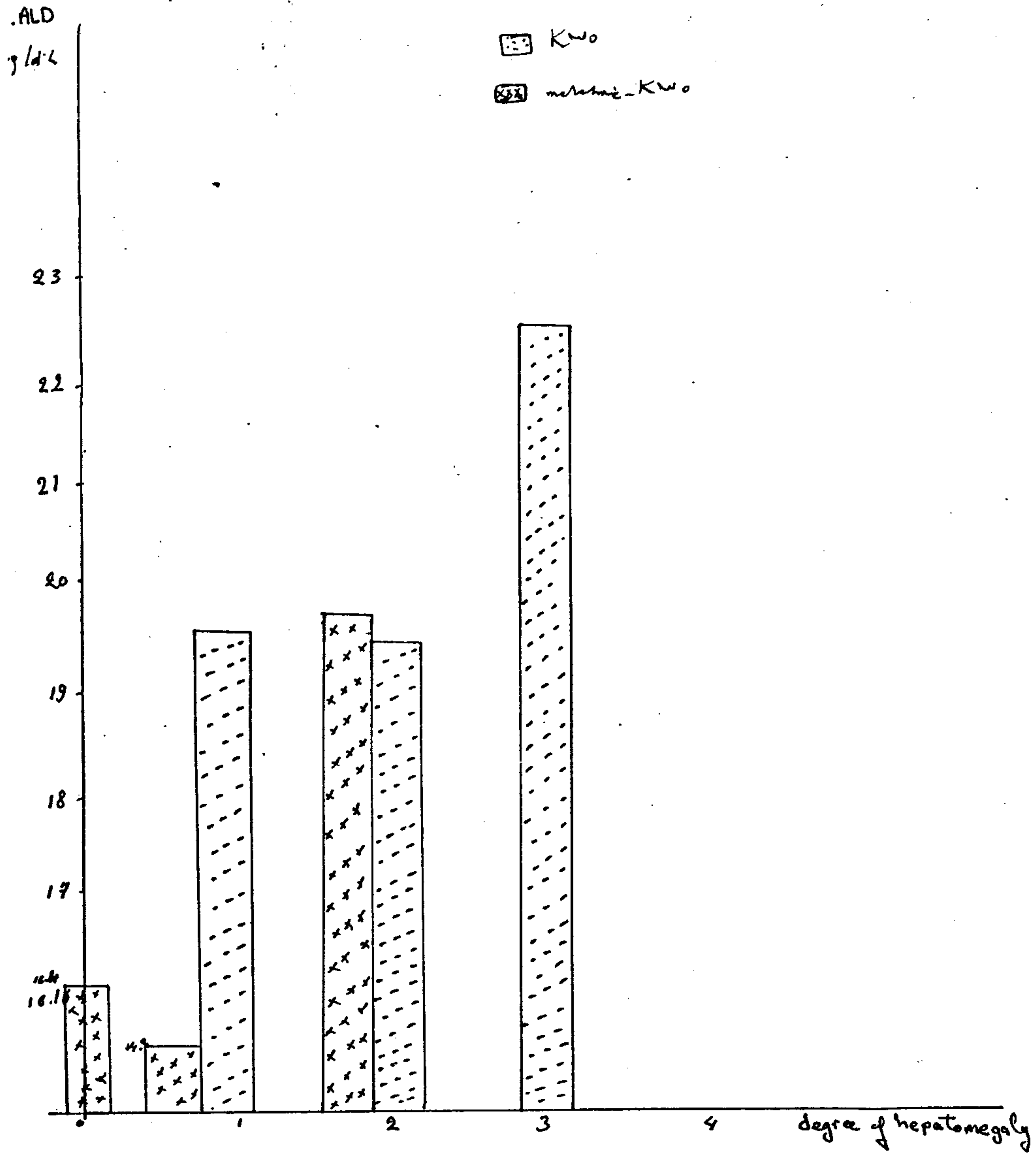

Fig (16) : showing the relation ship between hepatomegaly + S. aldosterone in KWO and marasmic KWO.

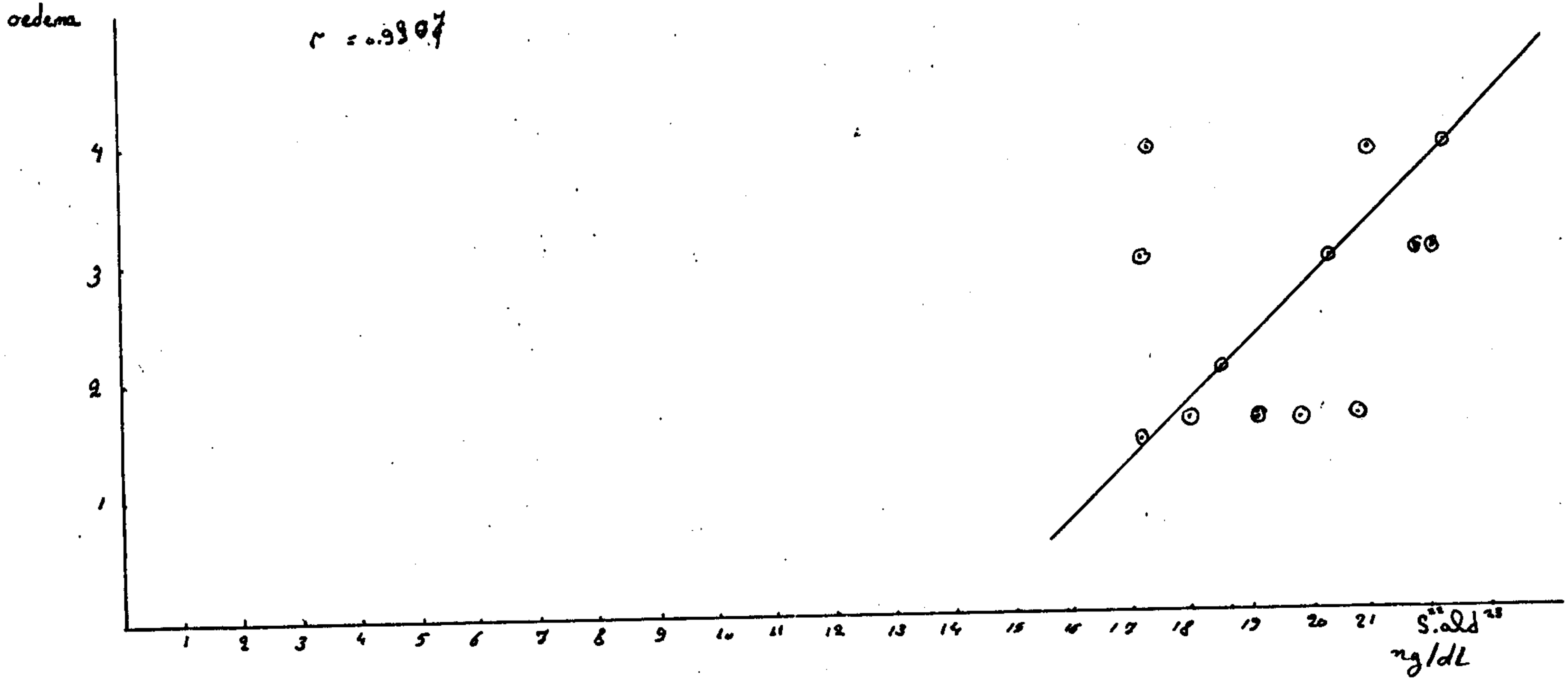

Fig (17): Showing the relationship between the degree of oedema + S ald. in K wo.

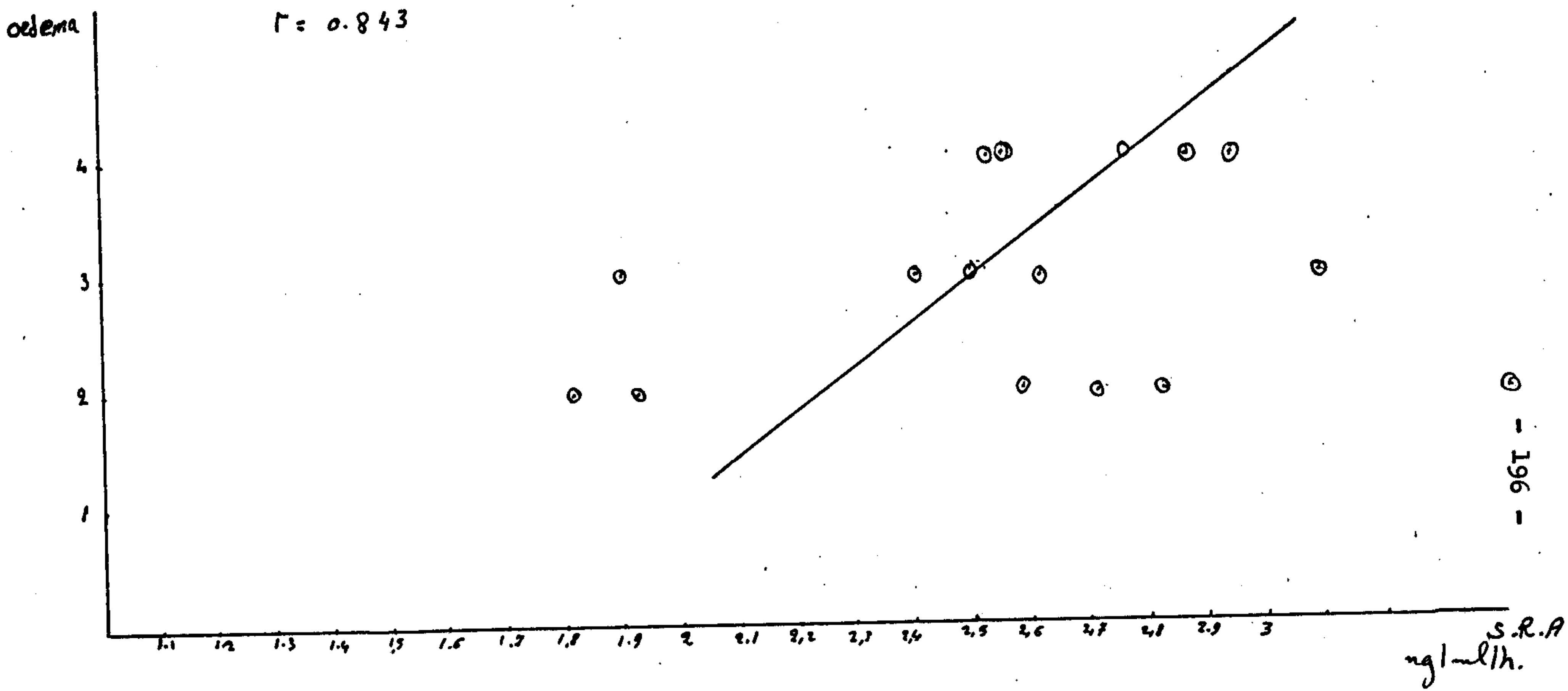

Fig (18) : Showing the relationship between the degree of oedema + S.R.A in KWO.

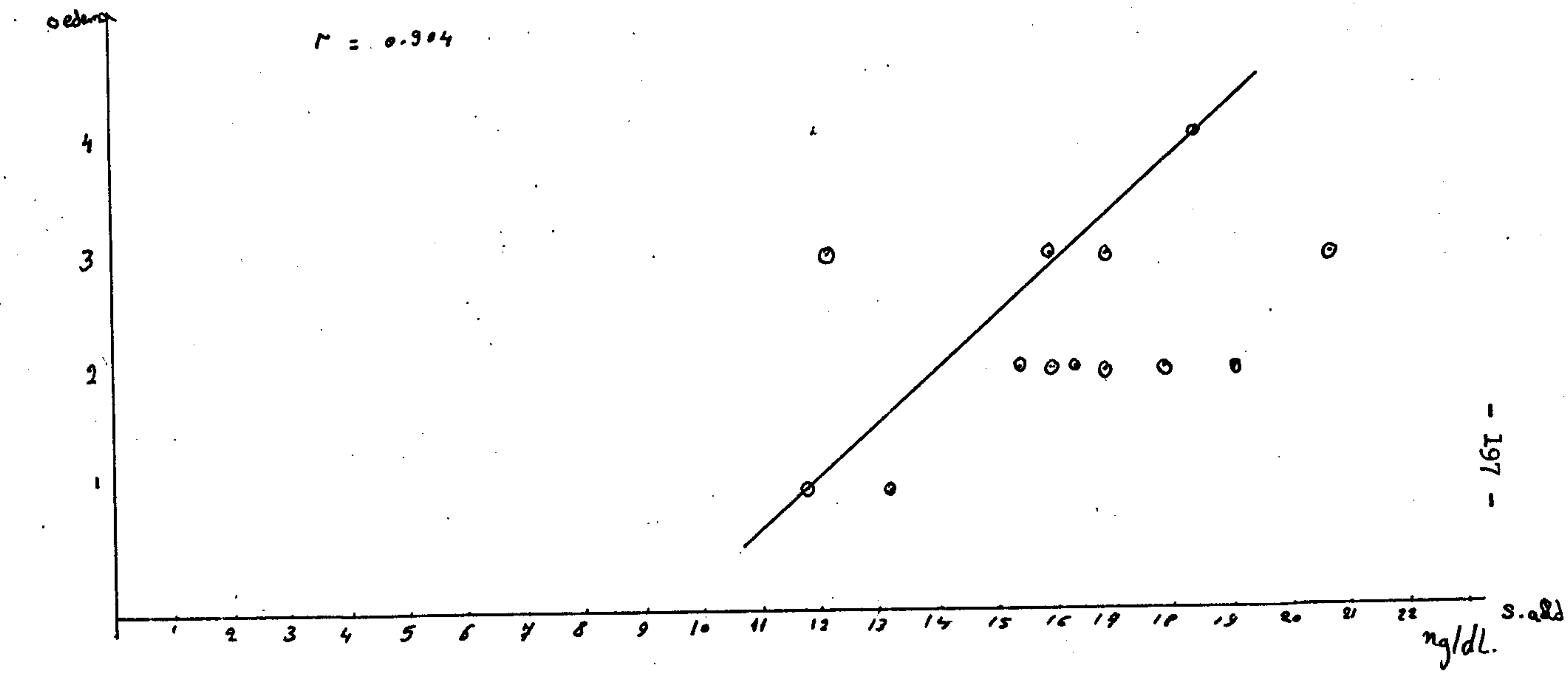

Fig (19): Showing the relationship between S.ald. & the degree of oedema in marasmic-K

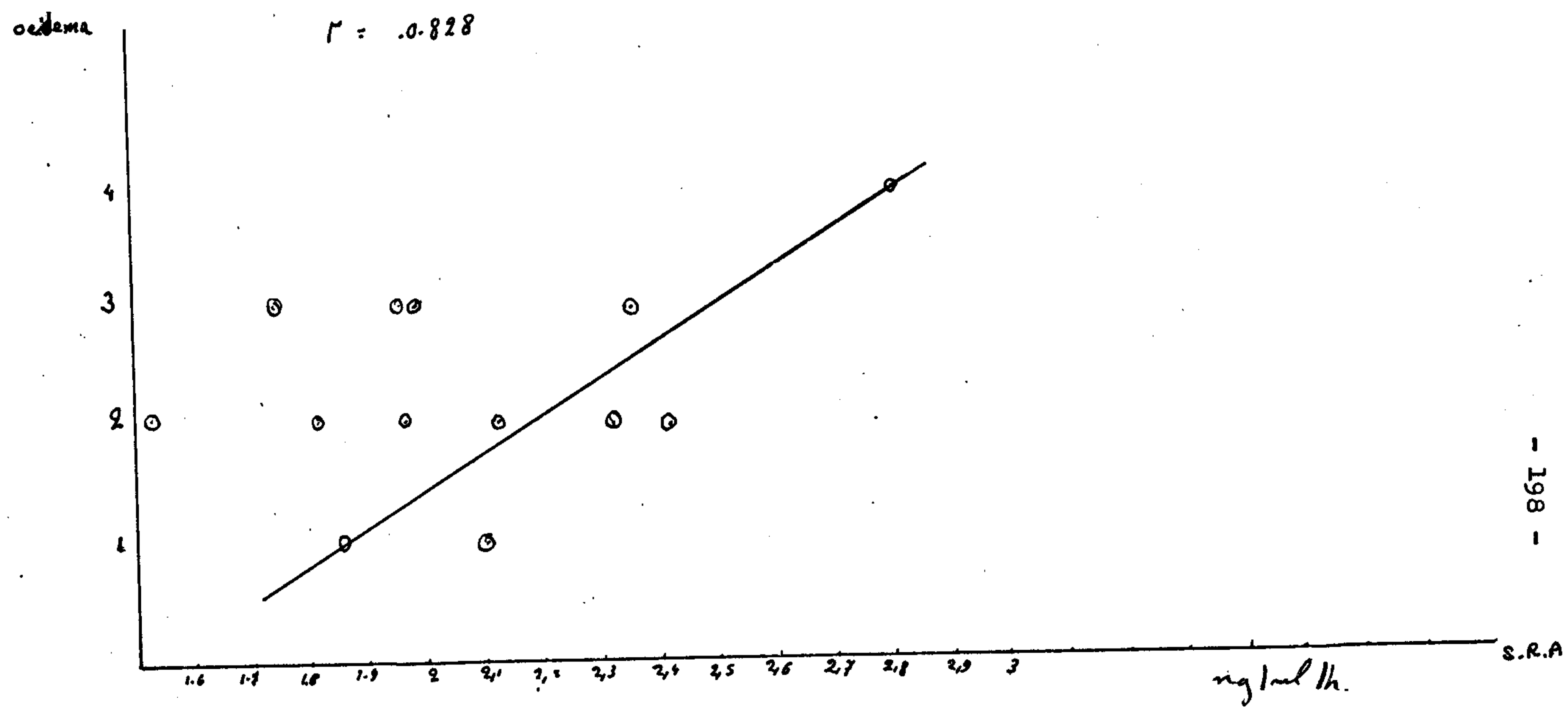

Fig (20) : Showing the relationship between the S.R.A and the degree of oedema in marasmic Ku

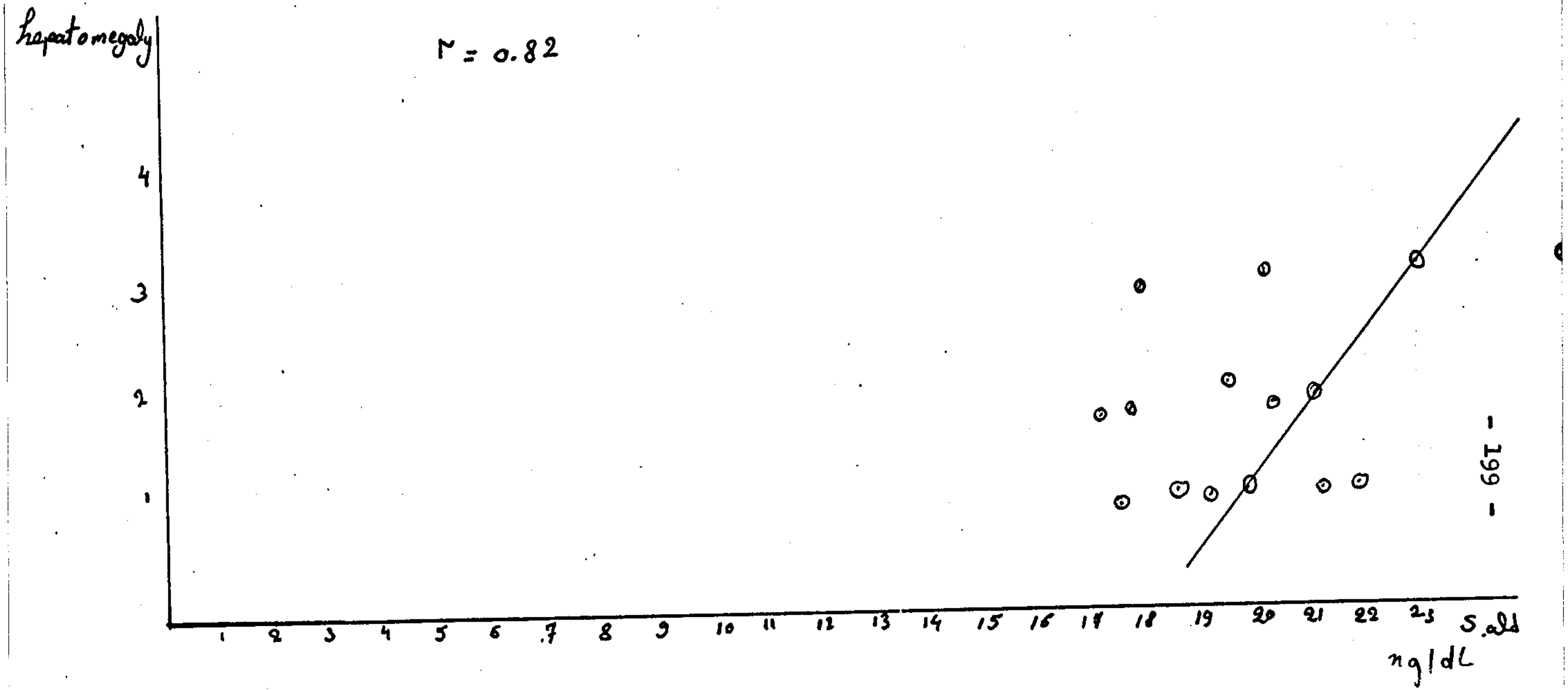

Fig (21): , Showing the relationship between The S. ald. & liver enlargement in Kwo.

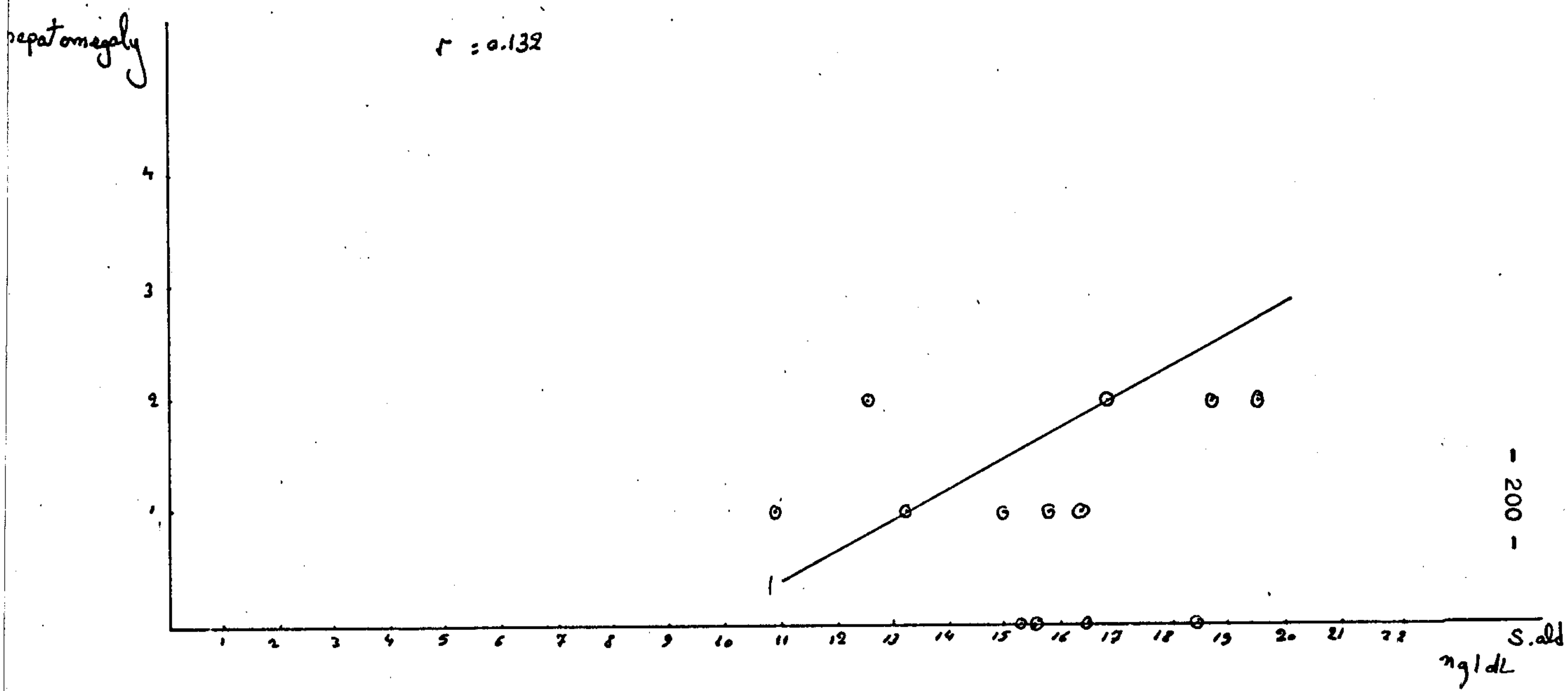

Fig (22) : Showing the relationship between The S. ald + liver enlargement in marasmic Kwa

However, children suffering from Kwashiorkor lose their oedema during treatment long before there was any significant increase in the serum albumin (Mc Cane and Widdowson, 1968). Also Golden and Golden (1980) showed that oedema of Kwashiorkor can resolve without any change in the serum albumin concentration. Thus hypoalbuminemia and Starling's hypothesis seem to be insufficient to explain the etiology of oedema. Also blood transfusion did not appear to hasten the clearance of oedema.

A close association has been shown between reduced total body potassium and oedema. Potassium deficiency has been suggested to be the cause of oedema (Mc Cane et al., 1969). Potassium depletion causes increased sodium reabsorption from the proximal tubules and resultant decreased sodium delivery to the distal tubules. Clinically, this may cause sodium retention and gross oedema even though aldosterone secretion is sharply reduced (Williams, 1981).

Increased activity of antidiuretic hormone (ADH) has been proposed (Srikantia, 1968).

The presence or absence of oedema in the malnourished subjects seems to correlate well with the dietary history of salt intake (Klahr and Alleyne, 1973).

Recently the possible role of aldosterone and in turn of renin in the causation of oedema has been investigated.

In this study 51 children suffering from malnutrition 28 of 'them with oedema (15 Kwashiorkor and 13 marasmic-Kwashiorkor) and 23 patients without oedema were studied in a trial to investigate the role of renin-angiotensin-aldosterone system in causation of nutritional oedema.

All of them were between 12 and 24 months of age (Table 1). Ten normal children of the same age group were studied as control.

Presence of oedema was the main criterion for selection of Kwashiorkor and marasmic-Kwashiorkor cases. Apathy, skin and hair changes were present in almost all the cases. In marasmic cases generalised muscle wasting, loss of subcutaneous fat, growth retardation and signs of vitamin and mineral deficiencies were the main clinical findings.

Poverty, lack of steady income, increasing family size, ignorance of both parents, low caloric and often low protein intake, sudden weaning with replacements of milk by rice water and infusions and disinterest in the child because of the large size of the family all were the underlying socio-economic factors of the disease.

Analysis of the anthropometric measurement data in marasmic patients showed that their weight were 5.7 kg $\pm$ 0.68 which is significantly reduced than that of the control ($P < 0.005$). Their length were 71.3 cm $\pm$ 3.91 which is reduced than that of the control but statistically insignificant ($P > 0.05$). Their head circumference were 45.8 cm $\pm$ 3.1 which is not of statistical significance ($P > 0.05$). The mid arm circumference were greatly reduced 9.79 cm $\pm$ 1.71 than that of the control and it is of high statistical significance ($P < 0.005$). The mid arm circumference is specific and sensitive in detecting malnutrition. It is relatively age and sex independent (Velzeboer et al., 1983). On relating the anthropometric data to our local standards of Abbassy et al. (1972), the weight of the marasmic children were below the 3^{rd} percentile indicating considerable wasting. As for the length, 13 % were on the 3^{rd} percentile, 35 % were on the 10^{th} percentile, 47.7 % on the 25^{th} percentile and only 4.3 % were on the 50^{th} percentile.

As for marasmic-Kwashiorkor the mean for their weight was 6 kg $\pm$ 0.72 which is significantly reduced ($P < 0.005$), their length was 62.7 cm $\pm$ 3.4 which is of statistical significance ($P < 0.05$) denoting that the condition is of chronic origin. The head circumference was 45.96 cm $\pm$ 2.3 which is statistically insignificant. The mid-arm circumference was 10.03 cm $\pm$ 1.98 which is of high statistical significance ($P < 0.005$).

In Kwashiorkor children the mean for their weight was 7.26 kg $\pm$ 0.78 which is statistically significant ($P < 0.005$), their length were 70.47 cm $\pm$ 4.4 which is significantly less than the control ($P < 0.05$). The mean for their head circumference was 45.98 cm $\pm$ 3.26 which is insignificant ($P > 0.05$). The mean for the mid arm circumference was 10.46 cm $\pm$ 1.8 which is of high statistical significance ($P < 0.005$).

As regards the laboratory findings serum proteins in the marasmic children was (6.87 gm% $\pm$ 0.49) which is similar to that of the control (7.04 gm $\pm$ 0.44) and it is statistically insignificant ($P > 0.4$). While in the marasmic-Kwashiorlor and Kwashiorkor children serum protein is greatly reduced (4.9 $\pm$ 0.55) and (4.7 $\pm$ 0.8) respectively and are of high statistical significance, P value < 0.005 and < 0.001 respectively. Also serum albumin in the marasmic children was (4.63 gm % $\pm$ 0.31) which is similar to that of the control (4.87 $\pm$ 0.73) while in the marasmic-Kwashiorkor and Kwashiorkor children serum albumin concentration were greatly reduced (2.41 $\pm$ 0.4) and (2.39 $\pm$ 0.54) respectively which are of high statistical significance, P values < 0.005 and < 0.005 respectively. This correlates well with the fact that once the serum albumin concentration has fallen to 3 gm/100 ml, the metabolic sequelae associated with Kwashiorkor ensue (Whitehead et al., 1973). At the present time determination of serum albumin concentration is considered the most effective laboratory method of screening for PEM (Mc Laren and Burman, 1976).

As regards serum electrolyte concentration: serum Na^+ concentration was 139.6 mEq/L, in the control, 142.9 $\pm$ 2.16 in the marasmus, 135.77 $\pm$ 1.883 in the marasmic-KWO and 131.13 $\pm$ 1.375 in the Kwashiorkor, all are statistically insignificant. Serum K^+ concentration were 4.15 mEq $\pm$ 0.08 in the marasmus, 3.65 mEq $\pm$ 0.138 in the marasmic-KWO and 3.5 $\pm$ 0.09 in the Kwashiorkor, all are statistically insignificant. In PEM there is a decrease of total body potassium (Garrow et al., 1965), but there is no direct correlation between total body potassium and serum potassium (Mc Laren and Burman, 1976).

Serum aldosterone concentration was found to be increased in marasmic-Kwashiorkor (15.69 ng/dl $\pm$ 0.74) while in the control it was 13.54 $\pm$ 1.27 and in the marasmus 14.4 $\pm$ 0.5. The increase in the marasmic-KWO was statistically insignificant ($P > 0.15$). While in KWO cases there were great increase in serum aldosterone concentrations (20.38 $\pm$ 0.8) and this was of great statistical significance ($P < 0.005$). Beitins et al. (1974) also found increased aldosterone concentration in Kwashiorkor and marasmic-KWO cases. In Kwashiorkor the increased body fluid volume would be expected to lower plasma aldosterone concentration, the elevated levels of plasma aldosterone actually observed in the presence of normal production rates, would indicate that the half life of aldosterone may be prolonged, possibly due to a disturbance of hepatic catabolism (Migeon et al., 1973). Worthington et al. (1977) found increased plasma aldosterone concentration in the experimental guinea pig and monkeys maintained on protein deficient diets.

In our results we found a positive relationship between the S. aldosterone concentration and the degree of oedema in both Kwashiorkor and marasmic-Kwashiorkor cases and this supports the possible role of aldosterone in pathogenesis of oedema in PEM cases. The correlation cooficient in both Kwashiorkor and marasmic-Kwashiorkor cases was ($r = 0.99$ and $r = 0.90$) respectively.

Also there were a positive relationship between serum aldosterone concentration and hepatomegaly in both Kwashiorkor and marasmic-KWO cases ($r = 0.828$ and $r = 0.132$) respectively. Godard (1974) suggests that some Kwashiorkor children with very enlarged liver exhibited high plasma aldosterone concentration, probably due to an impaired hepatic degradation of the hormone. The presence of fatty liver might alter the metabolic clearance rate of aldosterone (Beitins et al., 1974).

Hyperaldosteronism has been postulated in KWO by similarity to that occuring in other clinical conditions accompanied by oedema. The renin-angiotensin aldosterone system functions as a neurohormonal regulating mechanism for body sodium and water content, arterial blood pressure, and potassium balance. Oedematous conditions such as liver cirrhosis, nephrotic syndrome and congestive heart failure are characterized by increased plasma renin activity and aldosterone concentration (Kaplan and Pesce, 1984).

Trials were made to associate the oedema of PEM with increased aldosterone and renin production in a similar way to that occuring in those oedematous conditions. Lurie and Jackson (1962) studied aldosterone concentration in the urine of Kwashiorkor chidren. They found increased levels in some of the cases. Migeon et al. (1973) and Beitins et al. (1974) studied adrenal function in marasmic, marasmic-KWO and Kwashiorkor children in comparison with the normal. They found increased plasma aldosterone concentration with normal aldosterone secretion rate in Kwashiorkor and marasmic-Kwashiorkor cases, while increased aldosterone secretion rate with normal aldosterone concentration in marasmic children. The increased aldosterone concentration in Kwashiorkor and marasmic-Kwashiorkor cases may be due to the reduction of the percentage of bound aldosterone in the serum due to reduction of serum albumin (Leonard and Mc William, 1965), but the significance of this may be limited since aldosterone is loosely bound to serum albumin which has a high capacity but low affinity for the steroid. Second the presence of fatty liver might alter the metabolic clearance rate of aldosterone. In their recommendation Beitins et al. (1974) conclude that the occurence of high levels of aldosterone in children with Kwashiorkor who have marked oedema and liver enlargement, suggests that spironolactone administration may be of therapeutic value in selected cases.

Serum Renin activity was found to be increased in both Kwashiorkor and marasmic-KWO cases and it was of great statistical significance, the P values were (<0.005 and <0.005) respectively. The mean in Kwashiorkor cases were 2.62 ± 0.12 ng/ml/h, and in the marasmic-KWO cases 2.008 ng/ml/h $\pm$ 0.105 while in the control it was 1.3 ± 0.08 and in the marasmic cases it was 1.54 ± 0.09 ng/ml/h.

Our results denotes increased renin activity in cases of PEM with oedema and this was previously shown by Kritzinger et al. (1972, 1974), they found increased plasma renin activity in Kwashiorkor compared with healthy children and suggest that the increased renin activity contributes to the retention of water characteristic of PEM. Also Westhuysen et al. (1975) found increased plasma renin activity in rats during energy protein malnutition and they conclude that the increased concentrations results from increased secretion rather than from decreased inactivation. It has been suggested that the increased renin activity contribute to the oedema of KWO by its direct action on the kidney which prevents elimination of salt and water and which also releases vasopressin and aldosterone. The renin angiotensin system also increases water consumption.

A positive relationship was shown between serum renin activity and the degree of oedema in Kwashiorkor and marasmic Kwashiorkor cases, the correlation coefficient r was 0.84 and 0.82 respectively. This result is in favour with the conclusion of kritzinger et al. (1972, 1974) that the increased renin activity contributes to the retention of water characteristic of KWO.

On the other hand Westhuysen et al. (1975) found no strict causal relationship between plasma renin activity and the degree of oedema in children with KWO. They suggest that the increased renin activity probably results from a terminal change in cardio-vascular function. Also Westhuysen et al. (1977) on their work on pigs made experimentally oedematous by feeding them protein deficient diet found that the oedema preceede any increase in the effective plasma renin activity and found that oedema developed in some pigs without any change in their plasma renin activity, they suggest that the increased renin activity is not responsible for the initial fluid retention and oedema.

While the present study does not attempt to measure aldosterone secretion rates, it is important to recognize that such measurements of hormonal output rate do not reflect the removal of the hormone from the circulation. Therefore, as has already been pointed out by Migeon et al. (1973), plasma aldosterone concentration would appear to correspond more closely to the level of aldosterone at the cellular level. Nevertheless, due to the complexities involved in the metabolic regulatory mechanisms underlying mineralocorticoid actions further work on the hormonal adaptive mechanisms under nutritional stress is clearly required.

The results are also influenced by non-hormonal factors: protein binding in the plasma, liver catabolism and renal clearance.

SUMMARY

In this study 51 malnourished children and 10 normal control all were aged between one and 2 years, were studied in order to investigate the possible role of renin-angiotensin-aldosterone system in the pathogenesis of oedema of PEM.

Thorough clinical examination and anthropometric measurements with a detailed appraisal of the socio-economic and dietetic status was made. Laboratory determination of serum proteins, serum albumin, serum electrolytes (Na^+ and K^+) and radioimmunoassay of serum aldosterone concentration and serum renin activity were done for all the cases.

We found a significant decrease of serum proteins and serum albumin in Kwashiorkor and marasmic-Kwashiorkor cases. A significant increase in serum aldosterone in Kwashiorkor cases ($P < 0.005$), a non-significant increase in marasmic-Kwashiorkor cases ($P > 0.15$), and a significant increase in serum renin activity in both Kwashiorkor and marasmic-KWO cases ($P < 0.005$ and $P < 0.005$).

We found a positive relationship between serum aldosterone

concentration and the degree of oedema in both Kwashiorkor and marasmic-Kwashiorkor cases. The correlation coefficient r were 0.99 and 0.904 respectively.

Also a positive relationship between serum renin activity and the degree of oedema in Kwashiorkor and marasmic-Kwashiorkor cases. The correlation coefficient r were 0.843 and 0.828 respectively.

We found also a positive relationship between serum aldosterone concentration and the degree of hepatomegaly in Kwashiorkor and marasmic-Kwashiorkor cases. The correlation coefficient r were (0.82 and 0.132) respectively.

Our findings suggest that renin and aldosterone have a role in the pathogenesis of oedema as suggested before by Beitins et al. (1974), Kritzinger et al. (1972, 1974) and Worthington et al. (1977). Although the level of the hormones are affected by other factors such as protein binding in the plasma, liver catabolism and renal clearance, the significant raised levels of the hormones points clearly to their role in the pathogenesis of nutritional oedema. No one can deny the major role of the decreased serum albumin concentration in the pathogenesis of oedema of PEM as serum albumin is found persistently low in all the cases and all of the previous studies (Whitehead et al., 1973; Mc Laren and Burman, 1976).

As for the role of potassium in the pathogenesis of oedema as has been suggested by Mc Cane et al. (1969) we found a non-significant decrease of serum potassium in the cases of PEM with oedema, but as has been pointed out by Mc Laren and Burman (1976) there is no direct correlation between total body potassium and serum potassium.