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The composition of tissue lost through reduction of diet in obese patients

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'Obesity tissue' has been defined as the tissue gained as a result of overeating (Keys & Brožek, 1953) and its composition has been estimated in various ways (Brožek & Keys, 1955; Johnston & Bernstein, 1955; Keys, Anderson & Brožek, 1955; Passmore, Meiklejohn, Dewar & Thow, 1955; Ljunggren, Ikkos & Luft, 1957*b*). It has been assumed that the tissue lost by obese people on a reducing regimen is of a similar composition (Keys & Brožek, 1953; Ljunggren, 1957). In the present study the composition of obesity tissue lost by people on a reducing regimen was estimated from the changes in total and extracellular body water and exchangeable potassium.

EXPERIMENTAL

Subjects and procedure. Seven patients, five females and two males, being treated for obesity as out-patients, were studied. None showed signs of cardiac insufficiency, disturbances of water and electrolyte metabolism, or abnormal thyroid function. Their ages, body-weights and heights are shown in Table 1.

The measurements were taken before and after restriction of calorie intake by means of a prescribed diet containing about 800 kcal/day. All patients were given amphetamine to allay hunger, and five were also given a small dose of desiccated thyroid.

The interval between the two measurements varied from 80 to 303 days (Table 1).

Estimation of body water and potassium. Total body water was estimated as the volume of distribution of deuterium oxide (Ljunggren, 1955). Extracellular water was

estimated as thiosulphate space (V_{TS}) (Cardozo & Edelman, 1952), 'corrected' to give the calculated inulin space (V_{IN}) by the formula of Ikkos, Ljunggren, Luft & Sjögren (1956):

$$V_{IN} = 0.92V_{TS} + 4.42k - 6.31,$$

where V_{IN} and V_{TS} are expressed in litres and k is the percentage of thiosulphate that disappeared from plasma per minute. Intracellular water was taken as the difference between total body water and extracellular water. In five of the subjects body potassium was measured by isotope (^{42}K) dilution, as the amount of exchangeable potassium (Corsa, Olney, Steenburg, Ball & Moore, 1950). We used these methods in earlier studies of body composition in normal and obese subjects (Ljunggren, 1957; Ljunggren *et al.* 1957*a, b*).

RESULTS

The results of the measurements are shown in Table 1. A decrease in the body potassium and total, extracellular and intracellular water was found in almost all subjects along with the decrease in body-weight. The mean decrease in weight was 20 kg.

Table 1. *Losses of body-weight, body water and potassium by seven obese patients on a reducing regimen*

Subject	Age (years)	Sex	Height (cm)	Time on regimen (days)	Weight (kg)			Total body water (l.)			Extracellular water (l.)			
					Before	After	Loss	Before	After	Loss	Before	After	Loss	
A	45	♀	156	136	80.3	73.0	7.3	30.9	29.5	1.4	10.8	10.4	0.4	4.7
B	24	♀	165	303	102.2	80.3	21.9	37.2	34.4	2.8	11.9	11.9	0.0	7.8
C	20	♀	177	125	112.5	82.0	30.5	42.5	38.4	4.1	12.8	12.8	0.0	2.3
D	44	♀	161	190	132.0	94.0	38.0	45.3	40.2	5.1	16.1	13.7	2.4	2.3
E	20	♀	167	116	98.4	90.5	7.9	40.1	37.0	3.1	13.0	11.7	1.3	8.1
F	29	♂	181	93	138.3	114.2	24.1	59.1	55.2	3.9	16.7	14.7	2.0	3.7
G	34	♂	171	80	105.5	94.5	11.0	49.1	49.2	-0.1	14.7	14.6	0.1	-0.2
Mean for seven subjects							20.1			2.9			0.9	
Mean for five subjects							19.0			—			—	

Subject	Age (years)	Sex	Height (cm)	Time on regimen (days)	Intracellular water (l.)			Exchangeable potassium (equiv.)			Intracellular potassium (m-equiv./l.)	
					Before	After	Loss	Before	After	Loss	Before	After
A	45	♀	156	136	20.0	19.1	1.0	2.60	2.15	0.45	130	113
B	24	♀	165	303	25.3	22.5	2.8	2.90	2.45	0.45	111	109
C	20	♀	177	125	29.7	25.6	4.1	3.45	2.95	0.50	116	115
D	44	♀	161	190	29.2	26.5	2.7	—	—	—	—	—
E	20	♀	167	116	27.1	25.3	1.8	—	—	—	—	—
F	29	♂	181	93	42.4	40.5	1.9	5.20	4.70	0.50	123	111
G	34	♂	171	80	34.4	34.6	-0.2	4.10	3.85	0.25	119	111
Mean for seven subjects							2.0			—		
Mean for five subjects							—			0.43		

The concentration of intracellular potassium was similar to that previously found in healthy and obese subjects (Ljunggren *et al.* 1957*a, b*).

The mean values for the losses are also given in the table. The average composition of the tissue lost was calculated from these values. It was found to contain 14.5% total water (4.4% extracellular and 10.1% intracellular) and 22.7 m-equiv. potassium/kg. For these calculations it was assumed that the weight of 1 l. of body water is 1 kg.

DISCUSSION

Pawan (1956) and Passmore, Strong & Ritchie (1958) obtained results similar to ours. Pawan found the mean water content of the tissue lost to be 19% as calculated from the changes in the urea space in thirty-four obese patients on a reducing regimen. The mean loss in body-weight was 10.2 kg. Passmore *et al.* found the composition of the tissue lost to be: fat 73–83, protein 4–7 and water 10–23% by weight. Their calculations were made indirectly from the results of nitrogen and energy balances measured in seven obese females on a reducing diet. The mean weight loss was 15.3 kg. These authors found evidence of changes in composition of the tissue lost at different stages of weight reduction. No conclusion can be drawn from our own study in this respect. Our results also agree with those of Fourman & McConkey (1958) who found a potassium loss of 23 m-equiv./kg body-weight in three obese subjects on a reducing regimen.

In our previous study, using the same methods, we have estimated the composition of 'obesity tissue' by comparing the body composition of a group of obese females with that of a normal group. The composition was found to be: total water 22%, extracellular water 7%, intracellular water 15% and potassium 15 m-equiv./kg (Ljunggren *et al.* 1957*b*). These values agree reasonably well with those found in the study described here and thus support the assumption that the tissue gained by over-eating by normal and obese subjects is similar in composition to that lost by obese subjects (Ljunggren, 1957).

SUMMARY

1. Total, intracellular (by difference) and extracellular water and potassium in the bodies of seven patients (five female and two male) being treated for obesity as out-patients were determined before and after weight reduction.
2. The mean composition of the tissue lost was calculated. The total water content was 15% and that of the extracellular water 4%. The potassium content was 23 m-equiv./kg.

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