

# Fat Metabolism in Malnourished Tropical Children

## Some Preliminary Observations

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THE two principal types of malnutrition seen in tropical children are marasmus and kwashiorkor; they differ in their clinical features and in the diets that lead to them. In both states the diet is inadequate in protein, but in kwashiorkor the diet has a relative excess of carbohydrate. The very fatty liver and presence of reasonable amounts of depot fat in kwashiorkor offer a complete contrast to marasmus; this may be due to the relative excess of dietary carbohydrate. It was, therefore, believed that a study of the lipid metabolism in children with kwashiorkor and its comparison with that in children with marasmus and in children with fatty livers of non-dietary origin might show whether there was any characteristic alteration in lipid metabolism associated with a high carbohydrate-low protein-low fat diet.

### MATERIAL

Specimens of liver and depot fat were obtained postmortem from African children aged one to four years inclusive. The lipid was extracted from the dried material with petroleum ether (40° to 60°C.). The cases were divided into three groups according to clinical diagnosis, one group consisted of those with kwashiorkor, another marasmus and the third consisted of children who had died a natural death, the cause of which was not predominantly mal-nutritional. This latter group of control subjects can in no sense be considered normal.

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### First Series (South Africa)

The liver lipid was separated into three fractions, namely, phospholipid, nonsaponifiable and fatty acid and the proportions of these fractions in twelve malnourished subjects (seven with kwashiorkor and five with marasmus) were compared with those in twenty-four control subjects, some of whose livers were very fatty.

The results show that when fat accumulates in the liver in the control group there is an increase in the phospholipid fraction when expressed as gm./100 gm. dry liver ( $p = 0.05$ ), but no significant increase is found in those with kwashiorkor whereas in those with marasmus the findings are similar to those in the control group (Fig. 1). The nonsaponifiable fraction did not increase as the lipid accumulated in the liver in any group. However, there was a tendency for the proportion of the nonsaponifiable fraction to be lower in those with kwashiorkor (mean = 0.65 gm./100 gm. dry liver, standard deviation (S.D.) = plus or minus 0.66) than in those with marasmus (mean = 1.52 gm./100 gm. dry liver, S.D. = plus or minus 1.25) or the control subjects (mean = 1.27 gm./100 gm. dry liver, S.D. = plus or minus 0.75). Comparison of the means in those with kwashiorkor and the control subjects gave a probability value of 0.1 to 0.05. When the degree of unsaturation of the nonsaponifiable fraction as measured by the iodine number is studied it is seen that the unsaturation of the liver lipid in those with marasmus (mean = 90, S.D. = plus or minus 19) is greater than that of the control group (mean = 76, S.D. = 30), each comparison having a probability value of  $<0.05$ . The fatty acid fraction in those with kwashiorkor and the control group showed a similar and significant increase with a rise in total liver lipid.<sup>1</sup>

These results therefore show that the excess liver lipid found in those with kwashiorkor has not the same composition as the excess liver lipid due to

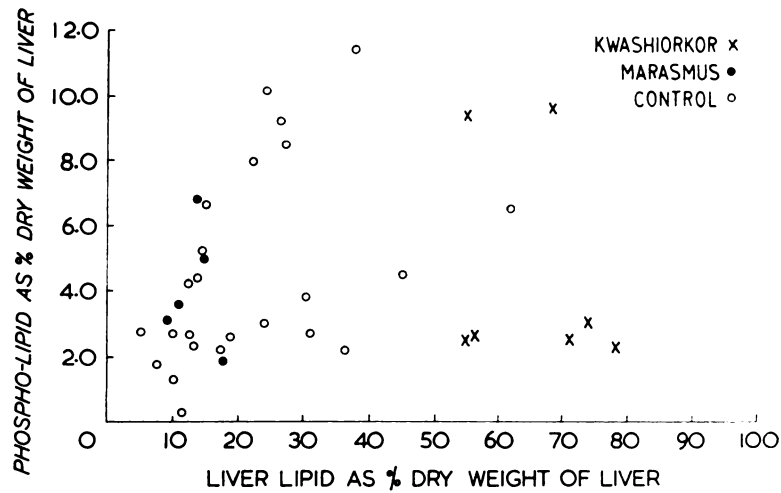


FIG. 1. The phospholipid fraction of liver plotted against the extent of liver lipid.

nonmalnutritional causes. Except for the degree of unsaturation of the nonsaponifiable fraction, the liver lipid in those with marasmus showed no difference when compared with livers having a similar low lipid content in the control group.

#### Second Series (Senegal, West Africa)

In this series the fatty acids from total hepatic lipid and from the depot fat of those with kwashi-

kor, marasmus (no depot fat) and the control group were analysed on a gas chromatograph.<sup>2</sup> Table I shows the results of the liver lipid analysis, there being no difference between any of the groups except for an increase in  $C_{18}:\Delta$  ( $p = 0.05$ ) in those with kwashiorkor.

More marked differences in the fatty acid proportions are seen in the depot fat (Table II), the  $C_{14}$  and  $C_{16}$  acids are reduced in those with kwashiorkor as compared to the control subjects but the  $C_{18}:\Delta$  is raised.

Compared with reported results on the depot fat of European adults (Table II) it is interesting to note that the proportions of fatty acids in depot fat from subjects with kwashiorkor are very similar to those of European adults, whereas in the control group the depot fatty acids are unlike those in the European adults.

If the fatty acid proportions in liver and depot fat are compared (Tables I and II) it is seen that in the subjects with kwashiorkor there is no signifi-

TABLE I  
Liver Lipid: Fatty Acid Fractions

Subjects	$C_{14}$	$C_{16}$	$C_{18}:\Delta$	$C_{18}:O$	No. Examined
Kwashiorkor.	3.8	34.8	53.6*	7.8	5
Marasmus...	5.3	46.9	36.5	10.7	3
Control.....	4.9	39.7	43.5	11.9	11

\* When compared with control,  $p = <0.05$ .

TABLE II  
Depot Lipid: Fatty Acid Fractions (%)

Subjects	$C_{12}$	$C_{14}$	$C_{16}$	$C_{18}:\Delta$	$C_{18}:O$	No. Examined
Kwashiorkor.....	2.9	8.3*	30.0*	51.6*	7.3	4
Control.....	7.9	15.8	44.9	26.4	5.1	7
European adult.....	1.0	4.4	33.3	55.3	5.2	(Cramer, Brown 1943 <sup>3</sup> )
European adult.....	1-2	3-5	27-45	43-57	2-15	(Moore, Cook 1959 <sup>4</sup> )

\* When compared with control,  $p = <0.05$ .

cant difference in any fraction examined, whereas in the control group the  $C_{14}$  is higher and the  $C_{18}:\Delta$  and  $C_{18}:O$  are lower in the depots than in the liver. Can it be that in subjects with kwashiorkor the liver has become a fat depot?

From these preliminary observations the following tentative conclusions may be drawn.

Fat metabolism is different in children with kwashiorkor from that in children of the same race and age group dying of other causes.

The fatty acid proportions in depot fat in children with kwashiorkor correspond to those found in normal European adults.

In kwashiorkor, the proportions of fatty acids in the liver and in the depots are similar.

In subjects with marasmus the fatty acids

in the liver are similar in proportion to those in the control group.

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