Investigations into Health and Nutrition in East Africa

with 132 tables and 70 figures

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Contents

Tables

Figures

1. Methods

a) Selection of the Families

With the first series of tests, it was hardly possible to get a representative selection of families from the statistical point of view. In Bumbuli we chose families with different levels of income derived from subsistence cultivation and extra earnings. Our selection was also made more difficult because some of the chosen families were not willing to undergo our tests. They had to be replaced by others in order to obtain the required number of samples. We intended to examine 20% of the families. This figure was almost reached in Bumbuli A, but in Bumbuli B, it was considerably less. A complete investigation of the whole village of Mulungui (with the exception of two families who refused) was carried out. Almost all the inhabitants in Funta were measured and weighed.

In other villages (Leguruki, Maranzara, Chakichani), where we worked for a shorter period, a classification by income was impossible. The headmen and the teachers living in these places gave us the names of families with medium incomes. From the names we chose those who were willing to cooperate with us.

All the members of the selected families (cooking units) were listed according to sex and age. Pregnancy and lactation were also noted. In most cases, the age had to be worked out according to a calendar of locally known events. The age of some children born in Bumbuli Hospital was known.

b) Dietary Investigations

After it had been established that enquiries of 4 days were sufficient to determine the menu and the amounts of food consumed, the survey team visited on at least 4 successive mornings the homes of the selected families and put questions to the housewives about the meals of the current day. During these questionings, the data concerning the previous day's meals were also checked, and alterations noted. The number of those partaking in the meals was noted. Also noted were those family members who happened to be absent and any guests who were temporarily present. Then the housewife brought the food which would be eaten at the midday and evening meals. This was weighed. Additional ingredients were measured by using whatever measuring instruments (teaspoon, woodenspoon etc.) which were locally used. We then measured their capacities. It must be pointed out that with investigations of this nature only the consumption of the whole family (cooking unit) could be established. The presence of investigators during the actual meal who would estimate the consumption of the individual family members would have been an offence to the people. Any presence

of an observer would in addition have changed the pattern of the meals and even have falsified the results.

In Bumbuli all the families under investigation were visited many times in the course of the year so we could judge the seasonal alternations in food amounts. Owing, however, to the great irregularity of the harvest periods and the yields it was impossible to work out a yearly average of food consumption.

Working on the recommendations of the Food and Nutrition Board of the National Research Council of the USA (Recommended Dietary Allowances), and grouping the people according to age and sex, the nutrient requirements (from now on referred to as "requirement") of the families were calculated. Due to the smaller body measurements of the Bantu population (see page 38 and Literature 13–16) we reduced the requirements of calories and protein by 10%. A correction in the average value is also in accordance with the recommendations of the Food and Nutrition Board and the Food and Agriculture Organisation. In the case of adults, semi-heavy physical work was taken into account; pregnancy and lactation were also taken into consideration as recommended.

Table 1 shows the nutrients that were under observation and the requirements that were worked out. The daily meals consisted of a small breakfast and two hot main meals. We worked out the requirement of a family during the 4 days of enquiry and estimated the presence or absence of a person at breakfast as 1/5, and at each of the other meals as 2/5 of his daily requirement.

The figures for the nutrient content of the foodstuffs were taken from the Food Composition Tables (17 and 18), which were checked and completed by our own analyses (see Chapter on Food Analysis A III 4, p. 55 ff). In all there were about 80 different types of food consumed. 10 of these foods provided not less than 90% of the nutrient consumption. In order to compare and judge the nutrient intake of the family, this was expressed as percentage of the calculated family requirement.

After evaluating the data we found some questionable results. We found that in some cases the calorie requirements were met by over 120%. Some cases were under 80%. This discrepancy was probably due to the incorrect values for the numbers of persons partaking in the meal. Moreover, in many cases, the estimation of calorie requirement for semi-heavy work was too high, because the working capacity was very seldom fully utilized[1]. Consequently, we decided not to take account of the supplies for the individual families. Since the enquiries were made by the same team and no definite trend was visible, we think we are justified in making some remarks on the different survey areas separately.

1 See ATTEMS, page 203.

Table 1. *Nutrients Considered, and their Assumed Requirements*

Years	Calories	Protein g	Calcium g	Iron mg	Vitamin A I.U.	Vitamin B_1 mg	Vitamin B_2 mg	Niacin mg	Vitamin C mg
Both Sexes									
1– 3	1,170	36	0.9	6	1,800	0.6	0.9	7	31
4– 6	1,530	45	0.9	7	2,200	0.8	1.2	10	45
7– 9	1,900	54	0.9	9	3,100	1.0	1.4	13	54
10–12	2,200	63	1.1	11	4,000	1.2	1.6	15	68
Males									
13–15	2,800	77	1.3	13	4,500	1.4	1.9	19	81
16–19	3,240	90	1.3	14	4,500	1.6	2.2	22	90
20–34	2,900	63	0.7	9	4,500	1.4	1.6	19	68
35–54	2,700	63	0.7	9	4,500	1.3	1.6	18	68
55 and older	2,300	63	0.7	9	4,500	1.2	1.6	16	68
Females									
13–15	2,340	72	1.2	13	4,500	1.2	1.8	15	72
16–19	2,160	68	1.2	14	4,500	1.1	1.7	14	72
20–34	2,100	52	0.7	11	4,500	1.1	1.4	15	63
35–54	2,000	52	0.7	11	4,500	1.0	1.4	15	63
55 and older	1,620	52	0.7	11	4,500	0.9	1.4	15	63
During the second half of pregnancy									
	300 additional	20	1.4	14	5,500	1.2	1.8	18	90
During the first 6 months after delivery (lactation period)									
	1,000 additional	40	1.8	14	7,200	1.5	2.2	17	135
Infants from 7 to 12 months old									
	kg × 90	kg × 2.5	0.7	6	1,350	0.5	1.7	6	27

c) Anthropometric Measurements and Clinical Investigations

The anthropometric measurements were similar to those used by W. KELLER investigating German students and recruits as well as soldiers in Tanzania, Kenya and in Guatemala (Literature 19–21). The measurements were not restricted to families, but applied to school children as well. Those who were to be examined gathered together at a pre-arranged time in an appropriate room. The weight of infants was taken by using a beam baby scale. The others were weighed with a spring balance. This was checked at regular intervals with certified weights. Children were weighed without clothes. No allowance was made for the clothes. Length was measured in infants with a length measuring board in a horizontal position. All other heights were measured with a stick fixed to the wall. In the Masai survey the rod was fixed at a tree. All persons were measured in barefeet.

Circumferences of the head, chest, upper arm and calf were taken with a

Altogether the areas that we investigated gave a much better picture than the one obtained by ROBSON (36) in other parts of Tanganyika.
Results of the determination of *total proteins* in the plasma are shown in table 8.

Table 8. *Total Protein in the Plasma*

Area	No. of determ. n	Av. value m	Values under 6.0	Values 6.0—6.4	Values 6.5—6.9	Values 7 and more
Bumbuli	128	7.27 (s = 0.61)	3 *(2%)*	7 *(6%)*	24 *(19%)*	94 *(73%)*
Soni	52	7.29	0	1 *(2%)*	15 *(29%)*	36 *(69%)*
Irente	34	7.41	1 *(3%)*	1 *(3%)*	6 *(18%)*	26 *(77%)*
Mazumbai	84	7.35 (s = 0.63)	0	7 *(8%)*	16 *(19%)*	61 *(74%)*
Coast	37	6.98	2 *(5%)*	5 *(14%)*	10 *(27%)*	20 *(54%)*
Masai	32	7.67	0	0	4 *(13%)*	28 *(87%)*

Although the average values are all within the normal range, a distinct tendency was noted. The values in Usambara were almost uniform, but they were much worse in the coastal area, and again better amongst the Masai.
Out of the 145 determinations made in Bumbuli of Vitamin C in the blood, we found an average of 1.26 mg% of ascorbic acid (s = 0.36). The results are, therefore, completely within the normal range and in accordance with the clinical findings.

e) Dietary Investigations

These were usually done at the same time as the clinical examinations. We visited people in both Bumbuli A and Bumbuli B several times from January 1965 to April 1966. In the two coastal villages the investigations were carried out in February and May 1965; in Upare in February 1965; in Leguruki in March 1965; in Soni from September to December 1965; and in Mulungui in January 1966. Eating habits are roughly similar in all places. At breakfast a heavily sweetened tea (in a few families accompanied by biscuits) is taken, or, in poorer families, this is replaced by a thin maize soup *(Uji)* or breakfast is omitted altogether. Normally a cooked meal is eaten at midday, and in the evening, although the midday meal is missing when there is a food shortage or if there is urgent agricultural work to be done. The various articles of food, however, were consumed in our survey areas in varying quantities, as can be seen from table 9. It lists the amounts of the most important foodstuffs consumed.
Particular difficulties arose in dealing with the consumption of alcohol, which is frequently accompanied by meat consumption in the bars of the areas under investigations. Such extra meals were not freely admitted by the families, and especially not to Europeans. After many enquiries, we decided to

Table 9. *Amounts of the Most Important Foodstuffs in the Total Consumption of Calories and Nutrients in the Different Survey Places*

Food	Cal.	Prot.	Ca	Fe	Vitamins A	B_1	B_2	Niacin	C
				Bumbuli					
Maize	38	38	5	22	17	33	23	23	2
Cassava flour	14	2	18	15	0	6	8	10	0
Leguminosae	3	10	9	14	+	13	7	4	1
Plantains	12	6	4	9	8	7	8	9	11
Wild spinach	1	2	22	8	42	3	11	3	1
Meat	2	12	2	5	+	2	8	10	0
Milk	+	1	13	+	2	1	6	+	+
				Mulungui					
Maize	36	37	3	16	13	35	17	20	+
Fresh cassava	3	1	3	3	+	2	2	3	12
Cassava flour	18	3	16	16	0	7	9	13	0
Leguminosae	3	10	5	12	+	13	6	4	1
Plantains	13	6	3	8	10	8	8	10	8
Wild spinach	1	5	30	15	62	5	19	5	1
Fish	+	3	13	1	+	+	1	1	0
Meat	2	11	1	5	+	1	5	10	0
				Soni					
Maize	33	44	4	21	17	31	20	21	+
Cassava flour	29	6	30	31	0	11	16	23	0
Wild spinach	1	3	19	9	49	3	11	3	+
Milk	1	4	17	1	4	2	11	+	+
				Maranzara					
Maize	12	12	1	4	20	10	5	7	+
Fresh cassava	17	5	22	15	8	13	15	16	89
Cassava flour	30	5	37	28	0	12	21	25	0
Leguminosae	10	29	23	35	4	40	23	9	2
Wild spinach	+	+	4	4	55	+	2	+	+
Fish	3	27	5	4	11	3	14	12	0
				Chakidhani					
Maize	14	14	1	5	26	13	6	6	+
Fresh cassava	12	3	15	12	7	9	10	9	90
Cassava flour	49	8	65	56	0	22	35	36	0
Fish	6	54	10	9	23	6	25	30	0
				Upare					
Maize	27	22	3	11	7	20	14	16	2
Leguminosae	13	29	31	41	+	36	21	15	3
Plantains	7	3	3	5	9	6	8	7	13
Meat	4	19	2	11	+	4	13	19	0
Milk	1	2	17	+	2	1	8	+	+

See remark next page.

Food	Cal.	Prot.	Ca	Fe	Vitamins A	B_1	B_2	Niacin	C
				Leguruki					
Maize	53	42	4	31	25	51	23	42	+
Leguminosae	6	13	9	19	+	13	7	8	3
Plantains	16	7	4	10	34	10	11	16	6
Milk	9	15	75	3	25	7	40	3	6
Meat, Blood	2	9	1	22	1	1	3	8	+

Note: Figures show percentages of the total consumption; the sign + means less than 1%.

include in our calculations an average consumption of 1 litre of locally brewed beer and 100 g of meat per male adult per survey day.

In all of the Usambara areas, maize provided about 40% of the intake of calories and proteins. Some 20% of the total intake of iron, vitamin A and B_2 and niacin (actually 30% in the case of B_1) was provided by maize. There is a high consumption of maize in the area. The importance of maize (the only grain amongst the important foodstuffs) was even greater in Leguruki, whereas in the coastal area it was much smaller. Here the protein-poor cassava provided most of the calories. It is advantageously supplemented by fish, which supplies 54% of the protein intake in Chakichani near the coast. In Maranzara, only 10 miles inland, the proportion is only 27%, but it is supplemented by a high bean consumption. Apart from the coastal area, the proportion of animal proteins is highest in Leguruki, where all families combine cattle raising with agriculture. Only here does the consumption of milk play an important role in providing protein, vitamin A and B_2. Only here is milk the most important source of calcium. We find the low consumption of milk and meat in the relatively well-off town of Soni inexplicable. In the surveyed areas with the exception of Chakichani and Soni, legumes (mostly Phaseolus vulgaris) were an important source of protein. The most important suppliers of calcium in Leguruki were milk and in other areas, cassava, wild spinach and legumes. Vitamin A as carotene is derived chiefly from wild vegetables. Maize is the second best supplier of vitamin A. The amounts of carotene in maize and wild vegetables is uncertain. Thus, carotene adequacy can be described in a semi-quantitative sense only. Furthermore, towards the end of the investigations we discovered that — to a small extent at least — liver and other organs were being consumed, although the term "meat" (*nyama* in Swahili) was used in speaking to the team. Apart from milk in Leguruki, all the important articles of food provided some riboflavin.

Tables 10 and 11 give a good picture of the supply of nutrients. Table 10 gives the average of requirement adequacies of calories and nutrients in the different villages; table 11 gives the number of families whose consumption of the required levels of nutrients is 90%, 60% and less than 30%. We used

the word "requirement" as being equivalent to the American term "recommendation". Even in the light of this fact, the low requirement coverage of vitamin A in Maranzara and Chakichani seems frightening. As our food investigations on the coast coincided with the dry period, the population had no wild spinach to eat. We found out that at other times of the year, young leaves of the cassava plant are eaten. The vitamin supply would then be better. In all the survey areas the supply of calcium, vitamin A and riboflavin was particularly bad. Niacin and protein were also poorly provided.

The requirement for calcium (1 g per person per day) was covered by less than 60% in almost all families, and by less than 30% in about half the families. It is known that the metabolism of calcium is adaptable to lower consumption levels. It can go down as far as 300 mg per person per day (37). But even this low level is not reached by half of the families we investigated.

Table 10. *Average Coverage of Requirement of the Various Nutrients and Calories in the Surveyed Areas*
(Total Intake per Total Requirement × 100)

Area	Cal.	Prot.	Calcium	Iron	Vit. A	Vit. B_1	Vit. B_2	Niacin	Vit. C
Bumbuli	81	68	22	106	40	82	40	64	91
Mulungui	63[a]	60	33	111	38	–	–	58	141
Soni	91	60	36	126	42	91	49	68	179
Maranzara	95	77	30	140	6	90	42	64	125
Chakichani	77	64	28	100	4	66	32	60	76
Upare	64	87	27	139	58	93	47	67	126
Leguruki	78	86	45	140	36	124	69	62	60

[a] The strikingly low consumption of calories is accounted for by an excessive estimate of the calorie requirements (see page 204).

Note: The calculation of the B_1 and B_2 requirements has, by technical error, been omitted.

According to the anthropometric measurements and the clinical examinations which have already been described, the provision of protein is one of the most severe problems. 15 to 50% of the families consumed less than 60% of their requirements. Less than half of the families covers their protein requirement by more than 90%. Although vitamins and minerals have a wide range between the optimal intake and one that is still sufficient, no such range exists for protein. An intake of only 60% must lead in the long run to nutritional damage. The supply of calories is not much less than the requirement which is on the average covered by 95%. It is also possible to save calories by diminishing the amount of physical work. Consequently, an insufficient supply of calories is more an economic problem than a food problem. The average relation of protein to calorie requirement coverage varies characteristically from village to village. In the two coastal villages with their high

Table 11. *Covering of the Nutrient Requirements in Percent Age Groups*

	Number of inquiries	Calories			Protein			Calcium			Iron			Vitamin A			Vitamin B			Vitamin B_2			Niacin			Vitamin C		
		>60	>30		>60	>30		>60	>30		>60	>30		>60	>30		>60	>30		>60	>30		>60	>30		>60	>30	
		>90	>60	>30	>90	>60	>30	>90	>60	>30	>90	>60	>30	>90	>60	>30	>90	>60	>30	>90	>60	>30	>90	>60	>30	>90	>60	>30
Bumbuli A + B	84	55	11	0	46	29	2	2	38	60	27	0	0	14	39	37	36	20	1	12	67	20	50	31	0	26	18	12
Mulungui[a]	21	50	20	0	40	40	5	5	40	50	20	10	0	20	25	50							35	50	0	10	10	10
Soni	19	40	5	0	60	25	10	5	70	25	15	0	0	15	40	35	40	15	0	30	55	15	45	35	0	0	5	0
Maranzara	4	50	0	0	0	50	0	0	40	50	25	0	0	0	0	100	25	25	0	25	25	25	0	50	0	25	0	0
Chakichani	4	25	25	0	50	25	0	25	50	25	25	0	0	0	0	100	75	25	0	25	50	25	50	25	0	25	0	25
Upare	5	60	0	0	0	20	0	0	20	80	0	0	0	0	20	40	60	0	0	20	80	0	80	20	0	0	40	0
Leguruki	7	55	15	0	30	15	0	15	55	30	30	0	0	15	40	45	0	0	0	40	45	0	25	45	0	45	40	15

[a] See remark made on table 10.

Note: The figures given represent the percentage of families in which the requirement of calories and of the various nutrients were met by more than 60% but less than 90%, to more than 30% but less than 60%, and to less than 30%.
In order to make comparisons between the areas under survey, the figures are also given for places where few investigations took place (e.g. Upare).

consumption of cassava, the calorie coverage is easily higher. In Bumbuli, the relation is 1, in Upare about 1, whereas only in Leguruki does the protein requirement coverage exceed that for calories.
Only the supply of iron in the examined people could be called sufficient. Nevertheless a higher iron intake might be needed to counteract the loss of blood in victims infected with parasites.

3. Conclusions

We must practice care in drawing conclusions from our experiences. The material gathered is indeed too small to make generally valid assertions. The surprisingly few cases of kwashiorkor amongst small children is confirmed by statistics of patients in the Bumbuli Hospital. This may be traced back to the fact that, in contrast to other areas (e.g. Uganda), in the villages we investigated either maize was the basic food (and maize is relatively rich in protein compared to cassava and bananas), or other high-value proteins were available where cassava or bananas form the staple diet (fish on the coast, milk in Leguruki). The main results of under-nourishment were muscle wasting and a uniformly retarded rate of growth. Whereas muscle wasting is characterised by a considerable underweight for the body length, we mean by "uniformly retarded growth" the uniformly delayed increase in both length and weight[9]. Our investigations comply with numerous others that the main problem is the feeding of children aged 6 months to 5 years. The satisfactory development of the children in the first 3 months is due to the mother's breast feeding. When breast feeding becomes insufficient undernourishment begins. Small children were more undernourished than the other members of the family, because they were dependent upon their parents who did not always know the best methods of feeding them, nor did they know the proper nutrients small children must have. When the mother's milk (usually given up to the end of the second year) was no longer sufficient, then the children received a thin gruel of maize flour. This was neither of sufficient value nor of sufficient quantity. In many cases it did not conform to a minimum standard of hygiene. If the child refused this food, then many mothers thought the child was replete and made no extra effort to give it more nourishment. The result was that the children have an average weight of only 9.2 kg at the age of 2 as compared with the Harvard-Standard of 12.4 kg. According to the classification of Gomez, this represents the borderline between first and second grade undernourishment. Not until the children grew older and were in a position to be sure of their share of the family's food, did the marasmic condition go over to "uniformly retarded growth". In most cases the children did

9 For a discussion on this retarded growth (nutritional dwarfing) see (38, 39).

not make up the under-development of their earlier years. Judging by the investigations of KAHN and FREEDMAN (40) in 1959 in South Africa and by BURGESS and BURGESS (31) in 1964 in Uganda, children of well-to-do Bantu do nearly reach the Harvard-Standard. So we can assume that underweight and length are not due to genetic reasons, but to undernutrition.

The anemia which is found so often in East Africa occurs only rarely in the Usambara villages. This was shown by the haemoglobin and the haematocrit values. But this fact seems not to be attributable to better feeding or hygiene, but to the high altitude above 3,000 ft. and to the low incidence of malaria. As was to be expected, much lower values were found in the coastal villages. As far as the haemoglobin-haematocrit quotient showed microcytic anemia was rare. This is in accordance with the good coverage of the iron requirement, as shown from dietary investigations. There was an insufficiency of protein, calcium, vitamin A, riboflavin and niacin. Except for protein the clinical examinations did not show so many signs of malnutrition as expected. Two of the reasons might be:

- the recommended dietary allowances have been set too high or,
- as a result of the chronic under-feeding, some sort of adaption occurs which demands a smaller supply of nutrients.

If this is pertinent, then hypovitaminosis A or B_2, for example, should occur if a one-sided improvement of the feeding situation occurs. This could explain why we found most signs of undernourishment in Leguruki, although our anthropometric measurements showed a better development of the children there.

There is no doubt that a higher consumption of animal protein would bring about the most harmonious improvement in nutrition of the people. If this were carried out, the present short supply of calcium, vitamin A, riboflavin and niacin would be removed. Such a solution would take a long time to bring about, but could be implemented as the standard of living improved. Since this cannot be expected to take place quickly enough a higher consumption of legumes should be the first step towards improving the nutritional situation from local sources.

M. G. ATTEMS showed in his report that the growing of beans would help to improve the soil in Usambara. Beans however cannot be stored for longer than 2 months because of noxious insects. This could be avoided by the use of insecticides like pyrethrum.

From the nutritional point of view, more consumption of beans would be advantageous for three reasons:

- Tests in the Max-Planck-Institut für Ernährungsphysiologie in Dortmund have proved that protein mixture of maize and beans (phaseolus vulgaris) has a high biological value for adults.
- Our own investigations on feeding in the Irente and Kifungilo orphanages have shown that children over 6 months old can easily digest beans when the outer skin has been removed. Growth then develops regularly, compared with the proceeding period, if the portion of milk in the nourishment of the child is replaced by beans. As we learned from the Bukoba orphanage, and from the Nutrition Rehabilitation Unit of the Medical School in Kampala, beans have been given to children from 1 to 2 years of age as protein source for a long time. The beans are easily digested.
- Such an addition would increase not only the intake of protein but also the intake of other deficient nutrients like riboflavin, niacin and calcium.

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III. Analysis of Some Important Foodstuffs of Usambara

by

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