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# Nutrition and Eye Disease in East Africa:

## Experience in Lake and Central Provinces, Tanganyika

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### The Country

Geographically, the neighbouring parts of Lake, Western and Central Provinces of Tanganyika, as outlined on Map 1, are homogenous and consist of cultivation steppe. Wide undulating plains are interspersed with low ridges, hill blocks and ranges (Fig. 1) few of which rise more than 1,000 feet above the general level of the country which is 3,500-4,000 feet above the sea. Large areas consist of mbuga flats (Fig. 2) composed of dark clay alluvial soil, of which only those parts with nearby permanent water for arable agriculture and stock are in use. A huge granite mass underlies the whole of the area and most of the soils are derived from this.

The annual rainfall is about 35 inches near Lake Victoria, falling to about 20 inches in the areas furthest from the lake. The dry season is from mid-May to mid-November during which the desiccating sun produces an almost perpetual haze over the dusty land. Most rain falls in March and April and tends to be unevenly distributed in localised storms. Near the lake there are numerous trees and bushes, but in the drier central area the rolling plains are almost treeless except for baobab and acacia thorn, while the grass cover is constantly removed by heavy grazing and the top soil pulverized by the large herds of cattle. The physical features of the area under consideration are similar to those of large parts of the central Sudan and northern Nigeria.

### The People

Eleven different tribes speaking Bantu languages inhabit this area and number approximately two million. They are primarily


Map 1. Map showing Tanganyika and its neighbouring territories. The area of Cultivation Steppe is outlined and the places where the surveys were carried out are marked.

agriculturalists and cattle are adventitious to their original economy. Only the Sukuma and Gogo, surveys amongst whom form the substance of this report, are considered here. The Gogo have been subjected to considerable Masai influence, whom they still imitate in their dress, and in addition to the admixture of neighbouring peoples which has applied alike to Sukuma and Gogo, the latter have also had an added element of slaves due to their situation on the old East-West trade route. Gulliver

(1959) has recently constructed a tribal map of Tanganyika and, attempting to summarise the efforts made in the past at classification of the Bantu-speaking peoples of this area, he places the Sukuma in the Western Bantu group and the Gogo "remain virtually unclassified" amongst the "Hamiticised Bantu".

Sukuma and Gogo have no fixed system of crop rotation, but fallowing of fields is practised and interplanting of several crops of different growth and habit is common. Ridge cultivation with the hoe, in which young and old of both sexes take part, often in parties, is the usual method. The two areas concerned in this study differ little in the type of foodstuffs grown, but markedly in the actual quantities of food available in different years, chiefly as a result of varying climatic conditions. Whilst the country around Mwanza has not experienced serious food shortage in modern times, Ugogo has suffered from numerous famines of which that in 1929-30 was perhaps the most disastrous, and that of 1953-54 the most recent. The development of surface-water catchment works in the drier parts in recent years has helped to diminish the danger from failure of the rains.

Sorghum is the principal crop, growing best, as does maize, in heavy black cotton soil, whilst cassava and millet predominate in the more hilly, sandy areas. Around Mwanza rice is grown in swampy areas, chiefly as a cash crop, but the main cash crop is cotton. Sweet potatoes do best where there is moisture, whilst cassava is usually regarded as a stand-by for times of shortage. Numerous pulses, leafy vegetables of many kinds and other vegetables, as well as fruits and nuts are consumed in their season. These are generally much more plentiful in the areas of higher rainfall, and here too fish are more easily obtained, being nearer the lake. As elsewhere in Africa, food taboos are tending to disappear, but in the remoter areas they continue to be observed, and applying especially to articles such as eggs, mutton, goat's meat and milk, they severely limit the intake of animal protein.

There are two main meals in the day, one round about noon, and the other shortly after sunset. A stiff porridge, made from the flour of maize, sorghum, bulrush millet or cassava, is the main item, and is generally eaten together with a relish of green vegetables and perhaps a meat or fish stew. Maize on the cob, cassava, ground nuts and tomatoes and other fruit are frequently eaten raw. Much fish is eaten dried and in this form finds its way to considerable distances from the lake. Local beer is made from sorghum, millet or maize.

Possession of stock is regarded as an investment at a high rate of interest and usually there is concern only for increase in numbers and not for stock breeding.

A typical Sukuma homestead is shown in Fig. 3, with its mud and wattle-walled and thatch-roofed rondevals with an enclosure of manyari hedge and sisal. The Gogo live in a steading consisting of a square of low-roofed buildings (Fig. 4). Here the whole patriarchal family is housed, and there are compartments for children and goats, with the cattle herded into the centre.

**Previous Work**

A survey carried out in Tanganyika in 1944-45 (Colonial Office, 1948) by "junior African officials" showed 8,304 blind persons, an incidence of 219 per 100,000 which may be regarded as a distinct underestimate. In two areas in Lake Province children formed 22 per cent of the blind population. Some unpublished work from this Institute showed that in Kwimba district, south of Mwanza, nearly half of the total disablement was due to blindness. Medical examinations carried out on 2,068 people revealed 216, or approximately 10 per cent, with eye disease. From the records of the hospital at Sumve, near Mwanza, and also from the writer's own more recent experience in Mwanza itself, it would seem that eye cases of all kinds form about 3 per cent of both out-patient and in-patient practice.

Very little is known about the precise nature of eye disease in this area. McKenzie (1939) working in Morogoro, in Eastern Province, found in most Africans whom he examined impairment of dark adaptation which responded to vitamin A. About 4 per cent of all admissions of estate labourers had xerophthalmia, but keratomalacia was rarely seen. Balletto (1954) examined the inmates of three famine camps in the Dodoma area during the latest famine in Central Province and attributed blindness in some of the children to keratomalacia.

Besides this rather meagre and superficial information there remains to be mentioned only the impressions of medical officers and others familiar with the people of this area to complete the knowledge of the incidence of eye disease before the present work was commenced. All agreed that especially in the drier parts there were many with scarred eyes and with squint, and that the proportion of totally

blind people seemed to be very high. Preliminary visits by the writer to Kola Ndoto, Dodoma and Mvumi in these parts confirmed for him these general impressions of others. Much emphasis had been laid upon the harmful role of native medicine in causing permanent damage to the eyes. In hospitals in two of these places the writer was able to point out to the doctors there that infants who had been treated in this way prior to their admission were suffering from vitamin A deficiency and that the underlying condition was keratomalacia. It cannot be denied that damage to the eyes may result from the Sukuma practice of using decoctions of the bark of a tree known locally as *mowa*, and the later application of *lukaka* or aloes for eye infections. Furthermore it is difficult to imagine a more harmful practice than that of putting into the eyes powdered cowrie shell, as in a case of keratomalacia seen by the author at Kola Ndoto. In Ugogo it is customary for the native medicine man to spit his preparation into the inflamed eyes. However, some vision might frequently be saved in these young children if the primary vitamin A deficiency were recognised in time.

## Survey Methods

At the beginning of the dry season in mid-May 1959, nutritional and eye examinations were carried out on primary school children in 10 schools within a 14-mile radius of Mvumi, in the heart of the Gogo country and 25 miles south of Dodoma, the provincial headquarters of Central Province. Because of the suspected high incidence of eye disease in the general population in this area, arrangements were also made through the administration and local chiefs for the people in each place to come to the school for examination. They were informed that they were to be medically examined but did not know before they came that only their eyes were to be looked at. In this way special selection of eye cases was avoided and the figures for blinding conditions might be an underestimate, as some thus totally disabled may have been left in their villages. Immediately afterwards in early June the children of five primary schools in villages just outside Mwanza received similar examinations.

The clinical examinations were designed to provide two distinct kinds of information. In the first place the external appearance of the eye was described, and in the second a series of signs in other parts of the body was recorded. This latter was calculated to reveal evidence of nutritional deficiency and was the same as that used by the Interdepartmental Committee on Nutrition for National Defence (I.C.N.N.D.) of the U.S.A., in surveys. All clinical nutritional and eye examinations were carried out by the writer. All measurements of height and weight were done by the same laboratory assistant, but it was unfortunately not possible to use the same weighing machine in each area. The details of name, age, sex and tribe were recorded by the teachers in the different schools and the clinical nutritional and eye data by nursing personnel at the C.M.S. hospital at Mvumi and by laboratory assistants at Mwanza. A code system of numbers was used for common signs and conditions, but anything unusual and relevant to the investigation was noted personally by the writer.

As a general rule all children in each school received the full nutritional and eye examination. However, two or three children defaulted after the clinical examination, and on the first day at Mvumi it was not possible to refract or examine for spoke formation most of the children because of lack of time. In all, 3,082 people were examined at Mvumi out of an estimated population of 24,000 in the area of the survey. Thus about a 1 in 8 sample was obtained. Of these, 1067 were primary school children, a disproportionately large fraction of the whole. No attempt was made to estimate ages of the rest, as experience with another group of Africans of accurately known age has shown how completely misleading such guesses can be. They were simply divided into babies (under two years) numbering 235, toddlers (aged 2-4) 223, children (4-16) 414, and adults (over 16) of whom there were 1,143. At Mwanza the primary school children numbered 438.

## School Children: Nutritional Data

*Height and Weight.*

Height (in bare feet) was recorded to the nearest $\frac{1}{4}''$. Weight was recorded correct to the nearest $\frac{1}{4}$ lb., taken with girls wearing a dress and knickers and boys wearing a shirt and shorts, and 1 lb. was allowed for these clothes. Precautions were taken as far as possible under survey conditions for uniformity of the working conditions from day to day and measurement to measurement. The numbers at Mwanza were inadequate, and other schools in the same area were visited for height and weight records only of unselected children.

*General Appearance.*

As far as possible a constant attempt was made not to allow dirtiness and untidiness to

affect this estimation but rather to make it represent the overall appearance of well-being as shown by alertness, posture and muscle mass.

*Special Signs and their Significance.*

These were looked for in the order in which they are mentioned below.

1. Hair depigmentation. Many children in both areas had rather fine, pale hair in the temporal regions. This was not recorded as depigmentation, but only the thinning of texture and change of colour from black to brown or reddish, when it occurred over the whole or almost the whole of the head.

2. Glands. The thyroid was recorded as enlarged when palpable and also visible. Parotids were frequently seen to be enlarged but this was always confirmed by palpation and a note made whether the swelling was bilateral or not and whether firm or soft. If it was apparently due to mumps, it was ignored.

3. Skin of face and neck. Dyssebacia consists of filiform excrescences sometimes likened to "shark skin". In mild cases it is often seen best in the naso-labial folds.

4. Eyes. Eyes are dealt with later, but the external examination was made here.

5. Lips. Angular lesions were recorded as present when there were bilateral soggy erosions seen when the mouth was held partly open. Cheilosis was only recorded as present if the lips were swollen with desquamation and inflammatory vertical fissures.

6. Tongue. Only the scarlet appearance of the whole tongue in glossitis and the magenta colour of riboflavin deficiency were recorded.

7. Gums. Pyorrhoea alone was recorded. This was considered to be present if the edges of the gums were red, and bled easily, and if pockets were present round the teeth and pus exuded from the edge of the gums.

8. Teeth. Caries was noted only when several teeth were affected.

9. Skin. Only follicular keratosis was looked for and this only on the arms and the thighs. In this lesion the skin is rough to the touch, with papillae formed by keratotic plugs projecting from the hair follicles. The surrounding skin is dry.

10. Skeleton. Frontal and parietal bossing, and knock knees and bow legs were noted.

### Eye Examination of School Children

*Signs of possible nutritional significance, noted as part of the nutritional examination.*

Thickened conjunctiva. Grades 1 and 2. This is evident by a wrinkling of the conjunctiva best seen when the eye is moved to and fro and the faint blueness of the sclera becomes obscured. A mild degree of this condition, almost universally present, was not recorded.

Pinguecula. A small slightly raised thickening of the conjunctiva in the inter-palpebral fissure just lateral to the limbus, white or yellow in colour.

Conjunctival pigmentation (diffuse). This gives a "muddy" appearance to the conjunctiva in the inter-palpebral fissure.

Conjunctival pigmentation (circum-corneal). Confined to a ring around, but separated from, the limbus.

Bitot's spots. Usually small (1-3 mm.) superficial whitish, foamy lesions of the conjunctiva. Seen most often in the lateral aspect of the bulbar conjunctiva, near the limbus and in the inter-palpebral fissure.

Xerosis conjunctivae and corneae. Regarded as being present when the bulbar conjunctiva was very dry and usually also heavily pigmented. Deficiency of the precorneal film and haziness of the cornea were also sometimes present but were not separately recorded.

Keratomalacia. The final stage of vitamin A deficiency affecting the eye in which the very hazy and vascularised cornea bulges and sometimes bursts leading to total loss of vision.

Pterygium. As its names suggests, a wing-like fleshy growth which starts at the corneo-scleral junction in the inter-palpebral fissure and grows on to the cornea to a varying extent.

### Other Eye Conditions

Trachoma. No attempt was made to differentiate the various stages. "Active trachoma" denotes follicular and papillary hypertrophy with pannus. (Stages 1 and 2 of MacCallan's classification). Herbert's pits were frequently the only evidence that there had been trachoma in the past. When trichiasis was recorded there was always lid scarring and some degree of keratitis.

Strabismus. Unilateral concomitant divergent squint appeared to be the most common variety, but no attempt was made to determine accurately the type of squint in each case. All instances noted were gross examples of the condition.

Nebula and Leucoma. These were fine and coarse scars of the cornea respectively, and nearly all were situated in the pupillary area, interfering with vision. Other terms used were those commonly employed in ophthalmology and do not require explanation.



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*Refraction.*

This was carried out using an electric retinoscope under complete cycloplegia produced by the repeated installation of hyoscine hydrobromide drops (1/20 per cent) as advocated by Sorsby *et al.* (1955). The ophthalmoscope was used in cases of high myopia for evidence of degenerative changes.

*Spoke Formation in the Lens.*

The precise nature and possible significance of these lesions is dealt with in the discussion. Their presence was noted during retinoscopic determination of the refraction. A rough system of scoring was used, based upon the number of spokes in each eye and their size and density. The maximum score for each eye was six. In the analysis of the results, adjacent odd and even scores were combined as there was a uniform tendency to be biased towards even rather than odd scoring.

## Data on Mvumi: General Population

*Nutritional Status.*

No special examinations were made, but by inspection evidence was sought of such nutritional conditions as beriberi, pellagra, rickets, scurvy, goitre and kwashiorkor.

*Eye Examination.*

This consisted of external inspection for signs of possible nutritional significance and other eye conditions.

*Conjunctival Smears.*

These were taken from the eyes of 100 people at Mvumi with conjunctivitis. The majority were babies. The smears were stained in each case with Giemsa stain for inclusion bodies and with Gram's stain for other organisms.

## Results in School Children

*General Condition.*

There was considerable variation in the cleanliness of the children at both Mvumi and Mwanza and this seemed to depend largely upon the vigilance of the school teachers. On the whole, however, the Mwanza children were much better cared for and better clothed. The majority at Mvumi had scabies, often badly secondarily infected. I was informed that here many days are lost every year, especially during February to April, through tropical ulcers. Some of the worst cases were still absent from school in May, but I saw several examples of less severe cases. At both places the cervical lymph glands were frequently enlarged and this seemed to be due to chronic nasal and pharyngeal sepsis—noses were often running and tonsils enlarged. Favus of the scalp was common at Mvumi but not seen in Mwanza.

*Nutritional status.*

Height and weight. Figs. 5 to 8 show the mean heights and weights for Mvumi and Mwanza boys and girls compared with those for Caucasian children of prosperous families in Cleveland, Ohio (Simmons, 1944). There is little difference between any of the groups at age 7, but thereafter the African curves fall well behind those of the American children. The Mwanza children are heavier and taller than those at Mvumi and their growth spurt at the time of puberty is greater. Girls show this spurt earlier than boys. The significance of these results is discussed later.

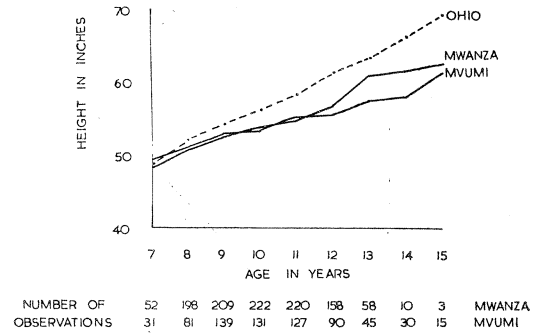


Figure 5. Height of boys.

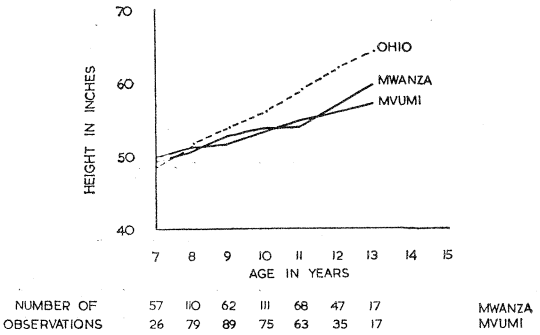


Figure 6. Height of girls.

General appearance. Table I shows that at both Mwanza and Mvumi more girls had a good general appearance than boys, and that in both sexes the Mwanza children looked better than those at Mvumi.

Special signs. Table I gives the percentage incidence of these signs in the two areas. Eye signs of possible nutritional significance are

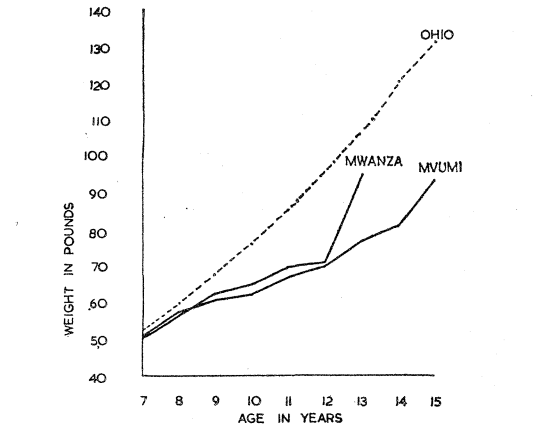


Figure 7. Weight of boys.

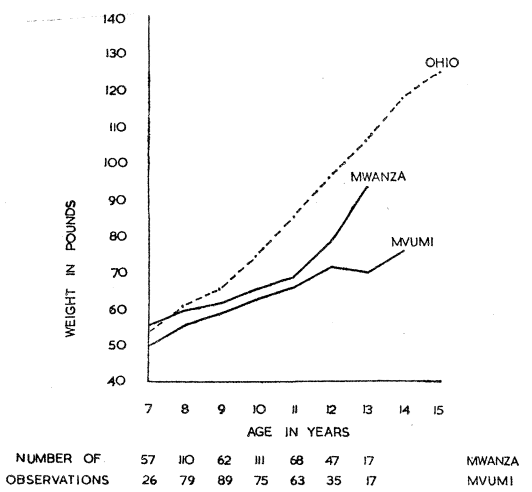


Figure 8. Weight of girls.

dealt with later. Pyorrhoea was much more common at Mvumi and caries at Mwanza. In both places the predominating condition had a higher incidence in males than in females. Angular lesions and cheilosis were both more common at Mvumi. Otherwise there was little difference between the two places.

Table II shows the incidence of the various signs in those with " poor " general appearance. Comparing these figures with those for all the school children it will be seen that in the case of depigmentation of the hair and cheilosis, in both places and for both sexes, there was a much higher incidence in the " poor " group.

*Eye Examinations.*

Signs of possible nutritional significance consisted of conjunctival thickening (grades 1 and 2), pinguecula, conjunctival pigmentation diffuse), conjunctival pigmentation (circum-corneal), Bitot's spots, pterygium and xerosis conjunctivae. In Table I the incidence of these signs in the two areas is shown. It is of considerable interest that, with the exception of Bitot's spots at Mvumi, all these lesions showed a higher incidence in the male at both Mvumi and Mwanza. The conjunctival changes of wrinkling, pinguecula and diffuse pigmentation had a considerably higher incidence in Mwanza in both sexes. For Bitot's spots the overall incidence was about the same in the two places and circum-corneal pigmentation was slightly less common in males at Mwanza than at Mvumi, but females had a distinctly higher incidence at Mwanza. The few cases of pterygium and xerosis conjunctivae were all seen at Mvumi. Reference to Table II for the incidence of eye signs of possible nutritional significance in children of " poor " general appearance shows that there was no difference between their incidence in this group and in the children as a whole. The significance of these results in relation to the nature of these conditions is discussed later.

Other eye conditions. From Table III the much greater incidence in Mvumi is evident, where most conditions occurred with approximately equal frequency in the sexes, although active trachoma was twice as common in girls whilst squint was nearly twice as common in boys. In Mwanza the rather small group of girls entirely escaped eye disease except for one with a single nebula. Trachoma, corneal scarring and squint were all very much less common in the boys of Mwanza than in those of Mvumi.

Refraction. Under full hyoscine cycloplegia the refraction was determined by retinoscopy. Measurements were made in the horizontal and vertical axes for both eyes where possible. The high incidence of corneal scarring at Mvumi prevented this examination in a number of cases in one, and occasionally in both, eyes.

Difficulty was experienced over the method of analysis of the data, as very few studies have been made of the refractive state in unsophisticated communities. Pendse (1954) followed that used by Sorsby (1928) in which the spherical equivalent of the result of the refractions in full cycloplegia was taken by making

TABLE I. NUTRITIONAL SIGNS IN MVUMI AND MWANZA SCHOOL CHILDREN.

| | *Male* | | *Female* | |
|---|---|---|---|---|
| | *Mvumi* | *Mwanza* | *Mvumi* | *Mwanza* |
| Numbers examined— | 670 | 331 | 395 | 114 |
| | % | % | % | % |
| General appearance— | | | | |
| Good | 18·7 | 25·9 | 31·4 | 44·7 |
| Fair | 60·7 | 65·9 | 59·7 | 55·3 |
| Poor | 20·4 | 8·2 | 8·9 | – |
| Cachexia | 0·1 | – | – | – |
| Hair— | | | | |
| Hair depigmentation | 4·2 | 5·7 | 3·8 | 2·6 |
| Glands— | | | | |
| Enlarged parotid glands bilateral and soft | 12·2 | 5·1 | 5·6 | 5·3 |
| Enlarged thyroid gland | – | – | – | – |
| Skin of Face— | | | | |
| Naso-labial seborrhoea | 2·1 | 0·3 | 1·8 | – |
| Eyes— | | | | |
| Conjunctival thickening | | | | |
| Grade 1 | 2·1 | 3·9 | 0·7 | 1·7 |
| Grade 2 | 0·3 | 0·6 | – | – |
| Pinguecula | 45·8 | 58·9 | 33·4 | 51·7 |
| Conjunctival pigmentation (diffuse) | 80·0 | 91·2 | 69·1 | 85·1 |
| Conjunctival pigmentation (circum-corneal) | 52·1 | 51·7 | 40·2 | 45·6 |
| Bitot's spot | 0·4 | 1·8 | 0·5 | – |
| Pterygium | 0·4 | – | – | – |
| Xerosis conjunctivae | 0·3 | – | 0·2 | – |
| Keratomalacia | – | – | – | – |
| Lips— | | | | |
| Angular lesions | 10·0 | 3·0 | 6·6 | 1·7 |
| Cheilosis | 9·8 | 1·5 | 5·3 | 0·9 |
| Tongue— | | | | |
| Raw red | – | – | 0·2 | – |
| Magenta | 0·1 | – | – | – |
| Gums— | | | | |
| Pyorrhoea | 44·2 | 7·8 | 24·6 | 3·5 |
| Teeth— | | | | |
| Caries | 7·8 | 19·3 | 7·1 | 23·7 |
| Fluorosis | – | – | – | – |
| Skeleton— | | | | |
| Bossing | – | 0·3 | – | – |
| Leg deformities | – | – | – | – |
| Skin— | | | | |
| Follicular keratosis | | | | |
| Grade 1 | | | | |
| Thighs | 4·1 | 0·3 | 7·6 | 0·9 |
| Thighs and arms | 1·2 | – | 0·2 | – |
| Arms | 0·4 | 0·6 | 0·2 | – |
| Grade 2 | | | | |
| Thighs | 0·1 | – | – | 1·7 |

allowance of −1·0 D for the distance and taking the lower hypermetropic axis as the determining factor. This method was tried at first in the present study, and the known increasing trend from hypermetropia to myopia with age in childhood was looked for. As the data from both Mwanza and Mvumi did not show this when analysed in this way, a different method was adopted. This was to calculate the mean spherical error for each eye and then take the mean of these two values for analysis, after allowing −2·0 D correction (−1·0 D for distance and −1·0 D for cycloplegia).*

The results are shown in Table IV. There were no marked differences between means for boys and girls of the same age and the values have been pooled to give larger numbers for each group. Myopes and hypermetropes of more than 4·0 D were excluded, and are dealt with separately. The usual trend with age is evident now for Mvumi and may not appear in the Mwanza data because of the smaller

* It is important to note that Pendse (personal communication) did not allow a further correction of −1·0 D for cycloplegia, although his cases were examined under atropine. There is, therefore, a basic 1·0 D difference between his data and mine.

TABLE II. INCIDENCE OF NUTRITIONAL SIGNS IN CHILDREN OF "POOR" GENERAL APPEARANCE.

| | *Male* | | *Female* | |
|---|---|---|---|---|
| | *Mvumi* | *Mwanza* | *Mvumi* | *Mwanza* |
| Numbers of "poor" general appearance | 137 | 27 | 35 | – |
| | % | % | % | |
| *SIGN* | | | | |
| Depigmentation of hair | 10·2 | 18·5 | 8·6 | – |
| Parotids | 16·8 | 3·7 | – | – |
| Naso-labial seborrhoea | 1·5 | – | – | – |
| Thickened conjunctiva | 2·2 | 3·7 | – | – |
| Pinguecula | 41·6 | 44·4 | 25·8 | – |
| Conjunctival pigmentation (diffuse) | 81·8 | 81·5 | 57·1 | – |
| Conjunctival pigmentation (circum-corneal) | 48·9 | 40·8 | 31·4 | – |
| Bitot's spots | – | – | – | – |
| Xerosis conjunctivae | 0·7 | – | – | – |
| Pterygium | – | – | – | – |
| Angular lesions | 10·9 | – | 5·7 | – |
| Cheilosis | 14·6 | 3·7 | 8·6 | – |
| Pyorrhoea | 49·6 | 7·4 | 17·2 | – |
| Caries | 11·7 | 22·2 | 5·7 | – |
| Follicular keratosis | 7·3 | – | 11·4 | – |

TABLE III. NON-NUTRITIONAL EYE CONDITIONS IN SCHOOL CHILDREN.

| | *Male* | | *Female* | |
|---|---|---|---|---|
| | *Mvumi* | *Mwanza* | *Mvumi* | *Mwanza* |
| Numbers examined | 670 | 331 | 395 | 114 |
| | % | % | % | % |
| Active trachoma | 3·0 | 0·3 | 6·3 | – |
| Herbert's pits | 6·4 | 0·3 | 6·3 | – |
| Squint | 9·2 | 1·8 | 5·3 | – |
| Leucoma x 1 | 3·1 | 0·9 | 1·8 | – |
| Leucoma x 2 | 0·3 | – | 0·3 | – |
| Nebula x 1 | 1·3 | 0·6 | 1·5 | 0·9 |
| Nebula x 2 | 0·1 | – | – | – |
| Corneal ulcer | 0·3 | – | – | – |
| Cataract x 1 | 0·1 | – | 0·3 | – |
| Anterior staphyloma | 0·1 | – | – | – |
| Total bilateral blepharitis | 0·1 | – | 0·5 | – |
| Phlyctenular kerato-conjunctivitis | 0·1 | – | – | – |
| Acute purulent conjunctivitis | – | – | 0·5 | – |
| Phthisis bulbi x 1 | 0·3 | 0·6 | 0·3 | – |
| † Old discrete colliquative keratitis | 0·4 | – | 0·3 | – |
| Posterior synechiae | 0·3 | – | – | – |
| Stye | 0·1 | – | 0·5 | – |

N.B. x 1 = unilateral. x 2 = bilateral.

† See page 118.

TABLE IV. MEAN REFRACTIONS OF MVUMI AND MWANZA CHILDREN.

| *Age* | *Number of Pupils* | | *Mean Refraction in D* | | *Standard Deviation* | |
|---|---|---|---|---|---|---|
| | *Mvumi* | *Mwanza* | *Mvumi* | *Mwanza* | *Mvumi* | *Mwanza* |
| 7 | 58 | 32 | −0·25 | −0·47 | ±0·97 | ±0·65 |
| 8 | 159 | 80 | −0·30 | −0·16 | ±0·95 | ±0·60 |
| 9 | 215 | 132 | −0·31 | −0·20 | ±1·03 | ±0·45 |
| 10 | 174 | 105 | −0·31 | −0·32 | ±0·88 | ±0·52 |
| 11 | 173 | 119 | −0·40 | −0·40 | ±0·94 | ±0·43 |
| 12 | 106 | 75 | −0·38 | −0·39 | ±0·98 | ±0·40 |

numbers there. Both the Mvumi and Mwanza children were myopic for their age by European standards.

Whilst there was no notable difference in the mean values for the two areas, striking differences became apparent when the data was dealt with in other ways. Firstly, Fig. 9 shows the percentage incidence of refractions for the age group 6 to 12 years. The scatter is seen to be much greater at Mvumi where all groups up to minus and plus 4·0 D were represented, whilst at Mwanza there were no refractions higher than plus 1·5 or minus 2·5. There was one child at Mwanza with axial ametropia of +6·0 D but, as has already been mentioned, this high order of ametropia is considered separately. There is also a slight difference in the skewness of the two sets of data expressed in this way; those for Mwanza being more to the myopic side.

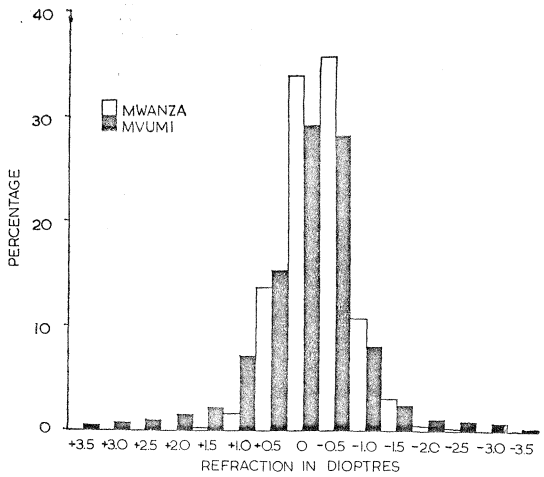


Figure 9. Percentage distribution of mean refraction.

Secondly, a further abnormal feature of the Mvumi data is brought out when the individual values for each meridian are considered. Thus in a high proportion of the children there exists a marked difference between values for the horizontal and vertical axes of the same eye, and also between the values for corresponding axes of the two eyes. These two conditions are here called mixed astigmatism and anisometropia respectively and were only regarded as being present when a difference between the two values concerned was equal to or exceeded 1·0 D. Thus mixed astigmatism was present when 1·0 D or more of difference was present between the values for the vertical and horizontal axes of the same eye. Anisometropia was present when there was 1·0 D or more difference between the values for the corresponding axes of the two eyes. Table V shows the much higher incidence of these two conditions at Mvumi than at Mwanza.

In Table VI an analysis has been made of the different types of anisometropia and their association with squint and with corneal scars. There were in all 83 cases of squint in Mvumi schoolchildren but of these there were only 58 which received refraction and which also had no corneal scarring. Of these 58 there were 33, or 56·9 per cent, who had anisometropia, this appearing to be the cause of the squint in this quite high proportion of cases. On the other hand from Table VI it is seen that about 1 in 4 or less of each type of anisometropia had resulted in squint. It might well be, however, that in the absence of correction of the refractive error a higher proportion would develop squint over the years.

It has long been customary to treat the higher degrees of ametropia as conditions with a different aetiology from the much more common aberrations of emmetropia of smaller

TABLE V. INCIDENCE OF ANISOMETROPIA AND MIXED ASTIGMATISM IN MVUMI AND MWANZA SCHOOL CHILDREN.

| | *Mwanza* % | *Mvumi* % |
|---|---|---|
| Mixed Astigmatism | 1·8 | 12·9 |
| Anisometropia | 2·9 | 18·3 |
| Total examined | 438 | 916 |

TABLE VI. ANISOMETROPIA, STRABISMUS AND CORNEAL SCARS IN MVUMI SCHOOL CHILDREN.

| *Type of Anisometropia* | *No.* | *With Squint* | *With Scar* | *With Squint and Scar* | *Proportion resulting in Squint* |
|---|---|---|---|---|---|
| Hypermetropic anisometropia | 47 | 9 | 6 | 2 | 7/47 |
| Myopic anisometropia | 58 | 17 | 3 | 2 | 15/58 |
| Antimetropia (one eye hypermetropic and the other myopic) | 63 | 12 | 4 | 1 | 11/63 |
| Totals | 168 | 38 | 13 | 5 | 33/168 |

degree. There is much evidence to show that the length of the eyeball is largely responsible for the refractive error in these grosser states and recently Sorsby *et al.* (1957) have brought forward further evidence to support this, and for the dividing line between what they term axial ametropia and the aberrations of emmetropia to be drawn at plus and minus 4.0 D.

Table VII gives details of the cases at Mvumi and of the single case at Mwanza. Because of the marked anisometropia and mixed astigmatism frequently present at Mvumi and already noted, a large refractive error in one axis only was sometimes brought down to within the range of an aberration of emmetropia when the mean of the four values for the two eyes was taken. Such instances are shown by a value only in the first column in Table VII, whilst those which are in the class of axial ametropia by both methods have two values shown.

Spoke-like opacities in the lens. In Table VIII are shown the percentages of children in the two areas with different degrees of spoke formation. The very high incidence of these lesions in both Mwanza and Mvumi children is apparent. There is, moreover, a highly significant difference between the incidence in the children of the two places ($\chi^2 = 10{\cdot}68$ $p < {\cdot}001$), the higher incidence being at Mvumi. Whilst the mere presence or absence of spoke formation can be determined with considerable accuracy, and the results are readily reproducible, the degree of change present can be estimated only in a very rough fashion and the results shown in Table VIII are not suitable for detailed analysis. There were more with the most marked degree of change in Mwanza, but because the grading was based on impressions

TABLE VII. DETAILS OF AXIAL AMETROPES (> ±4·0 D).

| Male | | | Female | | |
|---|---|---|---|---|---|
| *Age* | *Highest Single Value* | *Mean* | *Age* | *Highest Single Value* | *Mean* |
| | | *MYOPES.* | | | |
| 7 | −10·0 | − 4·6 | 7 | − 5·5 | |
| 8 | −10·0 | − 4·7 | 7 | − 5·5 | |
| 8 | − 6·5 | | 8 | − 5·5 | − 5·1 |
| 8 | −10·0 | − 6·9 | 8 | − 6·5 | |
| 8 | − 8·5 | − 8·5 | 8 | − 5·0 | |
| 9 | − 4·0 | | 8 | − 8·5 | − 5·9 |
| 9 | −11·0 | − 9·0 | 8 | − 4·5 | − 4·4 |
| 9 | − 5·5 | | 9 | − 6·5 | |
| 9 | − 9·0 | − 4·9 | 9 | − 5·5 | |
| 10 | − 4·75 | | 9 | − 6·5 | − 5·1 |
| 10 | − 5·0 | | 10 | − 7·5 | − 4·0 |
| 10 | − 9·0 | − 4·9 | 10 | −10·0 | − 8·2 |
| 10 | − 9·5 | − 8·7 | 10 | − 4·75 | |
| 11 | − 7·0 | | 11 | − 6·5 | − 4·0 |
| 11 | − 6·5 | − 5·7 | 11 | −12·0 | − 5·7 |
| 11 | − 6·5 | − 5·2 | 11 | − 6·0 | − 5·3 |
| 11 | − 6·5 | | 13 | −13·0 | − 7·3 |
| 11 | − 8·0 | | 14 | −11·0 | −11·0 |
| 12 | − 5·5 | | | | |
| 12 | −13·0 | −13·0 | | | |
| 13 | −14·0 | − 7·2 | | | |
| | | *HYPERMETROPES* | | | |
| 7 | + 4·5 | | *10 | + 6·0 | + 5·8 |
| 8 | + 4·0 | | 14 | + 4·0 | |
| 9 | + 7·0 | + 5·3 | | | |
| 9 | + 9·0 | + 4·3 | | | |
| 9 | + 4·5 | | | | |
| 9 | + 9·0 | + 8·2 | | | |
| 10 | + 5·0 | | | | |
| 10 | + 5·0 | | | | |
| 10 | + 4·0 | | | | |
| 11 | + 4·0 | | | | |
| 12 | + 4·0 | | | | |
| 12 | + 4·0 | | | | |
| 13 | + 5·0 | + 4·3 | | | |
| 14 | + 9·0 | + 7·1 | | | |

* The single Mwanza axial ametrope.

only, too much weight should not be given to this.

### Results in Mvumi: General Population

*Nutritional status.*

This was judged by clinical impressions and served only to establish the presence or absence of fairly gross nutritional disease. Vitamin A deficiency is dealt with under eye examination. No cases of the following conditions were seen: colloid goitre, beriberi, pellagra or scurvy. No classical case of kwashiorkor with most of the signs enumerated by Brock and Autret (1952) was seen. Two infants were judged to have what has been termed "pre-kwashiorkor". They were both stunted in growth, the hair was hypopigmented and poor in texture, and the skin was rough and rather scaly and dry in places. There was no clinical evidence of oedema or enlarged liver. Several infants had bossing of the skull without other evidence of rickets and this may have had another cause. Many babies and toddlers were judged anaemic by the condition of their mucous membranes, the buccal mucosa and tongue giving the best indication as the palpebral conjunctivae were usually inflamed.

*Eye Examination.*

The percentage incidence of eye signs of possible nutritional significance and other eye conditions in the four groups of babies, toddlers, children and adults is given in Table IX.

Certain features of the age and sex incidence

TABLE VIII. PERCENTAGE INCIDENCE OF SPOKE FORMATION SCORES IN MWANZA AND MVUMI SCHOOL CHILDREN.

| *Area* | *0* | *1 & 2* | *3 & 4* | *5 & 6* | *7 & 8* | *9 & 10* | *11 & 12* |
|---|---|---|---|---|---|---|---|
| Mwanza | 21·6 | 17·9 | 22·5 | 17·6 | 10·2 | 7·2 | 3·0 |
| Mvumi | 14·8 | 16·2 | 32·7 | 23·6 | 9·4 | 2·9 | 0·3 |

TABLE IX. RESULTS OF EYE EXAMINATIONS IN MVUMI NON-SCHOOL POPULATIONS.

| | *Male* | | | | *Female* | | | |
|---|---|---|---|---|---|---|---|---|
| | *Babies* | *Toddlers* | *Children* | *Adults* | *Babies* | *Toddlers* | *Children* | *Adults* |
| Number examined | 108 | 114 | 193 | 404 | 127 | 109 | 221 | 739 |
| | % | % | % | % | % | % | % | % |
| Conjunctival thickening | | | | | | | | |
| Grade 1 | — | 2·6 | 2·6 | 0·5 | — | 0·9 | 2·2 | — |
| Grade 2 | 0·9 | — | 0·5 | 0·5 | — | — | — | — |
| Pinguecula | 0·9 | 0·8 | 29·0 | 84·6 | 0·8 | 3·6 | 17·2 | 71·6 |
| Conj. pigmentation (diffuse) | 7·4 | 23·7 | 59·0 | 70·8 | 7·8 | 25·7 | 41·1 | 62·8 |
| Conj. pigmentation (circum-corneal) | 11·1 | 28·0 | 51·3 | 56·1 | 11·0 | 34·0 | 52·0 | 41·8 |
| Bitot's spot | — | — | 1·5 | — | — | — | — | 0·4 |
| Pterygium | — | — | — | 14·1 | — | — | 0·9 | 8·3 |
| Xerosis conjunctivae | 12·0 | 5·2 | 0·5 | — | 7·8 | 2·7 | 0·9 | 0·1 |
| Keratomalacia | 1·8 | 1·7 | — | — | 0·8 | 0·9 | — | — |
| Active trachoma | 0·9 | 7·0 | 6·7 | 2·4 | 1·6 | 1·8 | 8·6 | 4·2 |
| Conjunctivitis | 63·9 | 60·5 | 12·9 | 5·7 | 64·5 | 46·8 | 15·4 | 4·3 |
| Leucoma x 1 | — | 2·5 | 3·6 | 5·9 | 2·3 | 1·8 | 3·6 | 3·1 |
| Leucoma x 2 | — | 0·8 | — | 0·2 | — | 0·9 | 0·4 | 1·6 |
| Nebula x 1 | — | — | 0·5 | 2·4 | — | 0·9 | 1·3 | 2·7 |
| Nebula x 2 | — | — | — | 0·2 | — | — | — | 0·2 |
| Phthisis bulbi x 1 | — | — | 0·5 | 1·2 | 0·8 | 0·9 | 1·3 | 1·7 |
| Phthisis bulbi x 2 | — | — | — | — | — | — | — | 0·1 |
| Immature cataract x 1 | — | — | — | 3·9 | — | — | — | 1·9 |
| Immature cataract x 2 | — | — | — | 1·5 | — | — | — | 0·8 |
| Mature cataract x 1 | — | — | — | 0·7 | — | — | — | 0·9 |
| Mature cataract x 2 | — | — | — | 0·2 | — | — | — | 0·2 |
| Squint | 0·9 | — | 2·1 | 2·2 | — | 1·8 | 2·6 | 0·9 |
| Ectropion x 1 | — | — | — | — | — | — | — | — |
| Ectropion x 2 | — | — | — | — | — | — | — | 0·1 |
| Herbert's pits | 0·9 | 3·5 | 5·2 | 7·8 | — | 1·8 | 7·2 | 12·3 |
| Secondary cataract | — | — | — | 0·5 | — | — | 0·4 | 0·1 |
| Blepharitis | — | — | — | 0·2 | — | — | — | — |
| Trichiasis | — | — | — | 2·2 | — | — | — | 1·3 |
| Anterior staphyloma | 0·9 | — | 1·0 | 0·9 | — | — | — | 0·2 |
| Blind (unable to count fingers) | 0·9 | 0·8 | 1·0 | 0·5 | — | 0·9 | — | 1·0 |

N.B. x 1 = unilateral x 2 = bilateral

of some of the eye conditions may be pointed out now but discussion on them is reserved until later.

Pinguecula and diffuse pigmentation of the conjunctiva both showed a steady increase in incidence in both sexes with age. The same tendency was not quite so well shown in the case of circum-corneal pigmentation. The three Bitot's spot cases in each sex were confined to children in the case of males, and young adults in the case of females. Xerosis conjunctivae and corneae was most common in babies and toddlers, and in them more common in boys than in girls. Keratomalacia was confined to babies and toddlers; four boys and two girls. Finally, pterygium was almost confined to adults.

Acute or active trachoma was rare in babies, occurring mainly in toddlers and children, and being less common in adults. Herbert's pits had a steadily increasing incidence with age in both sexes. Acute conjunctivitis, excluding trachoma, diminished steadily with age in both sexes. Strabismus was much more common in the school children than in the rest of the population.

*Conjunctival Smears.*

Table X shows the different organisms found in the smears according to age grouping.

## Discussion

It has become quite popular in recent years to carry out clinical nutritional surveys, frequently in conjunction with dietary surveys of the same population, and much less frequently with biochemical investigations. Some of the best planned examples of the three-fold approach have been done under the auspices of the I.C.N.N.D. (Inter-departmental Committee on Nutrition for National Defence) of the United States, and for details of the methods used the Manual for Surveys of Nutrition issued by this committee should be consulted. Full accounts of some of the surveys are generally available (Pollack, 1956; A Nutrition Survey of the Armed Forces of the Republic of Korea, 1959; A Nutrition Survey of the Armed Forces of Pakistan, 1959). I have come to the present work with previous experience with the I.C.N.N.D. survey in Ethiopia, and after conducting dietary and clinical nutritional surveys in India (McLaren, 1955).

Something should first be said about the methods used in this survey. Attention was concentrated upon examination of the eyes, and the rest of the clinical examination was designed to pick up evidence of nutritional deficiency disease and was very limited in nature. A long list of signs was purposely avoided. Under the pressure of examining hundreds of cases consecutively there is an irresistible tendency to reduce the examination time and to miss out some signs. Ideally, there should be only one observer, as consistent results are otherwise difficult to obtain. He should have had considerable previous experience in the field, or else the criterion of presence or absence of signs will inevitably change during the progress of the survey.

No attempt was made to assess the diets being consumed by the children examined, all of whom were living at home. Unless carried out for a considerable period and repeated at different seasons, dietary histories are likely to be misleading. It may be safely assumed that in Tanganyika diets tend to be low in protein, fat and vitamin A, especially from animal sources.

It was not possible to take blood samples for biochemical determinations. In view of the wide accepted limits of normal values for circulating vitamins and the absence of gross signs of nutritional disease in these children, it is unlikely that such determinations would have provided any useful information.

The choice of primary school children in this survey had more behind it than their ready availability in large numbers. These children of

TABLE X. ORGANISMS FOUND IN CONJUNCTIVAL SMEARS AT MVUMI.

| *Organism* | *Babies* | *Toddlers* | *Children* | *Adults* |
|---|---|---|---|---|
| *H. conjunctivitidis* (Koch-Weeks bacillus) | 31 | 18 | 2 | 0 |
| *Diplococcus pneumoniae* (Pneumococcus) | 9 | 3 | 2 | 0 |
| *Neisseria gonorrhoeae* (Gonococcus) | 8 | 1 | 0 | 0 |
| Inclusion bodies (? Trachoma) | 4 | 5 | 0 | 2 |
| *H. lacunatus* (Morax-Axenfeld bacillus) | 4 | 2 | 1 | 1 |
| Staphylococcus aureus | 0 | 1 | 1 | 0 |
| No organisms | 3 | 7 | 5 | 0 |
| Numbers examined * | 50 | 31 | 11 | 3 |

* Some smears had 2 or 3 different organisms present. 5 slides were rejected as unsatisfactory.

from about 7 to 14 years of age were all alive during the last famine in Central Province in 1953-54, and were in the susceptible pre-school period at that time, when prolonged food shortage might be expected to have had a marked effect on the growth and development of those at Mvumi. The Mwanza children act as a comparable group which did not undergo famine at that time.

Thus it was the purpose of this part of the survey to find any possible evidence in the eyes of the Mvumi children of stigmata of early malnutrition, rather than to look for signs of present nutritional deficiency. It is during the earliest years of life, when rapid growth results in increased metabolic requirements and when dietary practices are frequently inadequate or harmful, that nutritional deficiencies are most likely to occur and to leave permanent damage in those who survive. Because of its very early development the eye might be expected to show such changes if they occur.

When the data on the primary school children of the two areas are considered it is evident that differences cannot be attributed simply to differences in nutrition. There are other environmental factors which have not been assessed in this study. The present nutritional position would seem to be similar in the two places. It is proposed to deal separately with the groups of data in the order followed in previous sections. Some of the data will provide suggestive evidence for the possible effects of malnutrition in the past, whilst other will either confirm or call into question the usefulness of certain signs as indications of malnutrition.

### School Children

General condition. In their classical study of the nutrition of the Kikuyu and the Masai, Orr and Gilks (1931) noted a high incidence of cervical adenitis and enlarged tonsils in the children of both tribes and the presence of tropical ulcer only in the poorer nourished Kikuyu. In these respects the present surveys' results are comparable.

### Nutritional Status

Height and weight. It is rather surprising that there was very little difference between the American and African children at the age of seven in respect of both height and weight and in both sexes (see Figs. 5 to 8). Thereafter, the Mwanza and Mvumi curves fell progressively further behind the Ohio standards, until the time of puberty, when there was a marked spurt of growth seen in the curves of both height and weight, in both sexes, and at both places. However, there is an interesting difference in the time of onset of this spurt in the two sexes. It occurred during the 12th year in the female but not until the 13th year in the male. This might be related to an earlier onset of puberty in the female sex. Data on puberty were not collected in this study, but the growth curves are consistent with the general impression that children in the tropics tend to grow very rapidly around puberty and that girls do so earlier than boys.

Although the growth spurt took place simultaneously at Mvumi and Mwanza its magnitude was greater at Mwanza. Until the age of 12 or 13 years there is little difference in the curves for the two places but thereafter they diverge considerably. It would appear that any retarding effect on growth that the last famine might have had on the Mvumi children was not evident in the early years of life. Whether it might have been responsible for the poorer response to the stimulus of puberty at Mvumi, possibly by an effect on the endocrine system, is conjectural.

General appearance. It must be admitted that the assessment of nutritional status in this way lacks precision. However, I believe it has distinct value in certain circumstances. In a group of children at school, one may safely assume that none of them is suffering from gross wasting disease or severe illness which might affect their appearance. If the observer is a clinician experienced in judging the configuration of the body, then this kind of data may be more reliable than it might at first seem to be. In view of the non-specific nature of many of the signs customarily recorded in nutrition surveys and the wide limits of normality of much biochemical data, the assessment of the general appearance deserves more attention. Skinfold thickness calipers such as those devised by Edwards *et al.* (1955) might have given further useful information. Jelliffe (personal communication) believes that the circumference of the lower arm may also reflect general nutrition. In keeping with the height and weight data, and possibly related, like these, to long-term dietary conditions, the Mvumi children of both sexes were of distinctly poorer general appearance than those at Mwanza. In both places boys were worse than girls and this may be an example of the almost universal tendency for males to fare less well than females.

### Special Signs

Hair depigmentation. The incidence is slightly higher in both sexes at Mvumi. The considerably higher incidence amongst those of "poor" general appearance in both places does suggest that this sign is of value in denoting nutritional status. Although the hair changes in kwashiorkor have received much attention in the past, the tendency at present is to regard them as one of the less constant features. The African hair seems specially susceptible to these changes and Close (1958) has shown that the cystine content of the hair of African kwashiorkor cases is decreased. This has not been found for the hair of Guatemalan and Indonesian cases and he has suggested an explanation of this difference based upon the structure of the hair.

Parotids. Enlargement was invariably bilateral and soft and was quite common in both sexes in both places. These glands are known to enlarge when malnourished subjects are fed on a good diet (McCance *et al.* 1951). Raoult *et al.* (1957) regarded enlarged parotids in children in French West Africa as a definite sign of protein malnutrion, either past or present; an opinion based upon a large series of cases studied clinically, by sialogram, histologically, and by protein electrophoresis. In the present survey whilst there was no correlation between enlargement of parotids and "poor" general appearance there was a tendency for the mean heights of children with enlarged parotids to be below that of the mean of the whole group of the same age and sex.

Dyssebacia. This sign was not often seen in children of either place and was not more common in those of "poor" general appearance. It is usually attributed to deficiency of riboflavin, as are cheilosis and angular lesions, but did not occur together with these lesions in the present surveys. The naso-labial seborrhoea seen in these children was much more common in those of 12 years of age and over (Table XI). It is known that the skin undergoes profound changes at puberty and especially in the region of the face and neck, *e.g.* seborrhoea and acne. There may possibly be an increased demand for riboflavin at puberty resulting in the manifestation of naso-labial seborrhoea in previously sub-clinically deficient individuals. In view of this it is important to know the age structure of any survey when this sign is recorded.

Lips. Angular lesions were more common than cheilosis, and the two were frequently seen together. The incidence of cheilosis was consistently higher in those of "poor" general appearance. Local trauma undoubtedly plays a part in the production of these signs (Horwitt, 1955).

Tongue. The great rarity of abnormal tongues of any kind in these children is notable. I have examined large numbers of children of the same age in India and Ethiopia and found many with fissures and papillary changes of various kinds. Food is highly spiced in these two countries but not in Tanganyika.

Gums. It is difficult to explain the much higher incidence of pyorrhoea alveolaris at Mvumi. Infection of the gingival tissue secondary to excess tartar formation is probably the most important conditioning factor. Nicholls (1951) expresses the opinion, with which most will agree, that cases of pyorrhoea with swollen gums should be recorded in nutritional surveys without prejudice to the causation.

Teeth. The good condition of the teeth at Mvumi may be related to the level of fluorine in the water. A sample taken from a borehole 5/49 at Mvumi and analysed by the Department of Geological Survey, Dodoma, showed a fluoride content of 1 p.p.m., which would seem to be about optimum. On the other hand, several samples from Lake Victoria near Mwanza have given values between 0·2 and 0·5 p.p.m. and this may account in part for the higher incidence of caries at Mwanza. Dental caries is also common in European children here.

Follicular keratosis. This was more common at Mvumi, in females than males, and with no higher incidence in those of "poor" general appearance. Unlike dyssebacia it occurred

TABLE XI. AGE DISTRIBUTION OF DYSSEBACIA AT MVUMI.

| *Age in years* | *% of all children at each age* | *% of children with dyssebacia at each age* |
|---|---|---|
| 7 | 5·25 | — |
| 8 | 14·75 | — |
| 9 | 21·01 | 4·76 |
| 10 | 18·99 | 9·52 |
| 11 | 17·51 | 14·29 |
| 12 | 11·52 | 23·81 |
| 13 | 5·71 | 19·05 |
| 14 | 3·69 | 9·52 |
| 15 | 1·57 | 19·05 |
| | 100·00 | 100·00 |

in young and old children. The thighs [illegible] commonly affected than the [illegible] instances was the con- [illegible] widespread or the follicles sufficiently enlarged for the second grade to be recorded. The aetiology of this sign is far from settled. Early workers (Frazier and Hu, 1931; Loewenthal, 1933; Nicholls, 1933) claimed response to preparations of vitamin A but these unfortunately also contained other fat-soluble substances. Indian workers (Menon *et al.* 1950; Rajagopal and Chowdhury, 1952) have had good results with rich sources of unsaturated fatty acids, whilst others have been unable to influence the condition by any therapy (Scrimshaw, 1958). It is by no means certain that everyone is referring to the same condition. Minor degrees of follicular enlargement and plugging, without dryness of the surrounding skin, situated usually in relation to frictional areas are very common in dark-skinned people. Among the skin diseases which have follicular keratosis as part of their symptomatology are Darier's disease, pityriasis rubra pilaris, and lichen pilaris. None of the three children at Mvumi with xerosis conjunctivae and corneae, which I regard as being due to vitamin A deficiency, had follicular keratosis.

**Eye Signs of Possible Nutritional Significance**

Thickened conjunctiva has perhaps been one of the most abused nutritional eye signs in the past. While it is true that the dry conjunctiva of vitamin A deficiency is always thickened, it does not follow that all thickened conjunctivae have this aetiology. Years of exposure to bright sunlight, dust and smoke, and repeated congestion due to attacks of conjunctivitis result frequently, even in young children, in wrinkling and thickening of the exposed portion of the bulbar conjunctiva in the inter-palpebral fissure.

Pinguecula, a localised thickening of the bulbar conjunctiva, is found in approximately half of all primary school children in the survey. A similar proportion of children was also affected in surveys carried out in India (McLaren, 1955). Like other conjunctival lesions, pinguecula *per se* causes no disturbance of vision, but I have seen instances in which it appeared about to transgress the limbus and invade the cornea and was at this stage indistinguishable from a very early pterygium.

With regard to diffuse conjunctival pigmentation, the figures in Tables I and IX show that this sign is present in the vast majority of healthy Africans. It should not be regarded as a sign of vitamin A deficiency unless accompanied by drying, marked thickening and changes in the cornea. The increasing incidence with age suggests that it develops as a result of local trauma, and this is supported by its higher concentration in the inter-palpebral fissure. Very young babies do not show this form of conjunctival pigmentation.

Circum-corneal pigmentation is about as common as the diffuse type and appears to be more closely related to the degree of general pigmentation of the body. It also seems to increase with age and traces are sometimes present even in new-born babies.

Bitot's spots, small superficial foamy collections of keratinised epithelial cells, have long been regarded as indubitable signs of vitamin A deficiency. Frequently they have been the only sign recorded in nutritional surveys, and in a recent survey of the vitamin A status in Ruanda Urundi (Roels *et al.* 1958) it was chosen as the only eye sign recorded, and a correlation was found with plasma vitamin A levels. However, there have always been certain gaps in the aetiological chain of evidence. For instance, they have never responded dramatically to vitamin A in high doses like xerophthalmia and keratomalacia, and some have found no response at all (Berliner, 1949a). Frequently they have been present in subjects who did not complain of night blindness, and in a recent study in Ethiopia there was no impairment of dark adaptation (Paton and McLaren, 1960). In many cases showing Bitot's spots, plasma vitamin A values have not been below the normal range (Paton and McLaren, 1959; Roels *et al.* 1958). A full investigation of Bitot's spots with clinical, dark adaptation, biochemical and therapeutic studies has not yet been carried out.

All that is known for certain is that they occur in some members of communities living on inadequate diets. That they occur in individuals with a lower plasma vitamin A level than those without them (Roels *et al.*, 1958) does not necessarily mean that they are due to vitamin A deficiency. This may merely indicate that these are the poorer nourished members of the community, possibly with lower values for many other factors. In the present study Bitot's spots did not occur at all in those children of " poor " general appearance, and, apart from one child with depigmentation of the hair, cases in which they were observed showed no other signs of low nutritional status. Whilst the spots

sometimes occurred on an otherwise normal conjunctiva, three out of the 11 children with them had grade 2 thickening of the conjunctiva. There were only four children in all with grade 2 thickening so these changes showed a very high correlation. On the other hand xerosis conjunctivae was not associated with either Bitot's spots or with grade 2 thickening. This suggests that Bitot's spots have as a component in their causation the factor responsible for thickening of the conjunctiva and that this is not deficiency of vitamin A.

Bitot's spots were slightly more common at Mwanza than at Mvumi. However, all the examples of xerosis conjunctivae and corneae were at Mvumi. This, together with the high incidence of xerosis and keratomalacia in the Mvumi children and the complete absence of these conditions in my two years' experience in Mwanza, strongly supports the previous evidence that Bitot's spots are not caused by vitamin A deficiency, although they undoubtedly accompany it at times.

Xerosis conjunctivae and corneae, and keratomalacia, undoubted signs of vitamin A deficiency, may be taken together. All three children with xerosis were at Mvumi. Untreated keratomalacia invariably results in loss of sight and is usually bilateral. This, together with its peak incidence in babies, explains why no cases were seen at school.

The three examples of pterygium were all in boys at Mvumi and were of minor degree. The drier atmosphere in Central Province may be partly responsible.

In conclusion it should be noted that none of these eye signs was found with a higher incidence in the group with "poor" general appearance. It is my opinion that, with the exception of Bitot's spots and xerosis conjunctivae and corneae, they may all be excluded from nutritional survey work without any loss of useful information. Bitot's spots should continue to be recorded, but as a non-specific sign of deficiency at the present time. Dark adaptation tests on suitable subjects, provide the earliest evidence for deficiency of vitamin A that we now have for use in the field. Of all the eye signs used in this survey, only xerosis conjunctivae and corneae of a fairly advanced state, and the ultimate state of active keratomalacia can be safely regarded as clear indications of vitamin A deficiency. Circumcorneal injection and corneal vascularisation have such a mixed aetiology that I did not even include them in the signs recorded.

*Other Eye Conditions.*

The cause of the very high incidence of strabismus at Mvumi merits further investigation. Some cases resulted from uncorrected errors of refraction, especially anisometropia, and in others the eye in which there was corneal scarring became amblyopic and deviated. There remains a small proportion in which the aetiology is obscure.

At Mvumi four possible instances of what I have elsewhere called Discrete Colliquative Keratitis (McLaren, 1960a) were seen. None of these was in the acute phase but each child denied a traumatic origin.

*Refraction.*

Sorsby *et al.* (1957) conclude that in Caucasian races about 70 per cent of all eyes fall into the refraction class of 0 to +1·0 D and that refractions close to emmetropia are more frequent than would be expected on a normal curve of distribution. The values for 3,674 eyes of palaenegrids studied by Holm (1937) had a fairly typical normal distribution but this may have been due to selection in his material. The only other study in other than a Caucasian race which may be compared with the present results and known to me, is that of Pendse (1954). It has already been pointed out that his method for calculating the refraction was found unsatisfactory with the grossly irregular Mvumi data and thus detailed comparison has been found impossible. With increasing interest being manifested in the refractive state of different races throughout the world, the need for international agreement on the definition and terms of expression of such data has become imperative. Pendse's data for both "backward" and "advanced" communities fall largely within the 0 to +1·0 D range. There is a printing error in his Table VIII where the mean for the "untouchables" is given as −0·6589; this should be +0·6589. If a further 1·0 D is subtracted from Pendse's data to make them comparable with mine, then the mean of −0·3411 for the "backward" community is similar to the means for both Mwanza and Mvumi. The mean of +1·0 D for his "advanced" community is about 0·5 D less myopic than that for a comparable group of "advanced" Indian primary school children in Mwanza still being studied. (The results of this work will be published later). The marked differences found between the Mvumi and Mwanza refraction data remain to be considered. These two groups of children differ only in their belonging to separate, albeit

closely related, tribes and in their habitat. Nevertheless the essential normality of the Mwanza refractions contrasts strikingly with (1) the greater scatter, (2) the high incidence of anisometropia and mixed astigmatism, and (3) the high incidence of axial ametropia of more than four dioptres, all found in the Mvumi data.

There is abundant clinical evidence that the higher degrees of refractive error are frequently inherited characteristics. Whilst this question was not investigated in the present study, Dr. H. Cori, Government Anthropologist, and an authority on both tribes, states that their marriage customs are very similar. If genetic factors play any part in the aetiology of the gross errors at Mvumi, it must be a very minor one.

A recent study (Phillips, 1959) has shown that, as in the present series, the association between anisometropia and strabismus is not invariable. In a series of hypermetropic anisometropes the mean spherical error of the less ametropic eyes was found to be significantly less in those without squint than in those with squint. Thus the development of squint in anisometropia seems to depend, at least in part, on the degree of the refractive error. The same worker found a very low incidence of squint in myopic anisometropes, as compared with the hypermetropic anisometropes. For some reason which is not apparent, this was not the case in the present study, the incidence of squint in myopic anisometropes being higher than in the other two groups.

Towards the end of the Mvumi survey marked asymmetry of the face was looked for and recorded but from the rather limited study made there appeared to be no relation between this and anisometropia. Finally, in the discussion of his data, Sorsby (Sorsby *et al.*, 1957) propounds the interesting hypothesis that the retina is the "organiser" of emmetropia. Ultimately the size of the retina determines the size and shape of sclera, cornea and lens and an emmetropic eye results from an orderly adjustment during growth of the various components and is initiated and maintained by the retina. When this correlation fails, refractive anomalies result. Just what could cause such a failure is entirely unknown, but it is possible that malnutrition during early life might be responsible.

It has not yet been established how adjustment is made in the human eye to the axial elongation that takes place with increasing age. From birth to adult life a reduction in the power of the eye of some 20 to 30 D normally takes place. In part at least, this is brought about by the flattening of the cornea, and failure in correlation between the increase in axial length and change of shape of the cornea may lead to refractive errors. In view of the vital role of vitamin A in the preservation of the integrity of both retina and cornea, and recalling the evidence for widespread and severe deficiency of this vitamin at Mvumi in babies, the possibility that the irregularities of refraction at Mvumi may arise in this way deserves further investigation.

*Spoke formation in the lens.*

The appearance of water clefts in the cortical portion of the crystalline lens is one of the commonest manifestations of incipient cataract (Bellows, 1944). These clefts lead to spoke-like opacities, which are merely water clefts with a cloudy medium, the opacification being a consequence of the deposition of myelin (Berliner, 1949b). The conversion of clear water clefts into opaque spokes takes several years, and many more usually pass before these, together with the lamellar separations which result in cuneiform opacities, lead to the intumescent or immature stage of cataract. These changes are exceptional in the earlier decades of life. Pfeiffer (1921) found that in 111 cases, 28% of those about 50 years of age, and 37% of those older, showed water clefts.

The opacities in question are shaped like a wedge, with the base situated peripherally. They should not be confused with those of coronary cataract, which are club-shaped, with the broader part centrally. They are readily distinguished from superficial radial striae which are linear and not wedge-shaped, and form a regular ring or wreath concentric to the pupil. The water cleft opacities are quite irregular in their distribution and only form a wreath when they are very numerous. Slit-lamp microscopy carried out on some of the most marked cases showed that the spokes were located usually in both the anterior and posterior cortex, and appeared to be subcapsular in position. However, Vogt (1930–31) drew attention to an optical illusion which makes them seem to be more superficial than they really are. It is indeed unlikely that they are truly subcapsular in these children as this would indicate that even the youngest and most active fibres were disintegrating. If this were so the process would be a most rapidly advancing one and impairment of vision would occur at

an early age. Nevertheless, if this very high incidence of lens opacities in young children is related to the eventual development of cataract in later years, it may constitute evidence in favour of the widely-held belief that cataract occurs at an earlier age in the tropics than it does in some other parts of the world.

### Mvumi: General Population

*Nutritional status.*

Apart from vitamin A deficiency there was almost no evidence of nutritional deficiency disease in the general population. Supporting evidence for this was obtained from the C.M.S. hospital at Mvumi where kwashiorkor admissions are uncommon and other deficiency states are distinctly rare. Severe microcytic anaemia in babies is very common here, as in other parts of Tanganyika and Africa as a whole, but the aetiology is probably not purely nutritional.

*Eye examination.*

No attempt was made to assess the incidence of blindness, apart from the numbers of those who could not count fingers at a distance of 1 metre given in Table IX. Many more would have had vision less than 3/60, the definition of blindness used in Great Britain, and many more again were totally blind in one eye.

Arcus senilis was very common in the older adults, seen mostly in those judged to be over 40 years of age. Some workers have described what they call a "pre-senile arcus senilis" in children and young adults. This was not observed at all, and I wonder whether they were really seeing peripheral corneal scarring of inactive trachoma.

Keratomalacia and xerosis conjunctivae and corneae showed the well-known tendency to occur more commonly in boys than in girls (Birnbacher, 1928; Oomen, 1958). Also confirming previous investigations was the greater prevalence in the younger age groups with the more severe keratomalacia being confined to babies and toddlers. Besides the six cases of keratomalacia seen during the survey I also examined three babies admitted to hospital at Mvumi who also were partially or totally blind from this cause. On a previous visit to the hospital in 1958 I had seen two other cases, both with xerosis corneae.

In the Wilson Carlyle school for the blind, situated about 20 miles from Mvumi, and at the Training Centre for the Blind at Kazima, near Tabora, I found several boys, natives of Central Province, who, from their history and the appearance of their eyes, had become blind during early childhood as a result of keratomalacia. It must be remembered that deficiency of vitamin A sufficiently severe to cause blindness also frequently results in death and only from amongst the survivors will blind schools draw their inmates. The prevalence of blindness due to vitamin A deficiency in this part is evident, and its aetiology is probably a combination of factors. Work still in progress (McLaren, unpublished observations) shows that liver stores of vitamin A in African babies at birth are often very low or even absent. Breast milk is not a good source of the vitamin (approximately 200 i.u./100 ml.) and in malnutrition the concentration may be very low indeed (Meulemans and de Haas, 1936). Breast feeding, sometimes without any supplementation, and usually with supplements containing neither vitamin A nor carotene, is frequently prolonged (an average of 14 months in Mwanza —McLaren, 1960b). Weaning is often abrupt and on to unsuitable foods, resulting in intestinal upsets, and this may be the final step in a long train of events leading to keratomalacia.

Quite unlike the vitamin A deficiency signs, pinguecula and the conjunctival pigmentations showed an increase in incidence with age, providing good evidence that they are not related to vitamin A, or probably any other deficiency state, but rather that they result from local irritation and minor trauma.

In Ugogo, trachoma is a disease usually acquired during childhood (Table IX), and in many instances undergoing spontaneous regression. The evidence for the latter part of this statement is the common finding of Herbert's pits in an otherwise normal eye. Thygeson (1958) states that these are strictly pathognomonic of trachoma, that they persist throughout life, and that their diagnostic importance cannot be over-emphasised. The breaking up of the continuity of the upper limbal pigment ring in these people made identification very simple. Shortage of water with consequent poorer personal hygiene, together with drier and dustier conditions, probably accounted for the high incidence in Ugogo as compared with Usukuma.

Pterygium rarely encroached on the papillary area, but in two adults it had completely traversed the cornea in both eyes, resulting in total blindness.

Finally, the high incidence of cataract in adults at Mvumi calls for some comment.

While only three were blind from this cause, a further ten had mature cataract in one eye, and as many as 42 more had immature cataract in one or both eyes. The ages of these people are not known, but most appeared to be "middle aged" rather than really old. Such early clinical evidence of so-called senile cataract is consistent with the high incidence of water clefts in the lenses of the school children. Whether infantile malnutrition is responsible can only be shown by further research.

As might be expected, the commonest infecting organism on conjunctival smear was *H. conjunctivitidis*, the cause of muco-purulent conjunctivitis. *H. lacunatus*, the cause of angular conjunctivitis, was not commonly found. Morphologically the inclusion bodies of inclusion conjunctivitis cannot be distinguished from those of trachoma, and in the absence of corneal involvement these two diseases cannot be differentiated. There might have been more instances of trachoma if scrapings had been taken.

## Summary

Clinical nutritional and eye examinations were carried out on large numbers of primary school children in two areas of Tanganyika. While the present dietaries of the two places are similar, the children at Mvumi have lived through a famine which occurred when most of them were in the susceptible pre-school age period. As the eye develops rapidly during early life it was thought that this organ might be especially liable to show stigmata as a result of malnutrition during this period.

Apart from a few with eye signs of vitamin A deficiency at Mvumi, there was little evidence of active malnutrition. Pyorrhoea alveolaris was very common at Mvumi and rare at Mwanza, whilst dental caries was common at Mwanza and rare at Mvumi. Depigmentation of the hair, enlargement of the parotid glands, and angular lesions of the lips were common in both areas and their significance and that of other signs recorded is discussed. At Mvumi heights and weights were lower and the general appearance was poorer.

Seven eye signs which are commonly employed in nutritional surveys were recorded and their nature, aetiology and relationship to malnutrition are considered. It is concluded that none of them, including Bitot's spots, can be regarded as an indubitable sign of a specific deficiency, apart from the advanced conjunctival and corneal changes of vitamin A deficiency.

Eye disease, especially trachoma, corneal scars and strabismus, was much more common in Mvumi children. Here too, there was a high incidence of refractive errors which were not seen at Mwanza. They consisted of mixed astigmatism, anisometropia, a wide scatter of the aberrations of emmetropia, and axial ametropia. At both places most children showed very early water cleft opacities in the periphery of the lens. All these new findings are considered in some detail.

More than 2,000 of the general population at Mvumi also received an external eye examination. The prevalence of eye disease in this area was confirmed, and new information about its nature obtained. Keratomalacia and purulent conjunctivitis cause much blindness in infants. Trachoma tends to regress spontaneously in many cases and rarely causes total blindness. In the older age groups cataract is common.

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## References

BALLETTO, G. M. (1954), *E. Afr. med. J., 31,* 459.

BELLOWS, J. G. (1944), *Cataract and Anomalies of the Lens,* p. 522. Kimpton, London.

BERLINER, M. L. (1949a), *Biomicroscopy of the Eye, 1,* 167, Hoeber, New York.

—— (1949b), *Ibid., 2,* 1114, Hoeber, New York.

BIRNBACHER, T. (1928), *Münch. med. Wschr., 75,* 1114.

BROCK, J. F., and AUTRET, M. (1952), *Bull. Wld. Hlth. Org., 5,* 1.

CLOSE, J. (1958), *Ann. Soc. Belge Méd. trop., 38,* 95.

Colonial Office (1948), *Blindness in British African and Middle East Territories,* H.M.S.O., London.

EDWARDS, D. A. W., HAMMOND, W. H., HEALY, M. J. R., TANNER, J. M. and WHITEHOUSE, R. H. (1955), *Brit. J. Nutr., 9,* 133.

FRAZIER, C. N., and HU, C. K. (1931), *Arch. intern. Med., 48,* 507.

GULLIVER, P. H. (1959), *Tanganyika Notes and Records,* No. 52, 61.

HOLM, S. (1937), *Les états de la refraction oculaire chez les Palénégrides. Acta Ophthal. Kbh.,* Suppl. XIII.

HORWITT, M. K. (1955), *Ann. N.Y. Acad. Sci., 63,* 163.

LOEWENTHAL, L. J. A. (1933), *Arch. Derm. Syph.,* N.Y., *28,* 700.

MCCANCE, R. A., DEAN, R. F. A. and BARRETT, A. M. (1951), *Studies in Undernutrition, Wuppertal, 1946-49. Spec. Rep. Ser. med. Res. Coun.,* London, No. 275.

MCKENZIE, A. (1939), *Trans. roy. Soc. trop. Med. Hyg., 32,* 717.

MCLAREN, D. S. (1955), *Health and disease in the Khond Hills, India; a Contribution to Global Epidemiology.* M.D. thesis University of Edinburgh.

—— (1960a), *Proc. Nutr. Soc. 19,* 89.

—— (1960b), *J. Pediat.* In the press.

MENON, P. S., TULPULE, P. G. and PATWARDHAN, V. N. (1950), *Indian J. med. Res., 38,* 173.

MEULEMANS, O., and DE HAAS, J. H. (1936), *Indian J. Pediat., 3,* 133.

NICHOLLS, L. (1933), *Indian med. Gaz., 68,* 681.

—— (1951), *Tropical Nutrition and Dietetics,* 3rd ed., p. 356. Baillière, Tindall and Cox, London.

Nutrition Survey of the Armed Forces of the Republic of Korea (1959), *J. Nutr., 68,* Suppl. 1.

Nutrition Survey of the Armed Forces of Pakistan (1959), *J. Nutr., 68,* Suppl. 2.

OOMEN, H. A. P. C. (1958), *Proc. Nutr. Soc., 17,* 8.

ORR, J. B. and GILKS, J. L. (1931), *The Physique and Health of two African Tribes. Spec. Rep. Ser. med. Res. Coun.,* Lond., No. 155.

PATON, D. and MCLAREN, D. S. (1960), *Amer. J. Ophthal.* In the press.

PENDSE, G. S. (1954), *Refraction and Body Growth. Ind. med. Res. Mem.* No. 38. Job Press; Kanpur.

PFEIFFER, C. E. (1921), *v. Graefes Arch. Ophthal, 106,* 71.

PHILLIPS, C. I. (1959), *Brit. J. Ophthal, 43,* 449.

POLLACK, H. (editor) (1956), *Symposium on nutrition: Studies on nutrition in the Far East. Metabolism, 5,* 203.

RAJAGOPAL, K. and CHOWDHURY, S. R. (1952), *Indian med. Gaz., 87,* 350.

RAOULT, A., THOMAS, J., THIERY, G., PERRIN, G. and PERRELLON, G. (1957), *Bull. méd. A.O.F. 2,* 5.

ROELS, O., DEBEIR, O. and TROUT, M. (1958), *Docum. Med. geogr. trop., 10,* 77.

SCRIMSHAW, N. S. (1958), *Fed. Proc.* 17. Suppl. 2, Part II, p. 133.

SIMMONS, K. (1944), *The Brush Foundation Study of Child Growth and Development II. Physical Growth and Development. Monograph of the Society for Research in Child Development, 9,* National Research Council, Washington, D.C.

SORSBY, A. (1928), *Bull. Jewish Hlth. Org.,* p. 1.

——, BENJAMIN, B., DAVEY, J. B., SHERIDAN, M. and TANNER, J. M. (1957), *Spec. Rep. Ser. med. Res. Coun.,* Lond. No. 293.

——, SHERIDAN, M., NOORES, N. and HAYTHORNE, J. (1955), *Lancet, ii,* 214.

THYGESON, P. (1958), *Trachoma Manual and Atlas. Jubl. Hlth. Serv. Publ.* No. 541, Washington.

VOGT, A. (1930-31), *Lehrbuch und Atlas der Spaltlampenmikroskopie des Lebenden Auges.* 2 vol. Springer, Berlin.

# Cholera in Calcutta during the Season of Prevalence, 1959

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## Introduction

Cholera is a grim disease which has been prevalent in India from remotest antiquity. The main endemic foci lie in the huge deltaic regions of the river Ganges; and Calcutta, the most infected city in the Indian peninsula, plays by no means a negligible part in the maintenance and spread of infection. Although there is usually a period of increased seasonal prevalence in April, May and June, the disease is maintained in the city by frank cases all the year round. As cholera has ceased to appear in pandemic form, the problem is crystallizing into an endemiological one, since the disease has now become largely confined to its classical endemic homes and adjacent territories.

In spite of advances in knowledge of the causal agent and methods of control, there are several gaps in our understanding of the disease, particularly with regard to social, cultural, economic and environmental factors which influence its spread.

The present study attempts to throw light on some of these factors and others that might play a role in maintaining the disease and the persistence of endemicity.