Trachoma in the Sudan

An epidemiological study

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The Sudan in its remote and recent history has been swept by epidemics of different diseases, some of which have taken a heavy toll of the population—malaria, yellow fever, Kala-azar, cerebrospinal meningitis, etc., are well-known examples of such diseases. When they occur every possible resource is made available for their control.

Trachoma is not as spectacular because it does not take away life, but it lurks in the community and many young and able adults have been blinded and incapacitated by it. Trachoma is the main cause of blindness in the Sudan, but there are others, such as onchocerciasis, bacterial conjunctivitis, and trauma.

The present report describes some data on the prevalence and distribution of trachoma which may help to explain its epidemiology in this part of the world.

Prevalence and distribution of trachoma

GEOGRAPHICAL DESCRIPTION

The Sudan is a vast plain covering nearly 2 500 000 km². It lies between latitude 21° 55' N and 3° 53' N, and longitude 21° 54' E and 38° 30' E (Fig. 1). The rainfall varies from 0 cm in the north to 152.4 cm a year in the south, producing areas of desert in the north and jungle in the south. In central Sudan, the rain falls mainly during a period of 4 or 5 months and the rest of the year is dry. Moving southwards, the period of rainfall becomes longer than in the north until, in the extreme south, it rains throughout the year.

Temperature shows great diurnal variations in the north, whereas further south the variation is less. This is possibly because of the increased rainfall and humidity, so that temperatures are almost constant throughout the year.

In northern Sudan, which is semi-arid, intense thunderstorms occur in the summer, bringing about strong winds that cause terrible sandstorms known as 'habubs', which cover everything with a blanket of dust.

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POPULATION

The Sudan is relatively sparsely populated with 13 000 000 people scattered over its 2½ million Km². The three southern provinces—Equatoria, Upper Nile, and Bahr El Gazal—are inhabited by people of negroid origin who have not mixed with the rest of the population. Central and northern Sudan are inhabited mainly by people of Arab origin. Each of these two groups has its own customs and beliefs.

SOCIOECONOMIC CONDITIONS

In northern Sudan, life is possible only along the banks of the Nile where the annual flood and irrigation schemes provide a stable and moderately prosperous agriculture. Central Sudan includes the great cotton-growing irrigated area between the Blue and White Niles, 'The Gezira', which is the

FIG. 1 Map of the Sudan

backbone of the economy. Permanent cultivation is otherwise impossible, except near the Ethiopian plateau in the east and the Marra Mountains in the west. The rest of central Sudan is dominated by nomads and semi-nomads. In the south, the people are primitive and live by rain-cultivation and cattle-breeding. Their cattle are of poor quality and not suitable for marketing; they are rarely slaughtered, except in celebrations (Barbour, 1961). Consequently, the people suffer from the multiple diseases of poverty such as malnutrition and tuberculosis.

PREVALENCE OF TRACHOMA

All cases of active trachoma in the Sudan, as well as admissions to hospitals of severe and complicated cases, are reported monthly by Province Ophthalmologists to the Division of Statistics, Ministry of Health. The records of the years 1959-69 having been made available to us, we analysed the data and the results are shown in Table I.

The highest incidence was in the Northern Province (see map), with a morbidity rate of 83.20 (per 1000). The next highest was Khartoum Province, immediately to the south, which had a morbidity rate of 66.87. South of Khartoum Province was the Blue Nile Province, the main cotton plantation centre, with a morbidity rate of 22.84. The three southern provinces, Upper Nile, Equatoria, and Bahr El Gazal, had the lowest incidence, the morbidity rate being 3.14, 0.94, and 0.23 respectively. As expected, the Northern Province and Khartoum Province had the highest numbers of severe and complicated cases, as judged by the annual admissions to hospitals: over 200 cases were admitted each year in each of these two provinces. This may be due to the high prevalence of the disease or, perhaps, to some other unknown factors such as bacterial superinfection, malnutrition, etc.

INCIDENCE OF TRACHOMA IN DIFFERENT AGE GROUPS

In order to see the age groups affected by trachoma and the different stages of the disease it was decided to examine children of up to the age of 15 years living in a highly endemic area, and for this the Northern Province was selected. The town of Atbara was the site of this investigation (Fig. 1).

Atbara is an industrial town and the centre of the Sudan Railways workshops. It has a population of about 50 000 and is supplied with clean, chlorinated water. The town is surrounded by villages, the inhabitants of which are mainly farmers, who have no supply of clean water and whose standard of hygiene is very low.

Children in the town of Atbara were examined for trachoma; Table II shows that 37.7 per cent of children under the age of 1 year in that town had developed trachoma. This prevalence increased until it reached 56.77 per cent in the age group 1-14 years.

The results of a similar study in the rural community are shown in Table III. It was noted that 48.3 per cent of children in rural communities became infected before the age of 1 year and that 71.3 per cent of children aged 1-4 years were infected with trachoma.

Factors influencing the prevalence and distribution of trachoma

In the Northern Province the morbidity rate was 83.20 and in Equatoria Province it was 0.94. In an attempt to find the reason for this high prevalence in the north and much lower prevalence in the south, various factors were examined:

Altitude

This appeared not to be of great significance, as the whole country is a vast plain with few mountains and hills.

Table I Mean annual incidence of active trachoma cases in the Sudan during 1959-1969*

Province	Total population	Mean annual cases	Morbidity rate (per 1000)	Mean annual admissions to hospital
Northern	1 066 000	88 490	83.20	208.8
Khartoum	633 000	42 321	66.87	204.4
Blue Nile	2 583 000	59 000	22.84	73.4
Darfur	1 625 000	13 268	8.16	64.5
Kassala	1 212 000	6611	5.45	40.5
Upper Nile	1 112 000	3489	3.14	51.5
Korodfan	2 196 000	8846	2.92	8.6
Equatoria	1 110 000	1045	0.94	8.3
Bahr El Gazal	1 239 000	288	0.23	0.8
Total	12 776 000			

*Data kindly supplied by Statistics Division, Ministry of Health, Sudan

Table II *Percentage of incidence of trachoma in children under 15 years* in urban areas: Atbara Town (Northern Province)*

Stage of trachoma	Age (yrs)		
	I	I-4	5-14
I	15.1	22.6	6.1
II	18.8	20.4	9.4
III	3.8	13.0	26.8
IV	0	0.7	10.7
Total	37.7	56.7	53.0

*Total number of children examined = 363

Table III *Percentage of incidence of trachoma in children under 15 years* of age in rural areas near the town of Atbara (Northern Province)*

Stage of trachoma	Age (yrs)		
	I	I-4	5-14
I	33.3	19.7	4.8
II	15.0	34.4	11.1
III	0	15.3	29.5
IV	—	1.9	21.7
Total	48.3	71.3	67.1

*Total number examined = 405

Table IV *Mean daily minimum and maximum temperatures in different parts of the Sudan during 1970*

Town	Province	Mean daily temperature (°C)	
		Minimum	Maximum
Atbara	Northern	21.4	37.5
Karima		20.5	38.0
Khartoum	Khartoum	21.6	37.7
Jebel Aulia		21.8	36.2
Kassala	Kassala	21.2	37.1
Port Sudan		23.6	33.5
Sennar	Blue Nile	20.0	37.3
Wad Medani		19.9	37.1
El Nahud	Kordofan	19.2	34.6
El Obeid		18.3	34.8
El Fasher	Darfur	16.6	35.6
Malakal	Upper Nile	20.9	35.0
Renk		20.2	35.5
Juba	Equatoria	20.6	34.6
Torit		19.4	34.4
Wau	Bahr El Gazal	20.2	34.8

Temperature

The daily variation in temperature is greater in the north than in the south. The mean daily maximum and the mean daily minimum temperatures at different meteorological stations in the

provinces are shown in Table IV. There was no great difference between the northern and southern areas, with the exception of one place in Darfur (El Fasher) where the mean daily temperatures were a little below that of other places, perhaps because of the neighbouring Marra Mountains.

When we examined the mean annual temperature throughout the country (Fig. 2), it was found that the mean annual isotherms were similar in the north and south.

Rainfall

This is the main variable element in the climate in the Sudan and is responsible for the fact that the Sudan is divided into several climatic belts, which run across the country from east to west, with barren deserts in the north, different types of savannah in the centre, and broad-leaved woodlands and forests in the south. The rainfall increases gradually from the north to the south. To determine whether there was a correlation between the prevalence of trachoma and the rainfall, the morbidity rate was plotted against the mean annual rainfall in each province. Fig. 3 shows that the morbidity rate fell as the amount of rainfall increased, except in the Blue Nile Province where, although the mean annual rainfall was high (437 mm), the morbidity rate was also high (22.84).

Relative humidity

Since the prevalence of trachoma was inversely related to the rainfall, with one notable exception, it was thought that the factor that affected trachoma

FIG. 2 *Map showing mean annual temperature*

FIG. 3 Rainfall and morbidity rates

was not the rainfall *per se* but rather the relative humidity. The mean annual relative humidity at a certain time of the day (8.00 am) was plotted against the morbidity rate. Fig. 4 shows that the latter fell regularly as the former increased until the morbidity rate was 0.94 per 1000 when the relative humidity was 75 per cent in Equatoria in the south.

Prevalence of bacterial conjunctivitis

Majčuk (1966) found that frank mucopurulent conjunctivitis was rarely seen in the north, but that the milder forms of conjunctivitis were more common, especially during the flood season (June–December), the highest incidence being reached in December (76.2 per cent) and the lowest in May (38.0 per cent). In central and northern Sudan, acute bacterial conjunctivitis was observed clinically, but no data were available.

FIG. 4 Humidity and morbidity rates

Fly density

It is unfortunate that there is no record of the density of eye-seeking flies in the Sudan, but the general opinion is that it is fairly uniform throughout the country. The factor favouring fly-breeding in the south is rotten fruit, especially mangoes and bananas. In northern and central Sudan, fly-breeding is encouraged by the use of pit and bucket latrines and by free-lying animal dung; the highest prevalence of flies occurs during the rainy season (June–October), (Nur, 1975)*.

Discussion

The most interesting finding was that, in the Northern Province and the Blue Nile Province, where cultural and religious traditions favour personal cleanliness and where there are settlement or irrigation schemes and a reasonably prosperous life, the incidence of trachoma was high. The average annual morbidity rates of active trachoma in 10 years in these two areas (as shown in Table I) were 83.2 and 22.84 per 1000 respectively. In the south, however, where there is a primitive community, bad personal hygiene, and poor socio-economic conditions, the prevalence of trachoma was low, the average annual morbidity rates being 3.12 in Upper Nile, 0.94 in Equatoria, and 0.23 in Bahr El Gazal. The difference in incidence between the north and the south was statistically significant ($P < 0.01$).

In an effort to explain this difference, many factors were studied. Altitude and temperature were excluded because the country is a vast plain and temperatures were generally equal in the north and the south (see map of annual temperature). It appeared that the factors which affected the prevalence of trachoma in the Sudan were the annual rainfall and the relative humidity, which are inter-related. The desert conditions in the north favour frequent high winds and strong sandstorms—'habubs'. These result in the bombardment of the eyes by small sand particles, producing *mechanical trauma* of the conjunctivae and rendering them susceptible to infection by trachoma agent. The area subjected to sandstorms extends from the northern province up to the Blue Nile Province, and this area has the highest incidence of disease (Table I). In the south, with its heavy rainfall, clay soil, and dense forests, there are no sandstorms.

On the other hand, a low humidity may produce a relatively dry eye that predisposes to trachoma infection, but this concept of the effect of humidity is not true in other parts of the world. MacCallum (1931) could not trace any definite relationship between the spread of trachoma and atmospheric

*Sudan Government entomologist

humidity in Egypt. In Iran, trachoma is hyper-endemic in a very humid area (Darougar, 1974).

Thygeson and Dawson (1966) believed that the high prevalence of trachoma in the desert is caused by lack of water and consequent poor personal hygiene. This may be the case, but we found that, in the town of Atbara in the north, which is supplied by piped and chlorinated water in adequate quantities, the incidence of trachoma in pre-schoolchildren (1-5 years old) was 56.7 per cent, and that in children of the same age group in the villages was 71.3 per cent; yet all these villages were on the bank of the Nile and there was no scarcity of water.

Conclusion

The high prevalence of trachoma in the north of the Sudan may be due to some or all of the following factors:

1. The frequent sandstorms that cause considerable and repeated ocular trauma may favour the proliferation of the trachoma agent. Hanna (1971) observed that the irritation caused by scraping the conjunctiva increased the amount of trachoma agent found 2-7 days later.
2. Irritation of the eyes by sand particles leads to frequent rubbing of the eyes with fingers, excessive watering and discharge in the eyes, and the possibility of contamination by the fingers and objects such as towels, handkerchiefs, etc.
3. The habit of frequent hand-shaking may favour transmission of the agent.
4. As in other parts of the Sudan, pre-schoolchildren rarely wash their hands and faces.
5. The occurrence of epidemics of bacterial conjunctivitis may enhance trachoma infection (Dawson, Daghfous, Messadi, Hoshiwara, Vastine, Yoneda, and Schachter, 1974; Vastine, Dawson, Daghfous, Messadi, Hoshiwara, Yoneda, and Nataf, 1974).
6. Eye-seeking flies are abundant in all parts of the

Sudan. Their possible role in the transmission of trachoma has yet to be established.

Summary

1. The prevalence and distribution of trachoma in the Sudan has been studied. The morbidity rate of 83.2 per 1000 in the Northern Province decreases southwards until it reaches 0.94 in the extreme south (Equatoria Province).
2. In endemic areas infection starts very early—in the first year of life.
3. There is a marked difference between the prevalence of trachoma in towns and villages—71.3 per cent for the age group 1-4 years in villages, and 56.7 per cent for the same age group in the towns. This is probably due to better standards of living and hygiene in the towns.
4. Some relationship has been found between the rainfall, the relative humidity, and the incidence of trachoma, but this does not necessarily apply in other countries.
5. The factors that may explain the high prevalence of trachoma in the northern Sudan are:
 - a. Mechanical trauma caused by frequent sandstorms.
 - b. Irritation of the eyes by dust particles, leading to excessive watering and discharge, and rubbing with the fingers.
 - c. The habit of frequent hand-shaking.
 - d. Poor personal hygiene in pre-schoolchildren.
 - e. Associated bacterial conjunctivitis.
 - f. The presence of eye-seeking flies.

We wish to thank Dr Omer El Baghir, Head of the Department of Statistics, Ministry of Health, and Dr Munier Beirum for the data on the prevalence of trachoma. We are also grateful to the officials in the Meteorological Department, Ministry of Communications and Transport, for the information on the climate in the Sudan.

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