Bull. Org. mond. Santé
Bull. Wld Hlth Org. } 1968, 39, 547-566

Sampling Studies on the Epidemiology and Control of Trachoma in Southern Morocco

K. KUPKA,[1] B. NIŽETIČ [2] & J. REINHARDS [3]

Mass-treatment campaigns against trachoma and seasonal conjunctivitis, using chlortetracycline ointment, were started in 1952 in parts of southern Morocco. This paper reports the results of a survey carried out between 1962 and 1965, under the auspices of the Moroccan Government, WHO and UNICEF, to evaluate the effects of the mass-campaign.

The survey assessed the prevalence, gravity and frequency of complications of trachoma by ophthalmological examinations, conducted in the home, and the results are compared with data published elsewhere which were obtained before treatment started in the 1950s in parts of the study area. Additional studies were made of the relation between trachoma and the availability and use of water, and between the prevalence of trachoma in females and their exposure to infection.

The over-all prevalence of trachoma was unaffected by the mass-treatment campaign but a larger proportion of the cases were at stage IV of the disease (healed). In one region, however, the prevalence of active cases (stages I–III) in the younger age-groups had decreased considerably. The occurrence of pannus decreased and while trichiasis decreased in children under 15 years of age, its prevalence increased in adults. This result may be important in planning future mass-campaigns.

INTRODUCTION [4]

Because of the high endemicity of trachoma and the regularly occurring seasonal epidemics of bacterial conjunctivitis in the south of Morocco collective treatment operations were commenced there in 1952, when broad-spectrum antibiotics became available, and these have since been extended on an ever-increasing scale. By 1960 almost the whole of the south had been covered. With the collaboration of the Government, WHO and UNICEF, Reinhards et al. (1959, 1968) conducted a series of clinical trials which proved the efficacy of the " intermittent treatment " schedule.[5]

A few authors have reported increased prevalence of trachoma in females (Bietti et al., 1962; Freyche, 1958; Nakamura, 1957). Such differences may disappear in countries with very high endemicity where everybody becomes infected.

Our observations in Morocco show that there is a higher prevalence of active trachoma, and particularly the grave cases, in women than in men and that loss of vision shows a similar difference. This difference appears early in life and seems to increase with age.

Since sex difference in host sensitivity to infection is unlikely, it would seem that environmental and behavioural factors are responsible.

The following observations, made by us during many years of daily contact with the population in their normal environment, have a bearing on this problem. They coincide with observations made by other ophthalmologists who have also had long experience in Morocco (Pagès, Decour, Trecolle and others). (1) The newborn female infant often receives less care than a boy, and thus may be more exposed to infection. (2) The young girl from about 5 years of age is often in full-time charge of her younger brothers or sisters whom she plays with and

[1] Medical Officer, WHO Epidemiology and Health Statistics Project, Rabat, Morocco; present address: Division of Health Statistics, World Health Organization, Geneva, Switzerland.

[2] Medical Officer, WHO Communicable Eye Diseases Project, Rabat, Morocco.

[3] WHO Regional Office for Europe, Copenhagen, Denmark.

[4] For general data on Morocco, its population, the communicable eye diseases problem and their control, as well as for bibliography, see Reinhards et al. (1968).

[5] The " intermittent " schedule consists of the local application of chlortetracycline ointment (1%) twice daily on 3–5 consecutive days per month for 6 consecutive months.

carries around on her back. Boys never have this duty and lead a more separate life. (3) The mother carries her newborn child on her back for a year or until the next one is born; then the older child is given to the care of a girl in the family.

The following observations about the eyes of young children have been made and confirmed in several surveys (Reinhards et al., 1968). They were infected early in life with acute and sub-acute bacterial conjunctivitis and remained infected for long periods throughout the year. All of them were also infected at an early age with an intensive form of trachoma and they presumably had large quantities of the TRIC agent present in the epithelium and in the discharge.

The eyes of young children, particularly if they are full of purulent or mucopurulent discharge, are constantly covered by a great number of flies and the number of flies seems to increase the more the children are grouped.

All this leads to the natural conclusion that the main source of bacterial and trachomatous eye infections in these areas is in the eyes of the younger children (between the ages of 6 months and 5 years) and that transmission by flies or otherwise occurs more easily to persons who are in a continuous and close contact with them.

Objectives of the study [1]

It has been claimed recently that the evolution of trachoma is modified following a mass-campaign, resulting in a shortening of the course of the disease, a decrease in the prevalence of active cases, the earlier appearance of scarring and a decrease in the complications and relative gravity of the disease. These claims have been made largely on the grounds of hospital and dispensary records and on personal impressions. Very few findings from the past can be used as a base-line for comparison, however, as, apart from the findings of geographically limited studies (Reinhards et al., 1968), reliable representative data are lacking.

The object of the present study was to describe the prevalence and gravity of trachoma and its complications in the most seriously affected regions of south Morocco, to compare the results with whatever data are available from the past and to evaluate the results of the control measures taken up to this time. The data may also provide a basis for evaluation of future evolution. A study was also undertaken of the reproducibility of the clinical investigation procedures used. In addition, we tried to investigate the influence of water resources and their utilization on the gravity of trachoma as well as to assess the effect of repeated and prolonged contact with an infecting source on the number of grave cases among females.

[1] Kupka (1965).

METHODS AND PROCEDURES

Sampling

For the trachoma survey a 2-stage sampling method was chosen as the most practical way of obtaining a reasonable specimen coverage over a scattered area with the minimal outlay of financial resources and personnel. Using the 1960 census, a plan was drawn up establishing 4 homogeneous [2] zones in the south, each consisting of about 100 000 inhabitants, corresponding wherever possible with administrative divisions. The geographical location of these zones is shown in Fig. 1. Zone A corresponded to the *cercle* [3] of Erfoud (Province of Ksar-es-Souk), adjacent to the southern limit of the experimental sector of Goulmima-Tinejdad; Zone B corresponded to the *cercle* of Zagora (Province of Ouarzazate), west of zone A; Zone C included the south-eastern parts of the *cercles* of Taroudant and Ouarzazate and was therefore partly in the Province of Agadir and partly in the Province of Ouarzazate, west of Zone B; Zone D corresponded to the *cercle* of Goulimine, in the southern part of the Province of Agadir between the Atlantic seashore and Zone C.

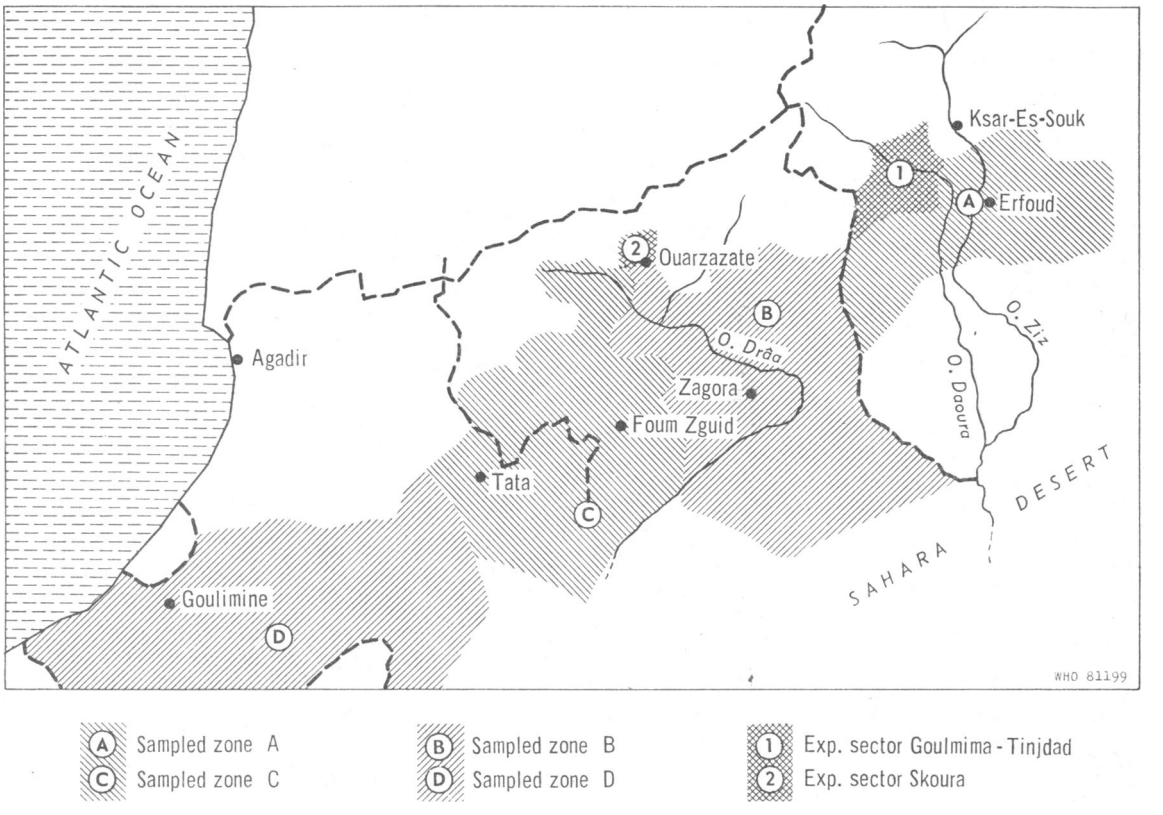
The villages in each zone were listed following the official village census list, and 10% (5% in Zone D because of the large number of villages) of these were selected at random. Owing to the wide variation in size of the villages, care was taken to include a fair proportion of larger and smaller ones, by making the selection separately from groups of large and groups of small villages. The official rural census thus provided the basis for the first stage of the sample. The selected villages were thereafter marked on a map.

An *ad hoc* census of the selected villages provided the basis for the selection of the second-stage sampling units. In each sampled village 10% of the

[2] The criteria of homogeneity were based on the following factors: climate, altitude, and general way of life of the population. The climate is of the pre-Sahara type; altitude was estimated by typical vegetation. The characteristics shared by all 4 zones were that they were palm-tree oases with sedentary rural populations.

[3] Administrative subdivision of a province.

FIG. 1
LOCATION OF SAMPLED ZONES AND EXPERIMENTAL SECTORS IN SOUTH MOROCCO



households [1] in Zones A, B, C and 20% of households in Zone D were randomly selected for examination. This resulted in a final sample of about 200 households or 1000 persons, since the average size of a household was about 5 persons.

Teams consisting of 2 health agents under 1 male public health nurse were sent to draw up simple street maps of all the villages selected and to make a census by households, recording the name of the head and number of the members of each household. Each house door was marked in paint with its census number, and this number was also marked on the map and the census list.

Family history

During the examination of randomly chosen households in Zone C, a trained interviewer who was attached to the medical team recorded the number of children with whom the women had lived in close contact during their childhood and their adult life. All women 40–45 years of age were interviewed in all sampled households. The length of contact with each child, expressed in years, was estimated separately, as best we could, for childhood and for adult life, basing the estimates on current local child-rearing practices and paying due regard to new births and deaths occurring during the period under investigation. There is always a tendency to underestimate rather than overestimate the number of children in the household, but these omissions would add further weight to any conclusions reached. The data were recorded on hand-sorted cards together with clinical data of gravity, and tabulation was made after manual processing. The observations were divided into several exposure classes by length of contact, separately for childhood, adult life, and for the 2 combined, enabling

[1] A household is defined as a group of people living together under one roof and using common resources of livelihood and was used rather than a " family " because of the very remote and complicated relationships often found.

us to determine the relative gravity of trachoma for each exposure class.

Water supply

An administrative clerk attached to the ophthalmological team also collected information on the distance of the households from the main supply of water used for drinking and other domestic purposes, and on the amount brought daily into the house in each sampled household. The distance was estimated by the clerk from the answers given and the information divided into classes of < 500 m; 500 m–1500 m; 1500 m–2500 m; and > 2500 m. All short distances and most medium distances were verified. The volume of water brought daily into a household was calculated from the number of containers of a special type used in that area which contained about 5 litres (their average volume was found in a preliminary study to vary by not more than half a litre). The *per capita* daily consumption was obtained by dividing the total volume by the number of household members. The answers were first recorded on a questionnaire and later transcribed on to hand-punched cards where coded clinical results were also recorded to simplify the establishment of correlations.

Medical examination

All members of the selected households were examined by the same ophthalmologist during a home visit. The households were notified of this visit beforehand, so that the maximum number of their members could be present.

Age estimation. In the absence of civil registration most people did not know their age, and this had to be estimated by the examining ophthalmologist from the person's general appearance. Mothers usually knew the age of their young children, even in months for those under 1 year, but after that they had often forgotten the exact age. Estimations were not too difficult for children, but were obviously increasingly difficult for adults.

Ophthalmological examination. The examinations were made by means of a simple binocular loupe, using artificial light when necessary. Field conditions did not permit the use of a slit-lamp. Where doubt existed, a second examination was made after an interval of a few days, or if necessary after a short period of treatment to eliminate bacterial infections. The results of the examination were classified according to the third report of the WHO Expert Committee on Trachoma (1962). A clerk recorded the clinical findings together with age and sex on IBM mark-sensing cards specially designed for such a purpose. Each card carried a code number to identify the person within the household, the household within the village, and the village within the zone. The data were processed and tabulated according to the model given in the third report of the WHO Expert Committee on Trachoma (1962).

Observer variation

Two ophthalmologists made the examinations in all the field trials in Morocco, Dr J. Reinhards from 1952 to 1958 and Dr B. Nižetič from 1960 onwards, and it was considered necessary to assess the observer variation both for the general measurements and for the clinical diagnoses.

Our investigation concerned the observer variation in (1) the estimation of the age of the examinees and (2) the classification of trachoma cases in MacCallan's stages. For this purpose, the 2 ophthalmologists, both with long experience of trachoma in Morocco, examined 100 children in a primary school, in December 1964, as well as 100 adults in the village of Aoufous, in Zone A.

One observer examined each class according to the usual procedure after the other had left. Later they both attended an assembly of the people to study a wider variety of ages and stages of the disease. Again each person was examined by both ophthalmologists at 2 independent examinations and the data were recorded on 2 cards. Thereafter, the observers re-examined the schoolchildren so that every child was examined 4 times during the same day. This procedure allowed the study of " intra-observer " as well as " inter-observer " variation.

Age estimation of the examinees. " Inter-observer " variation in age estimation was studied in the village population rather than the school, because of the uniform age-group of the schoolchildren, and the results are reproduced in Table 1. The degree of agreement, expressed as the diagonal total divided by the total number of observations, was 68%.

By reducing the number of age-groups and thus increasing their range (see Table 2), the proportion of agreement is increased to 86%. The age-groups used in this latter table are the ones which have been recommended by the WHO Expert Committee on Trachoma (1962) for the presentation of results and have been used throughout this study. The marginal totals exhibit greater agreement because many of the differences are compensated by similar under-

TABLE 1

CORRELATION TABLE SHOWING THE ESTIMATION OF THE AGE OF 100 VILLAGERS IN SOUTH MOROCCO, 1964, BY 2 DIFFERENT OBSERVERS

		Observer Y									
	Age-group (years)	< 1	1–4	5–9	10–14	15–19	20–29	30–39	40–49	⩾ 50	Total
Observer X	< 1	—	5	—	—	—	—	—	—	—	5
	1–4	—	10	—	—	—	—	—	—	—	10
	5–9	—	—	6	4	—	—	—	—	—	10
	10–14	—	—	—	4	2	—	—	—	—	6
	15–19	—	—	—	—	3	1	—	—	—	4
	20–29	—	—	—	—	4	8	4	—	—	16
	30–39	—	—	—	—	—	—	9	5	—	14
	40–49	—	—	—	—	—	—	2	11	1	14
	⩾ 50	—	—	—	—	—	—	—	4	17	21
	Total	0	15	6	8	9	9	15	20	18	100

or over-estimation by the observers. No significant bias was observed.

" Intra-observer " variation in age estimation was not studied because of the impossibility of each observer seeing the same village people twice.

Diagnosis of clinical stages of trachoma. The variation between observers was studied among 100 villagers as well as among 100 schoolchildren. For this, only the first examination done by each observer was taken into consideration. The variation within observers was studied only among schoolchildren because the villagers were seen by each observer only once. The likelihood of the examiners remembering individual cases was negligible, as the village examination was made between the 2 school visits.

TABLE 2

CORRELATION TABLE SHOWING THE ESTIMATION OF THE AGE OF 100 VILLAGERS IN SOUTH MOROCCO, 1964, BY 2 DIFFERENT OBSERVERS USING A SMALLER NUMBER OF AGE-GROUPS

		Observer Y						
	Age-group (years)	< 1	1–4	5–14	15–24	25–44	⩾ 45	Total
Observer X	< 1	—	5	—	—	—	—	5
	1–4	—	10	—	—	—	—	10
	5–14	—	—	14	2	—	—	16
	15–24	—	—	—	10	2	—	12
	25–44	—	—	—	2	25	2	29
	⩾ 45	—	—	—	—	1	27	28
	Total	0	15	14	14	28	29	100

TABLE 3

CORRELATION TABLE SHOWING VARIATIONS IN THE ESTIMATION OF THE CLINICAL STAGES OF TRACHOMA BY 2 DIFFERENT OBSERVERS AMONG 100 SCHOOLCHILDREN AND 100 VILLAGERS IN SOUTH MOROCCO, 1964

		Observer X							
	Trachoma stage	0	D	I	II	III F.[a]	III	IV	Total
Observer Y	0	2	—	—	—	—	—	—	2
	D	—	—	—	—	1	—	—	1
	I	1	1	2	2	1	3	5	15
	II	—	—	3	5	—	7	—	15
	III F.[a]	—	—	—	—	1	—	1	2
	III	—	—	5	6	14	44	15	84
	IV	7	—	1	—	6	15	52	81
	Total	10	1	11	13	23	69	73	200

[a] In all clinical trials such cases were classified as Category " X " or " Probable cure ": Presence of fine papillary hypertrophy or follicles non-pathognomonic of trachoma, but with no active corneal lesions; need for further observation or investigation (Reinhards et al., 1959).

The results of variation between the 2 observers (Table 3) show that the agreement between the 2 observers was 53%. When stages 0 and D, and stages II and III were combined the agreement was 73.5%; when cases were merely divided into non-active (0+D+IV) and active (I, II and III), the agreement reached 77%.

The results of studies on " intra-observer " variation are reproduced in Table 4.

The degree of agreement between the 2 examinations by observer X amounted to 67%, and when stages 0 and D, and stages I, II and III were combined, the proportion of agreement rose to 77%. For observer Y the respective results were 64% and 81%. By simplifying the classification into 2 groups, stages I, II and III (active cases) and stages 0, D and IV (trachoma free, doubtful and healed cases), the degree of agreement reached 82% and 81% for observers X and Y respectively. This last method of classification was used in estimating the prevalence of trachoma in the sampled population in this study.

Gravity and complications. Only the village population was studied because the schoolchildren were too young to include severe cases in the sense of the nomenclature of the WHO Expert Committee on Trachoma (1962). Among 100 people examined, 30 were classified as severe by observer X, compared with 20 by observer Y. On only 15 cases was there agreement between both observers. The proportion of agreement reached 80%, however, if presented in the conventional way, i.e., diagonal over marginal total.

Discussion of observer variation. From the above results it can be seen that the proportion of agreement between 2 examinations by the same observer (intra-observer variation), as well as 2 examinations by different observers (inter-observer variation) was very similar. Some disagreement is to be expected in cases where the procedures depend more on personal judgement than on objective measurement, but these results compare favourably with findings in other fields of clinical medicine. Comparisons of marginal totals exhibit much smaller differences, since over- and under-estimations at each examination compensate each other, thus demonstrating the absence of important bias. The detailed classification of the WHO Expert Committee on Trachoma (1962) may be more difficult to apply under field conditions than in a place with hospital facilities. So as not to mask real differences it would seem preferable to simplify the classification of cases into broader groups, at least in mass surveys, to reduce the observer variation to a minimum. The achievement of better agreement in qualitative and quantitative estimation of symptoms is difficult and may

TABLE 4

INTRA-OBSERVER VARIATION IN THE ESTIMATION OF THE CLINICAL STAGES OF TRACHOMA AMONG 100 SCHOOLCHILDREN FOR 2 DIFFERENT OBSERVERS IN SOUTH MOROCCO, 1964

		Observer X							
	Trachoma stage	0	D	I	II	III F.	III	IV	Total
Observer X	0	4	—	—	—	—	—	2	6
	D	—	—	—	—	—	—	—	—
	I	—	—	2	—	—	—	1	3
	II	—	—	—	5	—	2	—	7
	III F.	—	—	—	—	2	3	5	10
	III	—	—	1	1	3	27	3	35
	IV	3	—	1	—	2	6	27	39
	Total	7	—	4	6	7	38	38	100

		Observer Y							
	Trachoma stage	0	D	I	II	III F.	III	IV	Total
Observer Y	0	—	—	—	—	—	—	—	—
	D	—	—	—	—	—	—	—	—
	I	—	—	—	1	—	6	1	8
	II	—	—	—	3	—	5	—	8
	III F.	—	—	—	—	—	1	—	1
	III	—	—	—	4	—	38	3	45
	IV	—	—	1	—	—	14	23	38
	Total	—	—	1	8	—	64	27	100

depend on how long the examiners have been trained together for this specific purpose. Investigations into this problem should be pursued.

RESULTS AND DISCUSSION

Census of sampled zones

Results of both the official and the *ad hoc* census, as well as sampling data pertaining to the 4 zones, are shown in Table 5.

Of the 41 selected villages 3 had to be replaced in zone B, 1 because it could not be reached at the time owing to floods, and 2 others because they could not be located. One village in zone C was replaced because of the uncooperative attitude of the civil authorities. The replacements were selected at random from villages of comparable size.

In general, attendance was very good; but in order to obtain this high attendance, all villages had to be visited twice and some of them several times. Most of the non-attendance was due to permanent or seasonal migration.

The discrepancies observed in the population figures between the official census and the *ad hoc* census may be due either to errors in the official census or, more likely, to changes that had occurred between the 1960 official census and the *ad hoc* census. A comparison of the sex and age distribution of the sample in all 3 zones with that given by the 1960 official census shows that, apart from

TABLE 5
TOTAL POPULATION IN THE 4 SURVEYED ZONES AND DETAILS OF THE SAMPLE EXAMINED IN SOUTH MOROCCO, 1962–65

Zone	Number of villages			No. of households	No. of inhabitants	No. absent at examination
	with > 100 households	with < 100 households	Total			
Zone A						
Total population (official census)	59	203	262	18 945	104 604	—
1st stage sample (official census)	6	20	26	1 850	10 679	—
1st stage sample (*ad hoc* census)	—	—	—	1 784	10 495	—
2nd stage sample (*ad hoc* census)	—	—	—	178	988	—
Examined	—	—	—	178	964	24 (2.5 %)
Zone B						
Total population (official census)	51	363	414	22 084	124 348	—
1st stage sample (official census)	5	36	41	1 968	11 491	—
1st stage sample (*ad hoc* census)	—	—	—	1 637	10 537	—
2nd stage sample	—	—	—	166	940	—
Examined	—	—	—	166	936	4 (0.4 %)
Zone C						
Total population (official census)	35	308	343	18 519	89 163	—
1st stage sample (official census)	4	32	36	1 757	9 082	—
1st stage sample (*ad hoc* census)	—	—	—	1 788	9 333	—
2nd stage sample	—	—	—	182	877	—
Examined	—	—	—	182	870	7 (0.8 %)
Zone D						
Total population (official census)	29	897	926	21 186	100 275	—
1st stage sample (5 %) (official census)	2	46	48	1 313	6 111	—
1st stage sample (*ad hoc* census)	—	—	—	1 337	6 356	—
2nd stage sample (20 %)	—	—	—	269	1 277	—
Examined	—	—	—	269	1 243	32 (2.6 %)

differences due to the inaccurate estimation of age, most differences appear in the under-representation of persons under the age of 1 year, due to the reluctance of many parents to show young children to outsiders. The same discrepancy was also observed in the official census when compared with the United Nations model (United Nations, 1955). The under-representation of males between 15 and 44 years of age might be due partly to the migration of young males into urban areas for temporary work, and also to the tendency of males to wish to appear older than they really are: females usually wished to appear younger.

Prevalence of trachoma

Four zones have been investigated so far. Clinical findings on prevalence in zones A and B are shown in Table 6 and in zones C and D in Table 7.

TABLE 6

PREVALENCE OF TRACHOMA BY CLINICAL STAGES, BY AGE AND BY SEX IN ZONES A AND B

		< 1 year			1–4 years			5–14 years			15–24 years			25–44 years			⩾ 45 years			Total		
		M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total
Zone A																						
Total examined	No.	9	15	24	91	84	175	171	152	323	39	88	127	72	93	165	92	58	150	474	490	964
	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Tr 0	No.	5	2	7	5	3	8	4	4	8	—	1	1	—	—	—	—	—	—	14	10	24
	%	55.6	13.5	29.2	5.5	3.6	4.6	2.3	2.6	2.5	—	1.1	0.8	—	—	—	—	—	—	3.0	2.0	2.5
Tr I	No.	2	8	10	25	29	54	21	29	41	1	—	1	—	—	—	—	—	—	49	57	106
	%	22.2	53.3	41.7	27.5	34.5	30.9	12.3	13.2	12.7	2.6	—	0.8	—	—	—	—	—	—	10.3	11.6	11.0
Tr II	No.	2	5	7	60	52	112	105	84	189	3	6	9	—	—	—	—	—	—	170	147	317
	%	22.2	33.3	29.2	65.9	61.9	64.0	61.4	55.3	58.5	7.7	6.8	7.1	—	—	—	—	—	—	35.9	30.0	32.9
Tr III	No.	—	—	—	1	—	1	30	38	68	16	52	68	11	29	40	5	1	6	63	120	183
	%	—	—	—	1.1	—	0.6	17.5	25.0	21.0	41.0	59.1	53.5	15.3	31.2	24.2	5.4	1.7	4.0	13.3	24.5	19.0
Total actives (I+II+III)	No.	4	13	17	86	81	167	156	142	298	20	58	78	11	29	78	5	1	6	282	324	606
	%	44.4	86.7	70.8	94.5	96.4	95.4	91.2	93.4	92.2	51.3	65.9	61.4	15.3	31.2	24.2	5.4	1.7	4.0	59.5	66.1	62.9
Tr IV (healed)	No.	—	—	—	—	—	—	11	6	17	19	29	48	61	64	125	87	57	144	178	156	334
	%	—	—	—	—	—	—	6.4	4.0	5.3	48.7	33.0	37.8	84.7	68.8	75.8	94.6	98.3	96.0	37.5	31.8	34.6
Zone B																						
Total examined	No.	14	4	18	95	73	168	149	134	283	40	70	110	86	91	177	90	90	180	474	462	936
	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Tr 0	No.	5	2	7	1	1	2	1	—	1	—	—	—	—	—	—	1	—	1	8	3	11
	%	35.7	50.0	38.9	1.0	1.4	1.2	0.7	—	0.4	—	—	—	—	—	—	1.1	—	0.6	1.7	0.6	1.2
Tr I	No.	9	2	11	33	34	67	25	22	47	—	—	—	—	—	—	—	—	—	67	58	125
	%	64.3	50.0	61.1	34.7	46.6	38.9	16.8	16.4	16.6	—	—	—	—	—	—	—	—	—	14.1	12.6	13.4
Tr II	No.	—	—	—	59	36	95	58	63	121	—	3	3	1	2	3	—	—	—	118	104	222
	%	—	—	—	62.1	49.3	56.6	38.9	47.0	42.8	—	4.3	2.7	1.2	2.2	1.7	—	—	—	24.8	22.5	23.7
Tr III	No.	—	—	—	2	1	3	49	39	88	16	40	56	12	23	35	2	4	6	81	107	188
	%	—	—	—	2.1	1.4	1.8	32.9	29.1	31.1	40.0	57.1	50.9	13.9	25.3	19.8	2.2	4.4	3.3	17.1	23.2	20.1
Total actives (I+II+III)	No.	9	2	11	94	71	165	132	124	256	16	43	59	13	25	38	2	4	6	266	269	535
	%	64.3	50.0	61.1	98.9	97.3	98.2	88.6	92.5	90.5	40.0	61.4	53.6	16.1	27.5	21.5	2.2	4.4	3.3	56.1	58.2	57.2
Tr IV (healed)	No.	—	—	—	—	1	1	16	10	26	24	27	51	73	66	139	87	86	173	200	190	390
	%	—	—	—	—	1.4	0.6	10.7	7.4	9.1	60.0	38.6	46.4	84.9	72.5	78.5	96.7	95.6	96.1	42.2	41.1	41.7

TABLE 7

PREVALENCE OF TRACHOMA BY CLINICAL STAGES, BY AGE AND BY SEX IN ZONES C AND D

		< 1 year			1–4 years			5–14 years			5–24 years			25–44 years			⩾ 45 years			Total		
		M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total
Zone C																						
Total examined	No.	13	10	23	96	43	139	125	138	263	31	64	95	67	91	158	97	95	192	429	441	870
	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Tr 0	No.	8	5	13	16	4	20	5	5	10	—	1	1	1	2	3	—	—	—	30	17	47
	%	61.5	50.0	56.5	16.7	9.3	14.4	4.0	3.6	3.8	—	1.6	1.0	1.5	2.2	1.9	—	—	—	7.0	3.9	5.4
Tr I	No.	4	4	8	41	20	61	26	30	56	1	—	1	—	—	—	—	—	—	72	54	126
	%	30.8	40.0	34.8	42.7	46.5	43.9	20.8	21.7	21.3	3.2	—	1.0	—	—	—	—	—	—	16.8	12.2	14.5
Tr II	No.	1	1	2	38	17	55	34	45	79	1	2	3	1	1	2	1	—	1	76	66	14.2
	%	7.7	10.0	8.8	39.6	39.6	39.6	27.2	32.6	30.0	3.2	3.1	3.2	1.5	1.1	1.3	1.0	—	0.5	17.7	15.0	16.3
Tr III	No.	—	—	—	1	2	3	45	45	90	15	35	50	16	27	43	5	19	24	82	128	210
	%	—	—	—	1.0	4.6	2.2	36.0	32.6	34.2	48.4	54.7	52.6	23.9	29.7	27.2	5.2	20.0	12.5	19.1	29.0	24.1
Total actives I+II+III)	No.	5	5	10	80	39	119	105	120	225	17	37	54	17	28	45	6	19	25	230	248	478
	%	38.5	50.0	43.5	83.3	90.7	85.6	84.0	87.0	85.5	54.8	57.8	56.8	25.4	30.8	28.5	6.2	20.0	13.0	53.6	56.2	54.9
Tr IV (healed)	No.	—	—	—	—	—	—	15	13	28	14	26	40	49	61	110	91	76	167	169	176	345
	%	—	—	—	—	—	—	12.0	9.4	10.6	45.2	40.6	42.1	73.1	67.0	69.6	93.8	80.0	87.0	39.4	39.9	39.7
Zone D																						
Total examined	No.	19	13	32	127	115	242	157	166	323	28	93	121	61	158	219	132	174	306	524	719	1 243
	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Tr 0	No.	14	11	25	32	47	79	34	30	64	3	3	6	3	7	10	2	—	2	88	98	186
	%	73.7	84.6	78.1	25.2	40.9	32.6	21.7	18.1	19.8	10.7	3.2	5.0	4.9	4.4	4.6	1.5	—	0.7	16.7	13.6	14.9
Tr I	No.	4	2	6	51	43	94	43	48	91	1	1	2	—	4	4	—	—	—	99	98	197
	%	21.0	15.3	18.7	40.1	37.3	38.8	27.4	28.9	28.2	3.6	1.1	1.6	—	2.5	1.8	—	—	—	18.8	13.6	15.8
Tr II	No.	1	—	1	40	23	63	28	32	60	—	1	1	—	2	2	—	—	—	69	58	127
	%	5.2	—	3.1	31.5	20.0	26.0	17.8	19.3	18.6	—	1.1	0.8	—	1.3	0.9	—	—	—	13.1	8.0	10.2
Tr III	No.	—	—	—	4	1	5	35	41	76	10	32	42	2	36	38	4	19	23	55	129	184
	%	—	—	—	3.1	0.9	2.1	22.3	24.7	23.5	35.7	34.4	34.7	3.4	22.8	17.3	3.0	10.9	7.5	10.4	17.9	14.8
Total actives (I+II+III)	No.	5	2	7	95	67	162	106	121	227	11	34	45	2	42	44	4	19	23	223	285	508
	%	26.3	15.3	21.8	74.8	58.3	66.9	67.5	72.9	70.3	39.3	36.6	37.2	3.4	26.6	20.0	3.0	10.9	7.5	42.5	39.6	40.8
Tr IV (healed)	No.	—	—	—	—	1	1	17	15	32	14	56	70	56	109	165	126	155	281	213	336	549
	%	—	—	—	—	0.9	0.4	10.8	9.0	9.9	50.0	60.2	57.8	91.8	69.0	75.3	95.5	89.1	91.8	40.6	46.7	44.1

Trachoma was found to be almost universal in all 4 zones and in zones A, B and C the small fraction of trachoma-free (Tr 0) persons was in the very young age-groups; in zone D some trachoma-free people were also found among older children and adults. Everywhere the disease was acquired very early in life and its prevalence increased very rapidly with age. The first cases were found in 2- and 3-month-old infants (younger infants were rarely seen), usually earlier among girls than boys. Before they were 1 year old 50% were already infected and 95% were infected in the 1–4-year age-group; these proportions were generally reached somewhat sooner by girls than by boys (except in zone D). The greater frequency of cases among female infants might be ascribed either to differences inherent in sex or to sampling errors, but most probably it was due to the admitted neglect of girls in some tribes. Boys have a more privileged position in the family, and would be more readily treated if treatment were difficult to obtain. In zones A, B and C the prevalence of active cases was somewhat higher among females than among males in all age-groups. In zone D the opposite was found in children up to 4 years of age.

The beginning of the scarring process (stage III) occurred at about 3–6 years of age, in both males and females. At about 10 years of age 50% of the children had reached stage III, still with no significant difference between the sexes in any zone. From then up to the age of 45 years, active trachoma was more frequent in females than in males in each age-group. This could have been due to the fact that females remain in closer contact with infants and thus become frequently reinfected and are prevented from reaching stage IV (healed) (see pp. 562–564).

Stage IV was first observed between the ages of 5 and 11 years in zones A, B and C and earlier in zone D; it was usually seen earlier among boys than girls, and 50% of the sample reached this stage at about 25 years of age, again earlier in zone D and earlier for males than females. By 45 years of age, about 96% of males and 87% of females had reached stage IV.

The proportion of active cases (stages I, II and III) in the total population was calculated according to the method of Cochran (1963). The estimates, together with their 95% confidence intervals for the 4 zones, are presented in Table 8.

Thus, in zone A, for instance, the estimate of prevalence of active cases (stages I, II, III) was 63%, and the true unknown prevalence in the population lies between 59% and 67%, with 95% confidence.

TABLE 8

PREVALENCE ESTIMATES OF ACTIVE CASES[a] OF TRACHOMA IN THE 4 SAMPLED ZONES IN SOUTH MOROCCO, 1962–65

	Zone A	Zone B	Zone C	Zone D
Active cases (%)	63	57	55	41
95 % confidence limits (%)	59–67	54–61	51–59	38–44

[a] Stages I, II and III.

As can be seen from the confidence intervals, zone A had a significantly higher prevalence than zones C and D. While most of the physical factors of environment of the first 3 zones, such as climate, soil, etc., appear to be generally extremely similar, as are also the way of life, race and religion of the inhabitants, there is one geographical feature which, with its ecological consequences, differentiates zones C and D and might explain the differences in trachoma. Whereas in zones A and B the villages are clustered quite close together along the principal river running though each area, in zones C and D there are various smaller streams, each with a few villages strung out along them; the villages tend to be smaller as well as more widely scattered. Also, the proximity of zone D and a few parts of zone C to the Atlantic Ocean may improve the climatic conditions.

Although the prevalence of trachoma in the 4 zones might have been different before the mass-campaigns, the observed zone variation might also be due to the different impact of treatment during the mass-campaigns. There might have been differences in emphasis in the campaigns in the 4 zones, in their acceptance by the population or in the regularity of self-treatment within the family.

Unfortunately, the few data available on the past are of questionable reliability and comparison with the results of the present survey is difficult. The methods used in most of the previous work were not always indicated, geographical situations were often vague, and results were usually published as estimated ranges of prevalence, which could not be used to explain zone differences. The only studies described by Reinhards et al. (1968) which might eventually be used for comparison, are those from Skoura in 1952, adjacent to the north-east of our

sampling Zone C, and from Ouarzazate in 1953 included in our sampling Zone C. Even those studies are difficult to compare, but we may assume that units next to each other are likely to be similar, especially when ethnic as well as environmental conditions appear identical. The claim by most authors that trachomatous conditions were very much the same in all areas before mass-treatment started is of little value in comparative studies.

The prevalence of trachoma in the present survey is different from that found in the previous surveys of Reinhards et al. (1968). A number of children now escape infection for some time, particularly in Zone D. Unfortunately the under-representation of very young children in the sample prevents an accurate comparison with those observed recently in Skoura and Goulmima (Reinhards et al., 1968).

The total of active cases was also lower in our survey, varying from 41% to 63%, compared with 87% in Skoura and 92% in Ouarzazate in 1952 and 1953 respectively. This crude figure for prevalence may obviously be affected by sex and age distribution and may also vary with the prevalence of trachoma-free and healed cases (stages 0 and IV). Here, the difference appears mainly in the marked increase in the number of healed cases observed in the recent surveys. In the previous studies, only 8% (Ouarzazate) and 13% of healed cases (Tr IV) were registered as spontaneous cures compared with our findings of 35%–42% (first 3 zones) in 1960–64.

The observed approximately 3-fold increase in the number of cured cases may be considered as one of the most important features of the improvement in the situation, thanks to the mass-treatment effect. This finding is even more remarkable if consideration is given to the fact that the higher the endemicity, the greater the difficulty of obtaining a noticeable treatment effect; a possible reason being the increased likelihood of reinfection or the more pronounced degree of the infiltrative lesions. Unhappily in such conditions the intensity and regularity of treatment suffers; because of lack of personnel, only self-treatment could be organized in Morocco.

A study of the scarring process shows that the first cases of stage III start to appear at the time when the prevalence of active cases reaches its maximum (age-group 1–4 years) as found in earlier surveys. However, because a certain number of children now escape infection for a year or more it is possible that in some the cicatrization now starts earlier than before. A more detailed cohort study would possibly be needed to answer this question. Stage IV starts to appear in the school age-group (5–14 years). The surveys in the 1960s showed that stage IV was relatively much more important than in the earlier surveys. In the recent surveys 50% of the population reached stage IV at about the age of 25 years, a percentage never reached in any age-group in earlier surveys.

Relative gravity of trachoma in the sampled zones

An important distinction has been made between the *relative intensity* of trachoma—defined as the degree of activity of the disease in an individual case at a given time—and the *relative gravity* of trachoma—defined as the degree of disabling complications and sequelae, or of active lesions which, if untreated, will lead to disabling consequences.[1]

Data on relative gravity, grouped separately by the characteristics of the lesions, are given in Tables 9 and 10 for the 4 zones, and summarized in Table 11. Graphical presentation of the prevalence of grave cases by age and sex is attempted in Fig. 2.

The number of grave cases was consistently higher among females, and increased with age. The first severe cases appeared from 3 to 14 years earlier among females.

As shown in Tables 9 and 10, in zones A and B more than 7% and in zones C and D more than 2% of the total population suffered from trichiasis. An increase in prevalence with age was observed in all zones and in persons aged 45 years and over the rates reached between 6% and 26% for both sexes combined. Among females, trichiasis occurred earlier and about twice as frequently as in men, in all age-groups and in all 4 zones (Fig. 3).

Loss of vision

The recording of loss of vision and blindness is of great importance in any survey of communicable eye diseases. The presentation of data has to be made by age-groups and by sex. In all surveys made, loss of vision was recorded only in those cases with pathological signs which could have been caused by eye infections. However, it was virtually impossible to decide what proportion of the cases of

[1] Thygeson, P. & Maxwell-Lyons, F. (1961) *Trachoma: assessment of intensity and gravity.* In: *Report on the conference on the control of communicable eye diseases, Istanbul* (Unpublished document EURO-158.3, from the WHO Regional Office for Europe).

TABLE 9

PREVALENCE OF GRAVE LESIONS AND COMPLICATIONS OF TRACHOMA BY AGE AND SEX IN ZONES A AND B

		< 1 year			1–4 years			5–14 years			15–24 years			25–44 years			⩾ 45 years			Total		
		M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total
Zone A																						
Total trachoma cases I–IV	No.	4	13	17	86	81	167	167	148	315	39	87	126	72	93	165	92	58	150	460	480	940
	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
F_3C_1 or F_2C_2 or C_3	No.	—	—	—	—	—	—	2	1	3	—	9	9	6	23	29	20	21	41	28	54	82
	%	—	—	—	—	—	—	1.2	0.7	0.9	—	10.3	7.1	8.3	24.7	17.6	21.7	36.2	27.3	6.1	11.2	8.7
Trichiasis	No.	—	—	—	—	—	—	2	2	4	—	6	6	5	21	26	15	17	32	22	46	68
	%	—	—	—	—	—	—	1.2	1.3	1.3	—	6.9	4.8	6.9	22.6	15.7	16.3	29.3	21.3	4.8	9.6	7.2
Pannus ⩾ 4 mm	No.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	1	1
	%	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.7	0.6	—	0.2	0.1
Other central corneal opacities	No.	—	—	—	—	—	—	2	10	12	3	11	14	4	23	27	18	21	39	27	65	92
	%	—	—	—	—	—	—	1.2	6.7	3.8	7.7	12.6	11.1	5.5	24.7	16.4	19.6	36.2	26.0	5.8	13.5	9.8
Grave cases [a]	No.	—	—	—	—	—	—	4	12	16	3	17	20	11	33	44	30	26	56	48	88	136
	%	—	—	—	—	—	—	2.4	8.1	5.1	7.7	19.5	15.9	15.3	35.5	26.7	32.6	44.8	37.3	10.4	18.3	14.5
One-eyed	No.	—	—	—	—	—	—	—	3	3	1	4	5	1	4	5	4	5	9	6	16	22
	%	—	—	—	—	—	—	—	2.0	1.0	2.6	4.6	4.0	1.4	4.3	3.0	4.4	8.6	6.0	1.3	3.3	2.3
Blind	No.	—	—	—	—	—	—	—	—	—	—	—	—	—	4	4	1	5	6	1	9	10
	%	—	—	—	—	—	—	—	—	—	—	—	—	—	4.3	2.4	1.1	8.6	4.0	0.2	1.9	1.1
Zone B																						
Total trachoma cases I–IV	No.	9	2	11	94	72	166	148	134	282	40	70	110	86	91	177	89	90	179	466	459	925
	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
F_3C_1 or F_2C_2 or C_3	No.	—	—	—	—	—	—	2	1	3	2	9	11	8	19	27	17	34	51	29	63	92
	%	—	—	—	—	—	—	1.3	0.7	1.1	5.0	12.8	10.0	9.3	20.9	15.2	19.1	37.8	28.5	6.2	13.7	9.9
Trichiasis	No.	—	—	—	—	—	—	—	—	—	1	7	8	4	12	16	12	34	46	17	53	70
	%	—	—	—	—	—	—	—	—	—	2.5	10.0	7.3	4.6	13.2	9.1	13.5	37.8	25.7	3.6	11.5	7.6
Pannus ⩾ 4 mm	No.	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	1	1	1	1	2
	%	—	—	—	—	—	—	—	—	—	—	—	—	1.2	—	0.6	—	1.1	0.6	0.2	0.2	0.2
Other central corneal opacities	No.	—	—	—	—	—	—	4	2	6	1	6	7	12	12	24	15	31	46	32	51	83
	%	—	—	—	—	—	—	2.7	1.5	2.1	2.5	8.6	6.4	13.9	13.2	13.5	16.8	34.4	25.7	6.9	11.1	8.9
Grave cases [a]	No.	—	—	—	—	—	—	5	3	8	3	14	17	18	25	43	21	47	68	47	89	136
	%	—	—	—	—	—	—	3.4	2.2	2.8	7.5	20.0	15.4	20.9	27.5	24.3	23.6	52.2	38.0	10.1	19.4	14.7
One-eyed	No.	—	—	—	—	—	—	—	—	—	1	—	1	5	5	10	5	9	14	11	14	25
	%	—	—	—	—	—	—	—	—	—	2.5	—	0.9	5.8	5.5	5.6	5.6	10.0	7.8	2.4	3.0	2.7
Blind	No.	—	—	—	—	—	—	—	—	—	—	—	—	2	1	3	3	10	13	5	11	16
	%	—	—	—	—	—	—	—	—	—	—	—	—	2.3	1.1	1.7	3.4	11.1	7.3	1.1	2.4	1.7

[a] Total number of cases presenting one or more lesions: F_3C_1 or F_2C_2 or C_3, trichiasis, and central corneal opacities.

TABLE 10

PREVALENCE OF GRAVE LESIONS AND COMPLICATIONS OF TRACHOMA BY AGE AND SEX IN ZONES C AND D

		< 1 year			1–4 years			5–14 years			15–24 years			25–44 years			⩾ 45 years			Total		
		M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total
Zone C																						
Total trachoma cases I–IV	No.	5	5	10	80	39	119	120	133	253	31	63	94	66	89	155	97	95	192	399	424	823
	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
F_3C_1 or F_2C_2 or C_3	No.	—	—	—	—	1	1	2	8	10	1	6	7	4	9	13	8	22	30	15	46	61
	%	—	—	—	—	2.6	0.8	1.7	6.0	3.9	3.2	9.5	7.4	6.1	10.1	8.4	8.2	23.1	15.6	3.7	10.8	7.4
Trichiasis	No.	—	—	—	—	—	—	—	1	1	—	—	—	2	2	4	2	10	12	4	13	17
	%	—	—	—	—	—	—	—	0.7	0.4	—	—	—	3.0	2.2	2.6	2.1	10.5	6.2	1.0	3.1	2.1
Pannus ⩾ 4 mm	No.	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	1	1	1	1	2
	%	—	—	—	—	—	—	—	—	—	—	—	—	1.5	—	0.6	—	1.0	0.5	0.2	0.2	0.2
Other central corneal opacities	No.	—	—	—	—	—	—	1	—	1	—	1	1	1	1	2	7	12	19	9	14	23
	%	—	—	—	—	—	—	0.8	—	0.4	—	1.6	1.1	1.5	1.1	1.3	7.2	12.6	9.9	2.2	3.3	2.8
Grave cases [a]	No.	—	—	—	—	1	1	3	8	11	1	6	7	4	10	14	13	25	38	21	50	71
	%	—	—	—	—	2.6	0.8	2.5	6.0	4.4	3.2	9.5	7.4	6.1	11.2	9.0	13.4	26.3	19.8	5.3	11.8	8.6
One-eyed	No.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5	5	10	5	5	10
	%	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5.2	5.3	5.2	1.2	1.2	1.2
Blind	No.	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	1	2	3	2	2	4
	%	—	—	—	—	—	—	—	—	—	—	—	—	1.5	—	0.6	1.0	2.1	1.6	0.5	0.5	0.5
Zone D																						
Total trachoma cases I–IV	No.	5	2	7	95	68	163	123	136	259	25	90	115	58	151	209	130	174	304	435	621	1 056
	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
F_3C_1 or F_2C_2 or C_3	No.	—	—	—	1	—	1	2	4	6	2	8	10	2	16	18	11	36	47	18	64	82
	%	—	—	—	1.0	—	0.6	1.6	2.9	2.3	8.0	8.9	8.7	3.5	10.6	8.6	8.5	20.7	15.5	4.1	10.3	7.7
Trichiasis	No.	—	—	—	—	—	—	—	—	—	—	1	1	—	6	6	5	15	20	5	22	27
	%	—	—	—	—	—	—	—	—	—	—	1.1	0.9	—	4.0	2.9	3.9	8.6	6.6	1.1	3.5	2.6
Pannus ⩾ 4 mm	No.	—	—	—	—	—	—	—	1	1	—	—	—	—	1	1	1	8	9	1	10	11
	%	—	—	—	—	—	—	—	0.7	0.4	—	—	—	—	0.7	0.5	0.8	4.6	3.0	0.2	1.6	1.0
Other central corneal opacities	No.	—	—	—	—	1	1	1	1	2	—	2	2	2	6	8	6	16	22	9	26	35
	%	—	—	—	—	1.5	0.6	0.8	0.7	0.8	—	2.9	1.7	3.4	3.7	3.8	4.6	9.7	7.3	2.1	4.2	3.3
Grave cases [a]	No.	—	—	—	1	1	2	3	5	8	2	9	11	4	19	23	14	42	56	24	76	100
	%	—	—	—	1.0	1.5	1.2	2.4	3.7	3.1	8.0	10.0	9.6	6.9	12.6	11.0	10.8	24.1	18.5	5.5	12.2	9.4
One-eyed	No.	—	—	—	—	—	—	—	—	—	—	1	1	—	2	2	2	4	6	2	7	9
	%	—	—	—	—	—	—	—	—	—	—	1.1	0.9	—	1.3	1.0	1.5	2.3	2.0	0.4	1.1	0.89
Blind	No.	+	—	+	1	—	1	—	—	—	—	—	—	1	1	2	2	1	3	4	2	6
	%	—	—	—	1.0	—	0.6	—	—	—	—	—	—	1.7	0.7	1.0	1.5	0.6	1.0	0.9	0.3	0.5

[a] Total number of cases presenting one or more lesions: F_3C_1 or F_2C_2 or C_3, trichiasis, and central corneal opacities.

FIG. 2

DISTRIBUTION AND FREQUENCY OF GRAVE CASES BY AGE AND SEX IN THE 4 ZONES, 1962–65

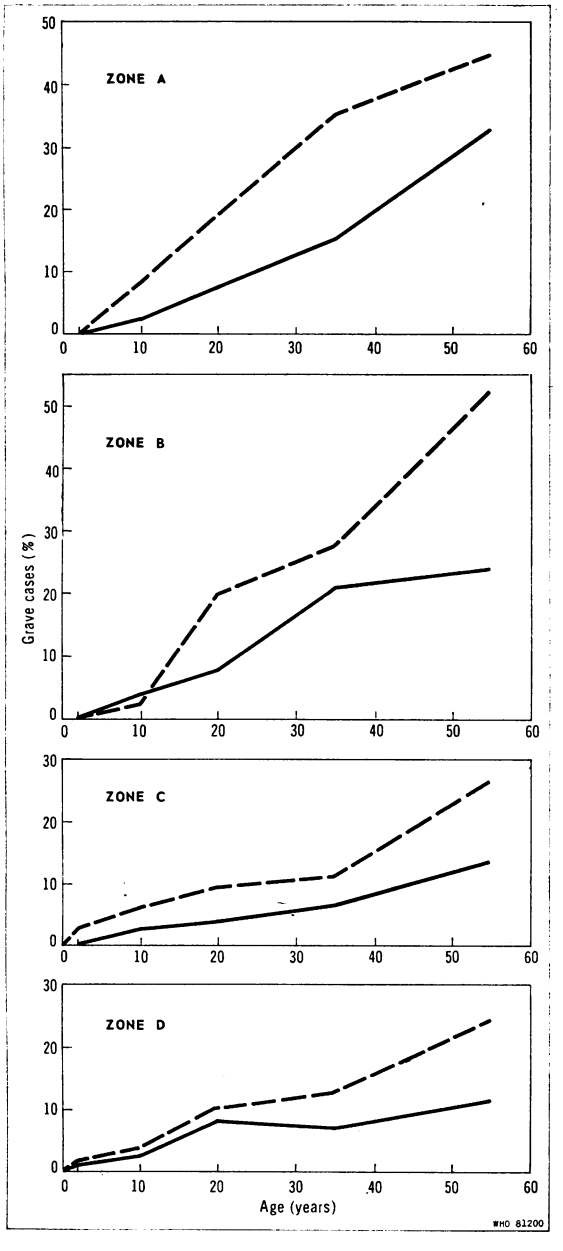


TABLE 11

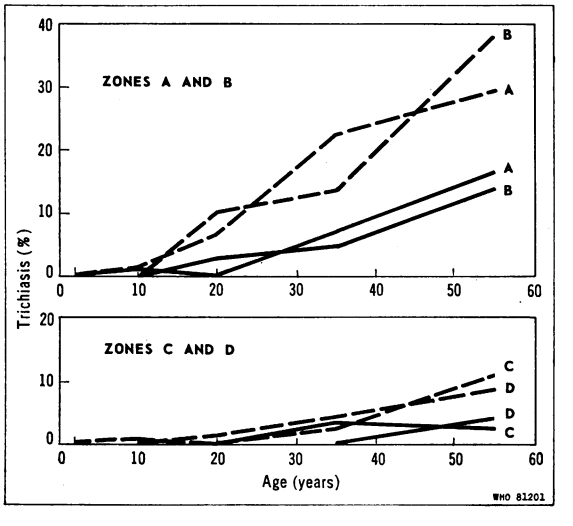
PREVALENCE OF GRAVE CASES (%) BY AGE AND SEX IN THE 4 SURVEYED ZONES IN 1962–66

Zone	Sex	Age-groups (years)					
		1–4	5–14	15–24	25–44	⩾ 45	Total
A	Males	—	2	8	15	33	10
	Females	—	8	20	36	45	18
B	Males	—	3	8	21	24	10
	Females	—	2	20	28	52	19
C	Males	—	2	3	6	13	5
	Females	3	6	10	11	26	12
D	Males	1	2	8	7	11	6
	Females	2	4	10	13	24	12

loss of vision were due to trachoma and what proportion to conjunctivitis. A number of typical pannus cases exist in which no circumscribed leucomata can be detected. Even in such cases the role of bacterial infection in the determination of the loss of corneal transparency cannot be evaluated. Also the presence of trachoma may play

FIG. 3

PREVALENCE OF TRICHIASIS, INCLUDING ENTROPION, BY AGE AND SEX IN THE 4 ZONES, 1962–65



a role in the origin of a leucoma but often this cannot be established with certainty.

Because definitions of blindness vary greatly from author to author and from country to country, it is difficult to compare differences or evaluate changes which may occur. The easiest group to delimitate includes the cases of total blindness, which can be defined as having no vision or not more than faulty light projection. The term " economic blindness " has been used for any degree of vision less than 20/200–5/200, but strict criteria cannot be followed in the examination of primitive communities in these natural conditions.

In this survey the finger-counting test was used where gross corneal opacities were present. The limit for economic blindness was taken to be 5/200.

Unfortunately this makes the comparison with older data impossible when 10/200 was set as the limit or only cases of complete blindness were counted.

Several other facts make comparability difficult: (1) In some southern tribes it is very difficult to see all blind adults for examination, even if they are known to be present in the household. (2) The survival rate of blind people may be lower than for the rest of the population of the same age. This has been observed even in developed countries and would make evaluation of changes in the blind rate and the rate of yearly new additions to the blind group extremely difficult.

In the zones A, B, C and D the number of economic blind in the sample was recorded as 1.1%, 1.7%, 0.5%, and 0.5% respectively, with higher rates among females than males in the first 2 zones and increasing with age (in retrospect we feel that the sample might have been too small to evaluate the blind rate correctly). Tables 9 and 10 show that those with one eye completely blind amounted to 1%–3% of the total with lowest rates in zones C and D. Here also the rates in females were higher than in men and increased with age.

Much higher rates of economic blindness were found in 1954 in the Goulmima experimental sector. This can be explained by the different standards applied to obtain a rough estimate of residual vision (in 1954, 10/200 was considered as the borderline).

A most striking feature was the almost complete absence of economic blindness in the younger age-groups in the 1962–65 surveys.

The relative absence of leucomata in younger persons who had lived most of their lives with self-treatment available may be explained by a maintained suppression of conjunctivitis in the whole population since 1953–55.

Difference in severity of trachoma in relation to sex [1]

We are aware that the method, described earlier, of collecting data by interrogation and linking this with clinical findings has many shortcomings when applied in a primitive community.

We are also aware of difficulties which arise in comparing data obtained in such " exposure classes " very different in numerical size. (In fact there were very few females in our sample who had had little or no contact with young children during their lives.)

Similar surveys are being continued and for the above reasons we propose to give the results of this study only to indicate the trends.

Interviews were obtained with 130 females between 40 and 45 years of age. The relation between the length of contact with an infected source of one or more young children during the woman's childhood, as well as during her adult life, and the prevalence of grave cases is reproduced in Table 12.

As can be seen from the column totals, the prevalence of grave cases increases with the number of years of contact during childhood, being 30% with no contact, 36% after 1–4 years' contact, and 45% after contact of 5–14 years. The linear trend was significant (at the 1% level) using the test procedure suggested by Yates (1948).

Similarly, an increase in the percentage of grave cases was observed with increased contact during motherhood as shown by the row totals. With no contact, 15% of grave cases was observed, increasing to 41% with contact of 15 years or more. Here, the increase in the percentage of grave cases was predominantly between those cases with no contact and those with 1–4 years' contact.

If the childhood and motherhood years of contact are combined (diagonal), the correlation is very similar for obvious reasons, increasing from 12% for no contact (either in childhood or motherhood) to 50% for maximum contact received in childhood and in motherhood.

A detailed analysis of the joint effect of childhood and motherhood contact on gravity would require greater numbers of observations and further studies may be useful.

In general, the data reported here have shown earlier onset and constantly higher prevalence of

[1] Kupka (1965).

TABLE 12

RELATION BETWEEN CHILDHOOD AND MOTHERHOOD CONTACT WITH AN INFECTIVE SOURCE AND PERCENTAGE OF GRAVE CASES OF TRACHOMA [a]

Contact during motherhood (years)	Childhood contact (years)							
	0		1–4		5–14		Total	
	No. examined	% Grave cases	No. examined	% Grave cases	No. examined	% Grave cases	No. examined	% Grave cases
0	8	12	5	20	—	—	13	15
1–4	10	40	6	33	1	0	17	35
5–14	49	33	28	36	6	50	83	35
⩾ 15	8	25	5	60	4	50	17	41
Total	75	30	44	36	11	45	130	34

[a] Among females 40–45 years of age in Zone C 1964–65.

active trachoma in females, with delayed healing and a markedly higher frequency of grave cases and complications (Vozza et al., 1964). Two factors seem to be involved in shaping the frequency and severity of trachoma: susceptibility and exposure.

Difference in susceptibility of the sexes was suggested by Bietti et al. (1962) who claimed that the conditions of exposure are similar for both sexes. However, a greater inherent susceptibility in the female sex would be somewhat exceptional, considering the findings in other diseases. Greater female susceptibility has been found in only a few infectious diseases such as whooping-cough, scarlet fever, diphtheria, dysentery, mumps and the common cold. Even then, the bias towards the female sex appears only in some age-groups, being non-existent or even reversed in others (Taylor & Knowelden, 1957).

In view of the observations presented, we are more inclined to favour the hypothesis of Freyche (1951). He ascribes the higher prevalence in females to greater and more frequent exposure to infection, due to social habits, at least in most of the countries where trachoma is prevalent. If differences in susceptibility do exist, they would be to a great extent confounded with large sex differences in way of life and environmental conditions [1]. These environmental differences are particularly evident in Morocco; not only are young girls less cared for than boys, but females usually have constant close association with young children throughout much of their lives. The risk of exposure is thus very high. Although the mother may at first be the source of infection to very young children (WHO Expert Committee on Trachoma, 1956) [2] with a prevalence of active cases among children close to 100%, one can easily speculate on the possibility of the mutual intensification of infection between mother and child reaching a vicious circle. In the absence of adequate acquired immunity the mother is unable to achieve spontaneous healing and remains in stage III of the disease. Higher rates of reinfection among females (Freyche, 1958) [3] and thus a prolonged course of the disease, increase the risk of severe lesions [4] such as conjunctival or corneal complications, and an early age of onset of trichiasis.

The results of our studies are consistent with the hypothesis that gravity of trachoma among females is mainly determined by the increased risk of reinfections; there were no indications whether

[1] Savic, D. & Popovic, M. (1958) *Epidemiological survey of trachoma conducted in the village of Martinci.* In: *Report of the European conference on trachoma control*, Dubrovnik, October 1958 (Unpublished document EURO-158, from the WHO Regional Office for Europe).

[2] See also: WHO Regional Office for Europe (1961) *Report of the conference on the control of communicable eye diseases*, Istanbul (Unpublished document EURO-158.3).

[3] See also: WHO Regional Office for Europe (1958) *Report of the European conference on trachoma control*, Dubrovnik (Unpublished document EURO-158).

[4] See: WHO Regional Office for the Eastern Mediterranean (1960) *Report of the conference on trachoma*, Tunis (Unpublished document EM/Trach.Conf./26).

TABLE 13

RELATION BETWEEN THE DISTANCE OF THE HOUSEHOLD FROM THE WATER SOURCE AND THE INCIDENCE OF TRACHOMA BY AGE-GROUPS IN ZONES A AND B, 1962–63

Distance from water source (m)	Age-group (years)							
	< 1		1–14		⩾ 15		Total	
	No. examined	% Incidence	No. examined	% Incidence	No. examined	% Incidence	No. examined	% Incidence
Active cases								
< 500	20	60	524	92	538	35	1 082	58
501–1 500	3	100	108	87	100	15	211	53
1 501–2 500	5	60	75	100	61	26	141	67
> 2 500	14	71	242	96	210	28	466	65
Total	42	67	949	93	909	25	1 900	60
Grave cases								
< 500	20	0	524	2	538	27	1 082	15
501–1 500	3	0	108	2	100	29	211	14
1 501–2 500	5	0	75	3	61	26	141	13
> 2 500	14	0	242	3	210	28	466	16
Total	42	0	949	3	909	27	1 900	14

superinfection or associated infections were to blame. The frequency of grave cases observed among females who have had no contact with siblings or their own children is 12.5% compared to the expected frequency of grave cases (by interpolation) in males of the same age-group, of 10% in zone C. This comparison strongly suggests that the susceptibility hypothesis is incorrect.

A study of the correlation between water supply and trachoma

Distance of household from the water source. An investigation was made of 343 families, out of 344, randomly selected in the first 2 zones. The relation between the distance from the water source and the frequency of active trachoma cases, as well as the prevalence of grave cases, is presented in Table 13.

Little correlation was found in the study of prevalence of active cases, but somewhat higher prevalence rates were observed for distances above 1500 m. The percentage of grave cases was very little higher for the households with the longest distance (>2500 m) to the water source.

Daily per capita *use of water.* The relation of water use to the prevalence of active cases, as well as the prevalence of grave cases, is shown in Table 14.

The prevalence of active cases was lower in the age-group 1–14 years with increased use of water. For the other age-groups no such evidence was found. However, because the age-group 1–14 years was numerically the most important one, the lower frequency of active cases with increased use of water was also found for the total population.

A higher prevalence of grave cases was associated with the lowest water consumption in all age-groups in which grave cases were found.

The proportion of water used for drinking and cooking purposes was not investigated but it was assumed that the amount consumed as intake was fairly constant in a given area and in a given season. It is very likely therefore that any additional amount would be used mostly for hygiene purposes and therefore would result in increased cleanliness. The information from Table 14 suggests some correlation between the water use and disease.

TABLE 14

RELATION BETWEEN THE *PER CAPITA* DAILY USE OF WATER, ESTIMATED IN LITRES, AND THE INCIDENCE OF TRACHOMA BY AGE-GROUPS IN ZONES A AND B, 1962–63

Volume of water (litres)	Age-group (years)							
	< 1		1–14		⩾ 15		Total	
	No. examined	% Incidence	No. examined	% Incidence	No. examined	% Incidence	No. examined	% Incidence
Active cases								
< 5	10	70	228	95	183	26	421	64
5–10	29	62	628	94	584	24	1 241	60
> 10	3	100	93	87	142	26	238	51
Total	42	67	949	93	909	25	1 900	60
Grave cases								
< 5	10	0	228	4	183	30	421	15
5–10	29	0	628	2	584	28	1 241	14
> 10	3	0	93	2	142	23	238	15
Total	42	0	949	3	909	27	1 900	15

Strangely enough, no correlation was found between the *per capita* use of water and the distance of the water source. One might conclude that the average amount used is a family characteristic, dependent more on the habits of cleanliness, and apparently unaffected by the distance the water has to be carried. Possibly, unless water is immediately available within the house, from a tap or a well, the distance from the house is not important.

Great caution should be applied in trying to draw any conclusions from this study, because of some confusing factors not taken into account in planning the study. For instance, we now realize that the transmission rate of communicable eye diseases in southern Morocco is usually higher in the larger and more crowded villages. In general such villages have developed only where a water supply is readily available near by. These and other factors should be taken into consideration in any future study of this type.

RÉSUMÉ

Un programme de traitement de masse du trachome a été lancé au Maroc en 1952; dès 1960, les opérations s'étaient étendues à la quasi-totalité du sud du pays. Pendant cette campagne, on a utilisé le traitement local intermittent, consistant en l'application locale d'une pommade à la chlortétracycline à 1%, deux fois par jour, pendant 3 à 5 jours consécutifs par mois durant 6 mois.

Au cours d'une enquête menée dans la région, de 1962 à 1965, sous les auspices du Gouvernement marocain, de l'OMS et du FISE, on s'est attaché à déterminer la prévalence du trachome, sa gravité et la fréquence des complications et à comparer, dans la mesure du possible, les observations faites aux quelques données recueillies vers 1950, avant le traitement. On a également recherché l'influence de certains facteurs de milieu, spécialement des ressources en eau et de leur utilisation, et les rapports existant dans le sexe féminin entre la prévalence et la gravité du trachome et les risques accrus d'exposition à l'infection.

On a procédé par sondage à deux degrés, l'unité du premier ordre étant le village, l'unité du second ordre la famille, au sens large du terme. L'échantillon de population final comprenait environ 4000 personnes, soit 1% de la population totale de la région. La collaboration des habitants a été très satisfaisante (99% de participation)

et on peut considérer l'échantillon comme représentatif en ce qui concerne la répartition par sexe et par groupes d'âge. Les résultats des examens ophtalmologiques ont été analysés pour faire ressortir les variations du diagnostic chez un même examinateur ou entre deux examinateurs. De même l'âge des habitants a été évalué par deux enquêteurs différents et les résultats de cette estimation ont été comparés. Dans tous les cas, une concordance satisfaisante a été notée.

Les examens ont montré que la prévalence globale du trachome à tous les stades (I à IV) était très élevée, atteignant selon les zones des taux de 84,9 à 98,9%. L'atteinte semble très précoce et la fréquence de l'affection augmente rapidement avec l'âge: 50% des infections surviennent avant 1 an et 95% des enfants de 1 à 4 ans sont trachomateux. L'apparition des cicatrices (stade III) se fait vers l'âge de 3 à 6 ans et 50% des enfants âgés de 10 ans sont au stade III. Vers l'âge de 45 ans, environ 96% des hommes et 87% des femmes ont atteint le stade IV. La proportion des cas actifs par rapport à l'ensemble des cas varie de 41 à 63%. La comparaison avec les rares données recueillies en 1952 et 1953 indique une proportion moindre de cas actifs et un taux de trachome guéri près de trois fois plus élevé pour l'enquête actuelle. Dans le sexe féminin, la gravité relative du trachome est toujours plus marquée et elle s'accroît avec l'âge; les cas graves apparaissent 3 à 14 ans plus tôt chez que les hommes. L'infiltration cornéenne importante (pannus $\geq$ 4 mm) s'observe dans 0,1 à 1% des cas et le trichiasis atteint, selon les zones, 2 à 7% de la population. Le pourcentage des cas de cécité (vision réduite à 5/200) varie selon les endroits de 0,05 à 1,7%.

L'étude de l'influence du sexe montre qu'en général les sujets de sexe féminin sont exposés à contracter l'infection plus précocement, ils présentent une plus forte prévalence de trachome actif, un taux moindre d'évolution vers la guérison et une tendance plus nette à la gravité et à l'apparition de complications. Selon les auteurs, ce phénomène est dû à un taux de réinfection beaucoup plus élevé chez les femmes et à des contaminations croisées à répétition entre les mères et les enfants. On n'a pu établir de corrélation nette entre la prévalence du trachome et la distance séparant l'habitation de la source d'approvisionnement en eau; cependant les indices de gravité sont généralement plus élevés lorsque cette distance est considérable. On a noté un plus grand nombre de cas de trachome actif ou grave si la consommation d'eau pour les soins d'hygiène était basse.

REFERENCES

Bietti, G. B., Freyche, M. J. & Vozza, R. (1962) *Rev. int. Trachome*, **39**, 113

Freyche, M. J. (1958) *The ecology of trachoma.* In: May, J. M., ed., *Ecology of human diseases*, New York, M.D. Publications, p. 21

Kupka, K. (1965) *A study of trachoma in villages of south Morocco*, Thesis, Pittsburgh

Nakamura, Y. (1957) *Rev. int. Trachome*, **34**, 93

Reinhards, J., Weber, A. & Maxwell-Lyons, F. (1959) *Bull. Wld Hlth Org.*, **21**, 665

Reinhards, J., Weber, A., Nižetič, B., Kupka, K. & Maxwell-Lyons, F. (1968) *Bull. Wld Hlth Org.*, **39**, 497-545

Taylor, I. & Knowelden, J. (1957) *Principles of epidemiology*, Boston, Little, Brown & Co.

United Nations, Department of Social Affairs, Population Branch (1955) *Age and sex patterns of mortality: model life-tables for under-developed countries*, New York (ST/SOA/Series A/22)

Vozza, R., Renna, V. & Felici, A. (1964) *Rev. int. Trachome*, **41**, 303

WHO Expert Committee on Trachoma (1956) *Wld Hlth Org. techn. Rep. Ser.*, **106**

WHO Expert Committee on Trachoma (1962) *Wld Hlth Org. techn. Rep. Ser.*, **234**

Yates, F. (1948) *Biometrika*, **35**, 176