Bull. Org. mond. Santé
Bull. Wld Hlth Org. } 1968, **38**, 189-195

Treponematosis in the Eastern Highlands of New Guinea

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Serological tests for treponemal disease were undertaken among the inhabitants of 10 census units in the Eastern Highlands of New Guinea. Many sera gave reactive results to some or all of the tests performed. To exclude biological false positive reactions the Treponema pallidum *immobilization (TPI) test was carried out on each serum, the results being taken to indicate the presence or absence of treponemal disease in the individual. Clinically, leprosy and malaria were rare and no cases of active yaws were seen. Some middle-aged people showed clinical evidence of old yaws infections. The prevalence of treponemal disease in the census units varied from 3.9 % to 79.2 %, males having a higher prevalence than females. The children under 15 years showed no serological evidence of treponemal disease in all but 3 units, in which the prevalence ranged from 14.3 % to 40 %. It is concluded that the treponemal disease involved was yaws. Special interest lies in the non-infected children and adults who have no relative cross-immunity from yaws in a country which is rapidly developing.*

In 1964–65, one of us (R. W. H.) investigated the disease *kuru* among the inhabitants of the Okapa subdistrict of the Eastern Highlands of New Guinea (see accompanying map). Many laboratory studies, including serological tests for treponemal disease, were started on these people. The tests were first carried out by Dr J. Tonge of Brisbane, who found that many of the sera gave reactive results to some or all of the serological tests performed. To exclude the possibility of biological false positive reactions, all the sera were then sent to the Institute of Clinical Pathology and Medical Research, Sydney, for repeat serological testing and for the *Treponema pallidum* immobilization (TPI) test.

The people in the treponemal survey all lived under similar conditions in scattered mountain villages at an altitude of 4500–6500 feet (1370 m–1980 m) in the Eastern Highlands of New Guinea. The languages spoken in the villages differed in some instances; however, the people studied all had similar dietary habits. A police patrol-post was first established in the area in 1951 but the region remained largely outside Administration control until 1956. Up to this time, the inhabitants indulged in intertribal and intervillage warfare, ritual killings, sorcery and cannibalism (Gajdusek & Zigas, 1959). A hospital was established at Okapa in the mid-1950s. Any information before then on the frequency of disease in the tribes must be largely conjectural. The area is now administered from the Okapa Patrol Post, established in 1954, which is in the centre of a region populated by tribes known to suffer from *kuru*. The sera discussed in this paper come from these tribes and their near-neighbours. For purposes of administration, the area has been divided into census units, 10 of which were included in this survey; 3 belonged to the South Fore language group, i.e., the Miarasa, Yagareba and Aï census units; 3 to the North Fore language group, i.e., the Opoiyanti, Keyonosa and Okasa census units; 2 to the Gimi language group, i.e., the Mino and Noveraisa census units; 1 to the Auyana language group, the Auyana census unit and 1 to the Keigana language group, the Afaru census unit (see accompanying map).

Every individual in each of these census units from whom serum was received had a complete clinical examination initially, with follow-up examinations at 6-monthly intervals over the next 2 years. At no time was clinical evidence of active yaws found. However, in some of the South Fore vil-

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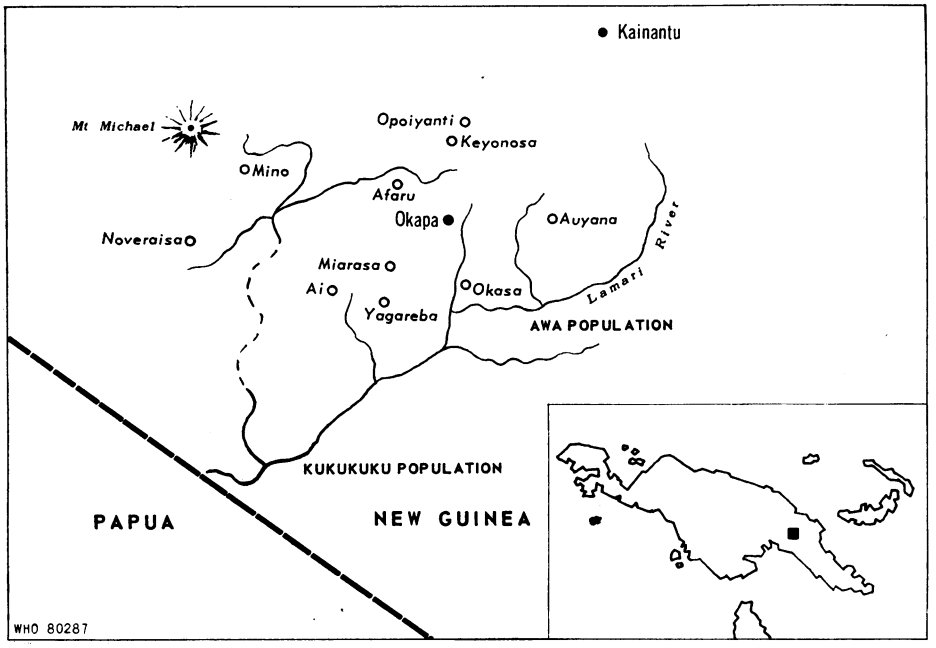
DISTRIBUTION OF CENSUS UNITS IN OKAPA DISTRICT OF THE EASTERN HIGHLANDS OF NEW GUINEA



lages, a number of middle-aged people had bowed tibia and facial deformities such as saddle noses, which were thought to indicate old yaws infections. No cases of venereal syphilis have been recorded in the region.

In the early stages of *kuru* investigations, penicillin was widely given and it was felt that by the end of 1958, 80%–85% of the people on the census records of each village had had injections of penicillin for one reason or another. It was reported (to R. W. H.) that in 1959–60, some cases of yaws were admitted to Okapa Hospital as well as some being seen in the Auyana people. Since 1960, no cases of active yaws have been reported.

No evidence of leprosy was found in the people examined and malaria was thought to be rare. However, earlier medical patrols in the area had found cases of leprosy and these were under treatment elsewhere. Gajdusek & Zigas reported in 1959 that leprosy and yaws were less common among the Fore people than in the surrounding tribes, who do not suffer from *kuru*, and that malaria is rare.

A total of 844 sera were collected from the inhabitants of the 10 main census units surveyed. A cardiolipin Wassermann reaction (CWR), a Reiter protein complement-fixation (RPCF) test, a Venereal Disease Research Laboratory (VDRL) test and a *Treponema pallidum* immobilization (TPI) test were performed on each specimen of serum. The results of the TPI test were used to indicate the presence or absence of treponemal infection in the tribes.

RESULTS

Results in total group studied

The prevalence of treponemal disease in the total population tested, as well as in relation to age-groups and sex is shown in Table 1.

Of the 844 sera tested, 247 gave reactive results to the TPI test, indicating that 29.3% of the population surveyed either have or have had a treponemal infection. Males accounted for 443 of the total group surveyed, with sera from 160 (36.1%) of them showing reactive TPI test results. Females made up 401 of the group, 87 (21.7%) of their sera being reactive to the TPI test. The children, aged 0–14 years, comprised 230 of the total group. Sera from 14 (6.1%) of them gave reactive results to the TPI test. Sera from both males and females also showed this 6.1% reactivity.

TABLE 1. RESULTS OF TPI TEST IN RELATION TO AGE AND SEX OF POPULATION STUDIED

Age (years)	No. of sera tested	TPI-reactive		Males			Females		
		No.	%	No. of sera tested	TPI-reactive		No. of sera tested	TPI-reactive	
					No.	%		No.	%
0-14	230	14	6.1	99	6	6.1	131	8	6.1
Total children	230	14	6.1	99	6	6.1	131	8	6.1
15-29	292	94	32.2	133	49	36.8	159	45	28.3
30-44	195	82	42.1	119	60	50.4	76	22	28.9
45-59	119	55	46.2	86	43	50.0	33	12	36.4
⩾60	8	2	25	6	2	33.3	2	0	0
Total adults	614	233	37.9	344	154	44.8	270	79	29.3
Total sera	844	247	29.3	443	160	36.1	401	87	21.7

These results reflect the prevalence of infection in the people tested, not necessarily in the population as a whole. The children, who have a low rate of infection, represent only 27% of the sera tested.

The population aged 15 years and upwards was considered adult; a total of 614 sera were received from people in this category, 37.9% of them being reactive to the TPI test. Sera from 44.8% of the males and 29.3% of the females gave reactive TPI test results. The adults were divided into four age-groups. The prevalence of treponemal infection, as indicated by the TPI test results, was highest in the 45–59 years group (46.2%), then in ages 30–44 years (42.1%), and in the 15–29 age-group it was 32.2%. Only 8 sera were received from the over-60 age-group. This was considered too small a number from which to draw valid conclusions in comparison with the other groups.

Sera from males in the age-groups 30–44 and 45–59 years showed the highest prevalence of reactive TPI test results (50.4% and 50.0%, respectively).

Results in relation to census units

Although the people in the census units lived under similar conditions in a comparatively small area of New Guinea, there was a marked variation in the serological evidence of the prevalence of treponemal disease. Table 2 shows the number of

TABLE 2. NUMBER AND PERCENTAGE OF TPI-REACTIVE SERA IN EACH CENSUS UNIT

Census unit	No. of sera tested	TPI-reactive		Males			Females		
		No.	%	No. of sera tested	TPI-reactive		No. of sera tested	TPI-reactive	
					No.	%		No.	%
Afaru	92	7	7.6	35	2	5.7	57	5	8.8
Auyana	72	57	79.2	32	28	87.5	40	29	72.5
Mino	127	5	3.9	53	1	1.9	74	4	5.4
Noveraisa	43	2	4.7	21	0	0	22	2	9.1
Opoiyanti	46	13	28.3	25	10	40.0	21	3	14.3
Keyonosa	60	13	21.7	31	8	25.8	29	5	17.2
Okasa	74	40	54.1	40	24	60.0	34	16	47.1
Miarasa	156	35	22.4	87	25	28.7	69	10	14.5
Yagareba	74	30	40.5	46	25	54.3	28	5	17.9
Ai	100	45	45.0	73	37	50.7	27	8	29.6

sera tested in each census unit, the number and percentage giving reactive TPI test results in each unit as well as in the males and females of that unit.

Sera from only 3.9% of the Mino were reactive to the TPI test, compared with 79.2% of the Auyana. In all but 3 of the census units, the percentage of males with serum giving reactive TPI test results exceeded females. These 3 units, the Mino, Noveraisa and Afaru, each had less than 8% of their total sera reactive to the TPI test. In 4 census units, the number of sera reactive to the TPI test exceeded 40% of the total sera tested in each unit—Auyana (79.2%), Okasa (54.1%), Ai (45.0%) and Yagareba (40.5%). In the Auyana, sera from 87.5% of the males and 72.5% of the females gave reactive results to the TPI test; the members of this census unit had the highest serological prevalence of treponemal disease, both as a total group and for males and females separately. Other units, apart from the Auyana, with more than 40% of their sera reactive to the TPI test, included, in males, the Okasa (60.0%), Yagareba (54.3%), Ai (50.7%), and Opoiyanti (40.0%), and in females, the Okasa (47.1%). The remaining census units, the Opoiyanti, Keyonosa and Miarasa, had between 21.7% and 28.3% of their sera showing reactive TPI test results.

Results in children 0–14 years of age

Sera were tested from 230 children in the 0–14 years age-group, of which only 14 were reactive to the TPI test, i.e., 6.1%. These 14 sera were 4 out of 13 from the Auyana, 6 out of 15 from the Okasa and 4 out of 28 from the Ai census units; in the remaining 7 census units, none of the 216 children's sera tested gave reactive TPI test results. Thus, children from the Auyana, Okasa and Ai census units had results to serological tests which indicated that they were suffering from treponemal infection. It is of interest that none of these children showed any clinical signs of the disease in the course of several examinations over 2 years. Guthe & de Vries [1] stated that the fluorescent treponemal antibody (FTA) test will detect nearly all early treponemal infections in a community. The FTA-200 test was performed on sera from 37 children, under 15 years of age, belonging to the Okasa and Ai census units. As the serological evidence of treponemal disease in the children in these groups was 40% and 14.3%, respectively, it was felt that perhaps some of the other children in the same group might have been developing early infections without clinical signs. If this were the case, the FTA-200 test should act as an indication of infection. However, in none of the tests performed did the result of the FTA-200 test differ from that of the TPI test.

Incidence of treponemal infection in language groups

As previously stated, the members of the 10 census units studied belonged to 5 different language-groups. The prevalence of treponemal disease in these language-groups, as indicated by the TPI test results, was 79.2% in the Auyana, 36.7% in the North Fore, 33.3% in the South Fore, 7.6% in Keigana and 4.1% in the Gimi (Table 3). From these results it would appear reasonable to assume that there is little fraternization between the various language groups despite their living in a moderately restricted area.

TABLE 3

PREVALENCE OF TREPONEMAL INFECTION, AS INDICATED BY TPI TEST RESULTS, IN EACH OF LANGUAGE GROUPS STUDIED

Language group	Census unit	No. of sera tested	TPI-reactive	
			No.	%
Keigana	Afaru	92	7	7.6
Auyana	Auyana	72	57	79.2
Gimi	Mino Noveraisa	170	7	4.1
North Fore	Opoiyanti Keyonosa Okasa	180	66	36.7
South Fore	Miarasa Yagareba Ai	330	110	33.3

Comparison of standard, Reiter and TPI test results

A comparison of the results of the CWR, VDRL, RPCF and TPI tests on sera from each census unit is shown in Table 4. As the result of the TPI test was taken to indicate treponemal infection, each of the other tests was compared with it. The results of the CWR agreed with those of the TPI test

[1] Guthe, T. & de Vries, J. L. (1966) *Surveillance reports. Epidemiological/serological evaluation of tropical yaws following mass penicillin campaigns (Thailand, Philippines, Nigeria)* (unpublished document WHO/VDT/66. 336). A limited number of copies of this document is available, to persons officially or professionally interested, on request to Venereal Diseases and Treponematoses, World Health Organization, 1211 Geneva, Switzerland.

TABLE 4
COMPARISON OF RESULTS OF CWR, RPCF AND VDRL TESTS WITH THE TPI TEST

Census unit	No. of sera tested	Reactive								
		CWR	RPCF	VDRL	TPI	In all 4 tests	CWR & TPI	RPCF & TPI	VDRL & TPI	TPI only
Afaru	92	6	14	6	7	6	6	7	6	—
Auyana	72	45	59	57	57	45	45	57	57	—
Mino	127	5	7	5	5	5	5	5	5	—
Noveraisa	43	2	2	2	2	2	2	2	2	—
Opoiyanti	46	12	13	11	13	11	12	13	11	—
Keyonosa	60	13	8	12	13	8	13	8	12	—
Okasa	74	28	36	35	40	28	28	36	35	4
Miarasa	156	31	38	35	35	31	31	35	35	—
Yagareba	74	26	23	30	30	23	26	23	30	—
Ai	100	33	42	36	45	33	33	42	36	3

in 3 census units and agreed in all but one test in each of 2 other units. The largest discrepancy in test results occurred with the RPCF test, agreeing completely with the TPI test results in only 2 census units. On the other hand, the VDRL test results showed agreement with those of the TPI test in 5 census units, and agreed in all but one test in each of 2 other units.

Kuru *patients*

Serum was received for treponemal serology from 25 patients suffering from *kuru*. This is a progressive cerebellar degeneration thought to be due to the action of one or more new environmental agents on a genetically susceptible population. It occurs in a small area of the Eastern Central Highlands of New Guinea and affects mainly people of the Fore linguistic group.

Of the 25 sera tested, 9 gave reactive results to reagin detection, RPCF and TPI tests; 1 serum was reactive to all tests except the TPI test; and the remaining 15 sera gave non-reactive results to all tests including the TPI test. Cerebrospinal fluid was tested from 17 of the *kuru* patients and all gave non-reactive results to the CWR, VDRL, RPCF and TPI tests.

Although the numbers tested are very small, there does not appear to be any relationship between *kuru*, a disease of the nervous system, and yaws or syphilis.

DISCUSSION

The treponemal disease studied in this survey was considered to be yaws. Endemic syphilis is largely a treponematosis of arid areas, whereas yaws occurs in moist, humid zones (Hackett, 1963), such as the Okapa district of the Eastern Highlands of New Guinea.

Guthe & de Vries (*op. cit.*) stated that infectious lesions in yaws, found on examination of a community, are only a fraction of the number of early infections in the population. No evidence of active yaws was found in any of the 844 people examined by us, although some of the older members of the Auyana and Fore had saddle noses and bowed tibia. Cases of yaws had been reported prior to 1960 in the Auyana.

The Auyana, Ai and Okasa villages, where the people were found to have the highest prevalence of reactive serology, are all situated closer to the Lamari River than are the other villages in the survey. On the opposite side of the river live the Awa and Kukukuku tribes, over which control was only established in 1963–65. One of us (R. H. W.) has heard from people who had been in the area descriptions which indicate that active yaws was frequently seen in these tribes up to 1965.

Although the Okapa district was largely explored and developed from Kainantu, about 60 km (37 miles) ENE of Mt Michael, it is possible that the people of the Gimi and Keiagana language

groups received some medical attention from early patrols from Goroka, about 40 km (25 miles) N of Mt Michael. This could account for the low prevalence of reactive serology in the Mino, Noveraisa and Afaru people, but unfortunately, no definite records could be found to confirm this.

Venereal syphilis was excluded, since none of the stigmata of congenital syphilis was seen in the children. One of us (R. H. W.) has had considerable experience of neurosyphilis and found no evidence of this condition in the adults. Specimens of cerebrospinal fluid tested gave non-reactive results to all the tests for treponemal disease. These findings are to be expected in yaws, in which the nervous system is not affected. The prevalence of treponemal infection in the males in our survey exceeded that in the females. Grin (unpublished data) stated that it is usual for there to be a slightly higher incidence of yaws in males than in females.

The discrepancy between the CWR and VDRL test results is a feature of serum reactions in yaws. The low complement-fixing antibody reactivity by the CWR results has been suggested by Guthe & Vries (*op. cit.*) to be a combination of different reactivity patterns in yaws as compared with syphilis, differences in test sensitivity related to stage and duration of infection, and smaller antigen particles in complement-fixation tests than in flocculation tests reacting differently with yaws serum. Yaws is an endemic treponemal disease of children under 15 years of age. None of the children in the 10 census units studied showed clinical signs of yaws, yet in 3 units they showed between 14% and 40% serological evidence of treponemal infection. Although penicillin was widely given through the area in various *kuru* investigations, some foci of active infection must exist in the Auyana, Okasa and Ai census units for their children to show reactive serology.

It is hoped to be able to follow these groups in future years. The children should be of special interest as they come from a primitive way of life with, as yet, limited contact with Europeans, in a country developing rapidly. Many of these children will become adults with no relative cross-immunity from yaws, as is possessed by older members of their tribes, against venereal syphilis. The adults of the 3 census units, Afaru, Mino and Noveraisa, with a prevalence of yaws of less than 8% are in a similar position to most of the children.

ACKNOWLEDGEMENTS

We would like to thank Dr F. R. Scragg, Director of the Public Health Department, Territory of Papua and New Guinea, for assistance and permission to publish this report, and Mr A. Nilsson, medical assistant for *kuru* research who gave willing assistance in the field-work. This paper is published with the approval of the Director-General of Public Health, New South Wales, Australia.

RÉSUMÉ

Les auteurs analysent les résultats d'une enquête sur les tréponématoses menée dans une zone montagneuse de l'est de la Nouvelle-Guinée où le *kuru* est fréquent. Les examens cliniques n'ont révélé aucune lésion pianique évolutive. Dans quelques villages, des traces d'anciennes infections pianiques ont été observées chez des personnes âgées. La pénicilline avait été largement employée dans cette zone au début des investigations sur le *kuru* et il semble qu'à la fin de 1958, 80 à 85% des habitants recensés de chaque village en avaient reçu des injections.

Des échantillons de sérum ont été prélevés sur 844 habitants des dix principales circonscriptions de recensement du district d'Okapa. Tous ont été soumis aux épreuves suivantes: Wassermann à la cardiolipine, VDRL, fixation du complément avec l'antigène protéique du tréponème de Reiter (FCPR) et TIT. Les résultats du TIT ont été pris comme critère de la présence ou de l'absence d'une infection tréponémique. Sur les 844 échantillons, 247 ont donné une réaction positive à ce test. Il apparaît donc que 29,3% des sujets étudiés étaient ou avaient été atteints d'une infection à tréponème. Les chiffres étaient de 36,1% pour l'ensemble du sexe masculin et de 21,7% pour l'ensemble du sexe féminin, mais de 6,1% seulement pour les enfants de moins de 14 ans des deux sexes. Sur 614 sérums d'adultes (15 ans et au-dessus), 37,9% étaient positifs, soit 44,8% chez les sujets masculins et 29,3% chez les sujets féminins. C'est dans le groupe d'âge 45-59 ans que le taux d'infection des adultes était le plus haut, alors qu'il était minimal dans le groupe 15-29 ans. Pour les dix circonscriptions considérées, la prévalence variait de 3,9% dans la circonscription de Mino à 79,2% dans celle d'Auyana. Le pourcentage des sérums positifs était plus élevé chez les hommes que chez les femmes dans

toutes les circonscriptions sauf trois (Mino, Noveraisa et Afaru) où le taux général n'atteignait pas 8%. De même, dans toutes les circonscriptions sauf trois (Auyana, Okasa et Ai), il n'y avait pas de cas positifs parmi les enfants de moins de 15 ans, alors que la prévalence chez les adultes allait de 3,9% à 40,5%.

D'une comparaison avec les résultats des trois autres épreuves (Wassermann à la cardiolipine, VDRL et FCPR, il ressort que les chiffres les plus proches de ceux qui précèdent ont été obtenus avec le VDRL. Les auteurs exposent ensuite les résultats d'épreuves pratiquées sur 25 échantillons de sérum et 17 échantillons de liquide céphalo-rachidien provenant de malades atteints de *kuru*. Ils indiquent les raisons qui incitent à penser que la tréponématose en cause est le pian. La syphilis endémique est largement répandue dans les zones arides, tandis que le pian sévit dans les régions à climat humide comme le district d'Okapa. La syphilis vénérienne doit être exclue, puisqu'il n'a pas été observé de signes de syphilis congénitale chez les enfants ni de signes de neurosyphilis chez les adultes.

Les enfants et les adultes non infectés posent un problème particulier dans ce pays qui se développe rapidement et établit de plus en plus de contacts avec le monde extérieur. A la différence de beaucoup des membres plus âgés des tribus, la plupart des enfants n'auront, lorsqu'ils parviendront à l'âge adulte, aucune immunité croisée résultant du pian à l'égard de la syphilis vénérienne.

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