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A study of immunity to rubella in villages in the Fiji Islands using the haemagglutination inhibition test

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SUMMARY

In the villages of Fiji, apart from Viti Levu, rubella is a disease occurring solely in widely spaced epidemics. Some villages may not be infected for over 20 years and will then contain substantial numbers of susceptible women of child-bearing age.

Evidence is produced that haemagglutination-inhibiting (H.I.) antibody to rubella is very long lasting in Fijians. The infectivity of the virus is discussed and it is suggested that, on the average, 50% of susceptibles are infected in a Fijian village during a rubella epidemic, but there are large variations.

INTRODUCTION

Fiji consists of a group of over 300 islands, at least 100 of which are inhabited. They are situated between longitudes 177° E. and 178° W. and latitudes 16° and 19° S., with a few outlying islands extending beyond these limits. The main island of Viti Levu has a land area of 4011 sq. miles. It has a road navigable by ordinary cars right round the island and several other fair roads. It is on the air routes between Australasia and North America and receives large numbers of tourists. The other islands have not got such good communications and some of the smaller islands are very isolated. The total population was approximately 477,000 at the 1966 census.

Because of the great variations among villages of the Fiji group in their sizes and degrees of contact with each other and outside communities the question arose whether the epidemiology of rubella would be relatively uniform amongst the villages and whether it would be comparable to that shown by surveys in other regions of the world.

Areas studied

The map (Fig. 1) shows the islands on which the villages studied were situated and the name and locations of the study villages on Kadavu and Vanua Levu.

Five villages in the Lau group were studied. These isolated islands are the farthest to the east. Nasau is on the island of Moce and Dravuwalu on Totoya.

Lomaiviti includes the island of Ovalau and smaller offshore islands. Our studies were made on two villages on Gau, Lawaki on Nairai and Yavu on Batiki.

The villages on Kadavu were all in locations which can only be reached by boat.

Most of those on Vanua Levu were also only to be reached by boat or on foot, but Wailevu was close to the main town Labasa and in easy communication with it and some others were accessible by road. Kadavu has an area of 159 sq. miles and Vanua Levu 2,137 sq. miles.

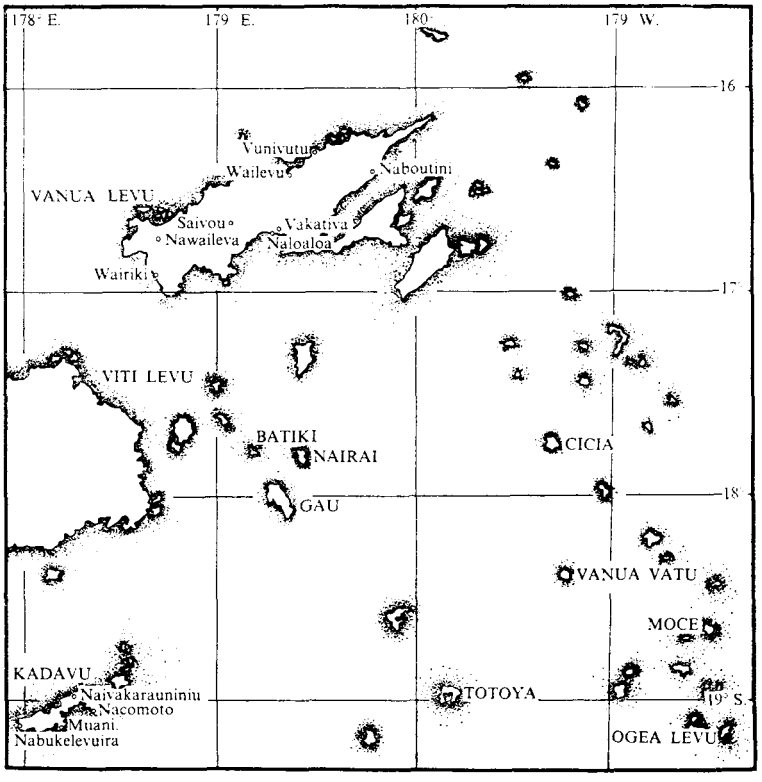

Fig. 1. Part of Fiji Island group showing islands studied.

MATERIALS AND METHODS

Serum specimens

Venous blood specimens from females in all age groups were separated in the field and transported back to Suva on wet ice. They were then stored at $-20°$ C. until used.

Antigens

Rubella haemagglutinating and control antigens were obtained from Microbiological Associates, Bethesda, Maryland.

Red blood cells

Fresh chick red blood cells were obtained for each test series. The cells were triple washed and suspended at the appropriate concentration.

Table 1. *Summary of results of testing sera from females for H.I. antibodies to Rubella virus*

Island group	Village	No. tested	No. +ve	% +ve	Age in years of youngest +ve
Lau	Ogea	57	20	35	20
	Cicia	55	25	45·5	12
	Nasau	131	61	46·6	9
	Dravuwalu	73	51	69·9	10
	Vanua Vatu	89	51	57·2	9
Lomaiviti	Navukailagi	49	24	49	9
	Lawaki	31	18	58	16
	Yavu	34	10	29·4	20
	Nukuloa	57	13	22·8	21
Kadavu	Nabukelevuira	79	43	54·4	4
	Nacomoto	69	40	58	11
	Muani	76	44	58	10
	Naivakarauniniu	32	19	59·4	11
Vanua Levu	Saivou	31	25	80·6	8
	Vunivutu	73	52	71·2	7
	Naboutini	39	21	53·8	11
	Naloaloa	30	22	73·3	9
	Wairiki	23	8	34·8	28
	Wailevu	78	51	65·4	8
	Nawailevu	41	23	56	8
	Vakativa	27	19	70·3	9

Test

The tests were carried out in Microtitre plates as a screening test at a serum dilution of 1/4 following the technique described by Plotkin (1969).

RESULTS

The results are summarized in Tables 1 and 2 and more details of individual villages in the Lau group are shown in Fig. 2. Only in one village was any serum from a child under 5 years old positive. At Nabukelevuira on Kadavu one 4-year-old was positive and since a 5-year-old was also positive it seems likely that rubella did occur in this village in 1965 or a little before. In none of the other three Kadavu villages studied were there any positives under the age of 10 years although a total of 41 sera from children under the age of 10 was tested from them.

Four villages had no positive sera from persons under the age of 20. In Ogea in the Lau group 35 sera from individuals below that age were tested.

Over the whole survey 90 % of the 40–49 age group were positive, 100 % of the 50–59 and 95 % of those 60 years old or more.

DISCUSSION

The results of this survey are substantially different from those which have been published previously. The extensive WHO collaborative study (Rawls *et al.* 1967) shows that in large centres in the U.S.A., continental South America, Europe and

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Table 2. *H.I. antibodies to Rubella in four groups in the Fiji Islands: numbers of individuals with antibody at different ages*

Ages...	0–4		5–9		10–14		15–19		20–9		30–9		40–9		50–9		60+		Totals		% +ve
Island group	No. tested	+	No. tested	+	No. tested	+	No. tested	+	No. tested	+	No. tested	+	No. tested	+	No. tested	+	No. tested	+	No. tested	+	—
Lomaiviti	7	0	44	1	18	2	21	4	19	8	22	15	20	17	10	10	10	8	171	65	38
Lau	34	0	74	2	58	21	57	31	52	41	54	40	32	29	21	21	23	23	405	208	51
Kadavu	15	1	48	2	35	17	20	15	42	26	32	26	24	20	21	21	19	18	256	146	57
Vanua Levu	29	0	57	12	42	20	33	24	50	41	63	57	32	31	20	20	16	16	342	221	65
Totals	85	1	223	17	153	60	131	74	163	116	171	138	108	97	72	72	68	65	—	—	—
Percentage +ve	1·2		7·6		39·2		56·4		71		81		90		100		95·4		—		—

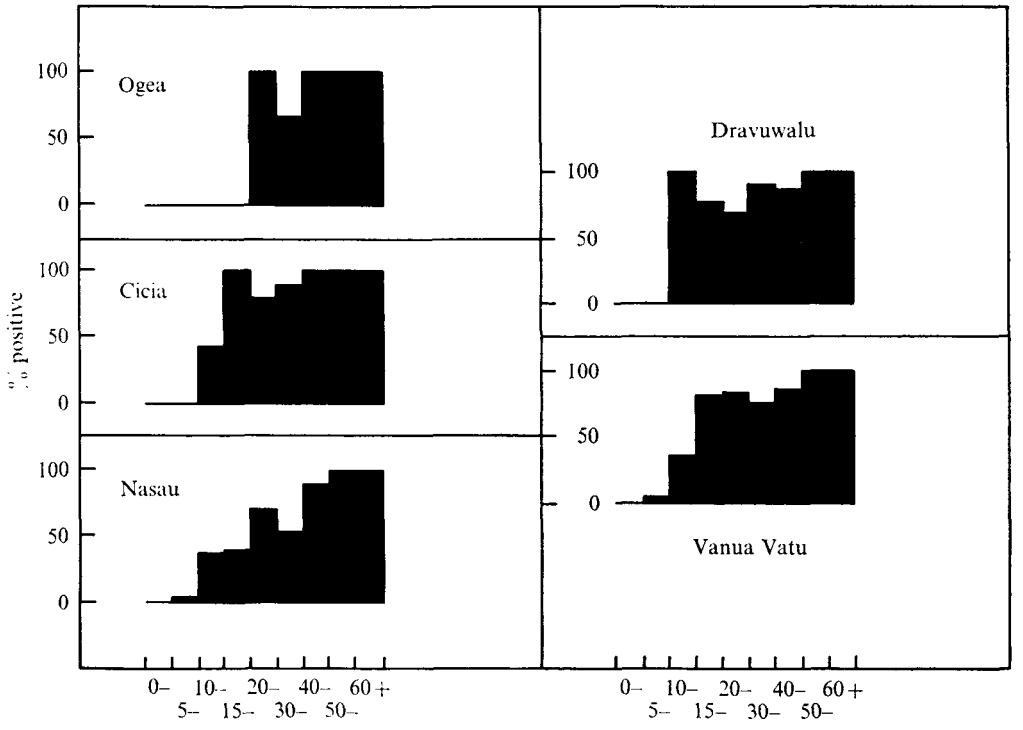

Fig. 2. H.I. antibodies of Rubella virus in various villages of the Lau Islands. Percentage of females with antibody in different age groups.

Australia 50% or more of children had antibodies against rubella virus by the age of 8 years and the proportion of women positive by the age of 17 was near 80%. In Japan the figures for children were similar, but the percentage of positive adults was lower. This study showed lower positive rates in Jamaica and Trinidad.

A later collaborative study (Dowdle *et al.* 1970) confirmed these results for continental South America and the Carribean and showed that, while in most countries there was little difference between urban and rural populations, in Peru, Jamaica, Panama and Trinidad the percentage positive in the rural 5–9 age group varied between 25 and 33%. A further study (Golubjatnikov, Elrea & Leppla, 1971) found that Mexican children showed 76% of positives by the age of 7 and 100% by 13. In Paraguay only 17% were positive at the age of 7 and 80% of positives was reached only at 15 years.

The delay in development of antibodies in the rural areas of some countries suggests that rubella is not so infectious as measles. Our results show clearly that in the villages we have studied rubella is an epidemic disease which, despite its ability to survive in the presence of neutralizing antibody at least in congenitally infected infants, is unable to remain endemic under conditions found in Fiji.

Epidemics are infrequent and apparently fail to spread uniformly throughout the villages on the larger islands as well as to all the small islands. An interesting example is Gau island in Lomaiviti where Navukailagi had an epidemic approxi-

Table 3. *H.I. antibodies to Rubella virus with suggested number of exposures*

	Exposures								
	None			One			> 1		
Island group	Total	+ve	%+ve	Total	+ve	%+ve	Total	+ve	%+ve
Lau	115	0	0	108	48	44·4	182	160	88
Lomaiviti	72	0	0	52	22	42·3	47	43	91·5
Kadavu	47	0	0	90	40	44·4	119	106	89
Vanua Levu	90	3	3·3	88	58	65·9	164	160	97·6
Totals	324	3	0·9	338	168	49·7	512	469	91·6

mately 9 years before the survey was undertaken; while Nukuloa on the other side of this small island and through which most communication with larger centres takes place had been unaffected for over 20 years.

Figure 2 indicates that there are great differences in the proportion of susceptibles infected in different epidemics and different villages. However, an attempt was made to assess the average proportion of susceptibles infected during a single exposure under the conditions in the Fiji group and assuming that few infected persons, if any, lose antibody detected by the H.I. test. This assumption is supported by the observation, typical amongst others, that in Ogea where no infection had occurred for 20 years, 22 out of 24 persons tested, aged 20 years or more, had antibody; and the finding that all 72 sera tested from women between the ages of 50 and 59 and 65 of 68 from those 60 years old or more were positive. However, Freestone, Rowlands & Prydie (1972) have found a relatively poor correlation between rubella antibodies and a history of rubella except when the attack was recent, and favour the theory that this is due to loss of antibody, but in view of the difficulty of making a clinical diagnosis of infection with rubella virus and the difficulty many patients have in recalling minor illnesses, other explanations are possible.

If our assumptions are correct then our data indicate that the average percentage of susceptibles infected in a rubella epidemic is about 50 %, although the variation from village to village is very large (Table 3 and Fig. 2).

Finally this study has revealed the existence of large numbers of susceptible women of child-bearing age and suggests that in Fiji and in other areas with a similar distribution of population serious consideration should be given to developing a rubella vaccination programme designed to protect this group as far as possible.

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