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The prevalence of hepatitis B infection amongst urban and rural populations in Western Samoa

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SUMMARY

A group of 240 urban and 200 rural dwellers in Western Samoa over the age of 20 years was studied for serological evidence of current or past infection with heptatitis B virus (HBV). Overall, 5·5% of subjects were found to be currently infected with HBV and a further 74·5% showed detectable levels of antibody. Antibody to the hepatitis B core antigen was found to be a better marker of past infection than antibody to the surface antigen of the virus. Both the infection rate and carrier rate were higher in males than females and subjects living in rural areas were more likely to be infected than those living in urban areas.

INTRODUCTION

Previous studies in Pacific populations have shown that the hepatitis B virus is endemic in the region (Austin, Maquire & Miles, 1974; Blumberg *et al.* 1974; Mazzur & Jones, 1977; Gust, Lehmann & Dimitrakakis, 1979; Wong, Purcell & Rosen, 1979) and has revealed striking variations in the prevalence of infection and of chronic carrier rates amongst different groups (Gust, Dimitrakakis & Zimmet, 1978; Vitarana *et al.* 1978). Numerous suggestions have been made to account for these observations, including inherited differences in response to infection, the effect of differences in child rearing and other social practices and differences in the virus itself.

To determine whether the incidence of infection was related to life style, a study was undertaken amongst urban and rural dwellers in Western Samoa.

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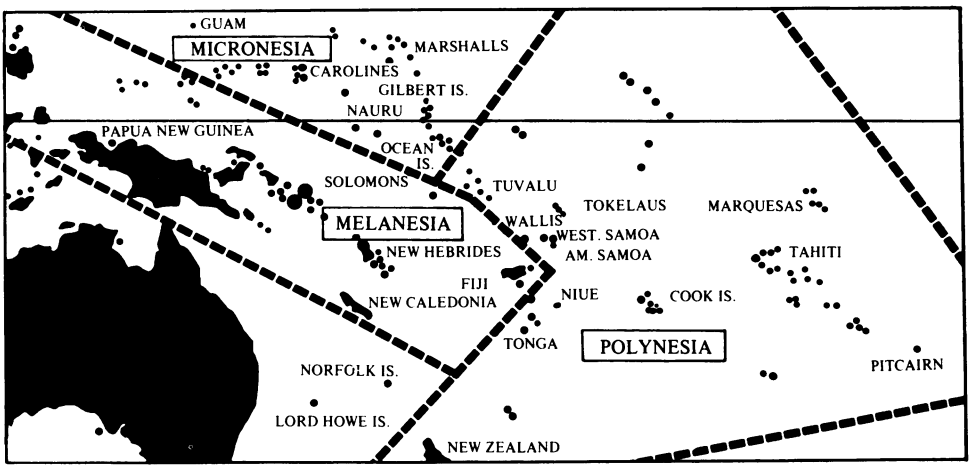

Fig. 1. Map showing location of the populations studied.

MATERIALS AND METHODS

Population studied

Western Samoa is an independent state and a member of the British Commonwealth. It consists of two large and several small islands lying between 13 and 15° S latitude and 168 and 173° W longitude, approximately midway between Hawaii and Australia (see Fig. 1).

The two major islands, Upolu and Savai'i, are volcanic in origin and mountainous, the bulk of the population living on a relatively narrow coastal fringe. The main city of Apia is situated on the island of Upolu and is the centre of Government and commerce. The estimated population is 155 000 of whom more than 90 % are Polynesians.

The climate of Western Samoa favours primary production and copra, cocoa processing, fruit- and fish-canning are major sources of income. Recently, several manufacturing industries have been established. As in many Pacific islands, increasing tourism is changing the life style of the Western Samoans. Apia has become a large town and now has a number of hotels and restaurants, as well as banks, shops and commercial houses. Many people work in sedentary occupations as clerks in the Civil Service or the trade stores and live in houses rather than huts. In the rural areas the traditional life styles are maintained, although some villagers have access to motor vehicles and electricity.

Design of the study

In August and September 1978, a study was carried out by the Government of Western Samoa, the World Health Organization and the Department of Metabolic Medicine and Epidemiology of the Royal Southern Memorial Hospital, Melbourne, to determine the prevalence of certain communicable and non-communicable diseases in rural and urban areas of the islands. The city of Apia and the two groups of villages on each of the main islands were chosen for study. In each study area a house-to-house census was made and all ethnic Samoan residents over the age of

20 years registered. The census takers issued a number to each subject, explained the purpose of the survey and gave each person an appointment to attend the survey centre for testing.

Urban sample (Apia)

The villages of Apia, Malifa, Tauese, Faatoia, Tanugamanono and Magiagi were chosen for the urban sample. The survey provided a total of 937 people aged 20 years and over, of whom 428 (45·7 %) were males and 509 (54·3 %) females. Of these, 744 (or 5·5 % of the adult population of the area) kept their appointments.

Rural sample (Upolu)

The villages of Saleilua, Poutasi and Vaovai in the Faleolili district on the central couth coast were chosen for the Upolu rural sample. The survey provided a total of 475 people aged 20 years and over of whom 251 (52·8 %) were males and 224 (47·2 %) females. Of these, 334 (or 19·4 % of the adult population of the area) kept their appointments.

Rural sample (Savai'i)

The villages of Tuasivi, Si'ufaga, Sapine, Lu'ua, Malae, Salimu and Sa'asa'ai in the Tuasivi district on the east coast of the island were chosen for the Savai'i rural sample. The survey provided a total of 480 people of whom 224 (46·7 %) were males and 256 (53·3 %) females. Of these, 401 (or 19·7 % of the adult population of the area) attended for examination.

The age and sex distribution of the three groups was similar to that revealed by the 1976 national census of each district. Blood samples were collected aseptically from each subject, the serum separated and stored at −20 °C until it could be tested.

For the purpose of assessing the prevalence of infection with HBV, a subset of 400 sera was chosen, comprising 200 sera from urban dwellers and 200 sera from rural dwellers. Equal numbers of sera from males and females in each group were chosen by a system of random numbers.

Detection of infection with HBV

Each serum specimen was tested for hepatitis B surface antigen (HBsAg) and antibody (anti-HBs) and antibody to hepatitis B core antigen (anti-HBc) by solid-phase radioimmunoassay (SPRIA) (Austria II, Ausab, Coreab, Abbott Laboratories, North Chicago) according to the manufacturer's specifications. Before a serum was accepted as positive for HBsAg or anti-HBs the result was repeated and the reaction blocked with specific antibody or antigen (Gust & Lehmann, 1975; Gust *et al.* 1979). Subtyping of HBsAg was performed by SPRIA as previously described (Gust, Dimitrakakis & Lucas, 1980).

Table 1. *Age-specific prevalence of markers of hepatitis B infection in Western Samoa*

Age (years)	tested No.	HBsAg+ Anti-HBc+ Anti-HBs−	HBsAg− Anti-HBc+ Anti-HBs+	HBsAg− Anti-HBc+ Anti-HBs−	Total with evidence of current or past infection with HBV
20–24	68	3 (4·4%)	24 (35·3%)	15 (22·0%)	42 (61·7%)
25–34	79	3 (3·8%)	31 (39·2%)	24 (30·4%)	58 (73·4%)
35–44	79	5 (6·3%)	27 (34·2%)	31 (39·2%)	63 (79·7%)
45–54	84	5 (5·9%)	19 (22·6%)	53 (63·1%)	77 (91·6%)
55+	90	6 (6·7%)	25 (27·8%)	49 (54·4%)	80 (88·9%)
Total	400	22 (5·5%)	126 (31·5%)	172 (43·0%)	320 (80·0%)

RESULTS

After serological testing was completed, the subjects were allocated to one of four groups: chronic carriers of HBV (in whom both HBsAg and anti-HBc was detected), subjects with no serological evidence of past infection with HBV (in whom HBsAg, anti-HBs and anti-HBc could not be detected), and two groups with evidence of past infection with HBV (those in whom anti-HBc and anti-HBs could be detected, and those in whom only anti-HBc was present).

The age-specific prevalence of markers of infection with HBV is shown in Table 1. Overall, 22 of the 400 subjects tested (5·5%) were HBsAg positive and were probably chronic carriers of HBV, while a further 298 (74·5%) showed antibody directed against either or both the core and surface antigens of the virus. Interestingly, less than half of the latter group had detectable levels of anti-HBs. The frequency with which anti-HBc was found to be the only serological marker of past infection, increased steadily with age; whereas in the 20–24 year age group anti-HBc was detected alone in 15 of 39 subjects (38·5%), and in the over 55 age group it was the sole marker of past infection in 49 of 74 (66·2%) subjects.

The age-specific prevalence of markers of infection is shown in Table 2 related to gender and place of origin.

DISCUSSION

Hepatitis B virus appears to be endemic in Western Samoa as it is in every Pacific island studied to date. Infection appears to be acquired early in life and is associated with the development of a relatively high rate of chronic carriage of HBsAg.

Remarkably different carrier rates have been reported from various Pacific populations but these do not appear to be related to cultural patterns or ethnic origin. Equally large differences have been demonstrated between various Polynesian populations as between Micronesians and Polynesians and great differences can often be detected between different villages or even households on the same island (Gust *et al.* 1978). The high carrier rate in Western Samoa presumably reflects a high incidence of infection early in life. A proportion of such infections is probably acquired at birth, the remainder in the first few years of life through intimate contact with acutely or chronically infected individuals in the family

Table 2. *Age-specific prevalence of markers of HBV infection amongst rural and urban males and females in Western Samoa*

Age (years)	Male					Female				
	No. tested	HBsAg+ Anti-HBc+ Anti-HBs−	HBsAg− Anti-HBc+ Anti-HBs+	HBsAg− Anti-HBc+ Anti-HBs−	Total with evidence of infection	No. tested	HBsAg+ Anti-HBc+ Anti-HBs−	HBsAg− Anti-HBc+ Anti-HBs+	HBsAg− Anti-HBc+ Anti-HBs−	Total with evidence of infection
Urban										
20–24	18	1 (5·5%)	9 (50·0%)	3 (16·7%)	13 (72·2%)	12	0	3 (21·4%)	3 (21·4%)	6 (42·8%)
25–34	20	1 (5·0%)	9 (45·0%)	9 (45·0%)	19 (95·0%)	20	0	9 (45·0%)	3 (15·0%)	12 (60.0%)
35–44	17	0	4 (23·5%)	8 (47·1%)	12 (70·6%)	21	2 (9·5%)	6 (28·6%)	6 (28·6%)	14 (66·7%)
45–54	24	2 (8·3%)	5 (20·8%)	11 (45·9%)	18 (75·0%)	21	1 (4·7%)	5 (33·8%)	14 (66·2%)	20 (95·2%)
55+	20	3 (15·0%)	8 (25·0%)	9 (45·0%)	17 (85·0%)	25	1 (4·0%)	7 (28·0%)	13 (52·0%)	21 (84·0%)
Total	99	7 (7·1%)	32 (32·3%)	40 (40·4%)	79 (79·8%)	101	4 (4·0%)	30 (29·7%)	39 (38·6%)	73 (72·3%)
Rural										
20–24	21	2 (95·0%)	8 (38·1%)	6 (28·6%)	16 (76·2%)	15	0	4 (26·7%)	3 (20·0%)	7 (46·7%)
25–34	17	2 (11·8%)	4 (23·5%)	10 (58·8%)	16 (94·1%)	22	0	9 (10·9%)	2 (9·1%)	11 (50·0%)
35–44	19	2 (10·5%)	5 (26·3%)	11 (57·9%)	18 (94·7%)	22	1 (4·5%)	12 (54·5%)	6 (37·3%)	19 (86·3%)
45–54	20	2 (10·0%)	2 (10·0%)	16 (80·0%)	20 (100%)	19	0	7 (36·8%)	12 (63·3%)	19 (100·0%)
55+	23	1 (4·3%)	8 (34·8%)	12 (52·2%)	21 (91·3%)	22	1 (4·5%)	5 (22·7%)	15 (68·2%)	21 (95·4%)
Total	100	9 (9·0%)	27 (27·0%)	55 (55·0%)	91 (91·0%)	100	2 (2·0%)	37 (37·0%)	38 (38·0%)	77 (77·0%)

group. In tropical areas ample opportunity exists for the transmission of infection through the saliva or by contamination of cuts or sores with blood or serum. Mosquitoes and other blood-sucking insects may play a role in the passive transfer of virus under certain circumstances, although there is as yet no data to show that this is an important factor in the natural history of the disease.

The higher prevalence of infection amongst rural dwellers may be related to their more active life style with increased opportunities for abrasions and for the development of tropical sores which offer excellent opportunities for contaminating other people with virus.

The higher carrier rate in males has been noted by a number of authors and remains inadequately explained. Perhaps the most likely explanation is that the carrier state in women is less prolonged than in men. Recent data obtained in a longitudinal study of aboriginal populations in Australia provides convincing evidence for this suggestion (Hardy *et al.*, unpublished data).

The presence of anti-HBc was found to be the most sensitive marker of past infection; in fact, if the sole criteria of infection had been the presence of HBsAg or anti-HBs, 172 out of 320 subjects (53·7%) would have erroneously been regarded as not immune.

There are several possible explanations for these findings. Firstly, antibodies to the core antigen may be longer lasting than those directly against the surface antigens. This possibility is supported by the decreasing frequency with which anti-HBs was detected with increasing age. Another explanation is that unusual subtypes of HBV exist in Western Samoa and the commercial tests for anti-HBs which are designed to detect antibodies to HBsAg/adw and HBsAg/ayw are relatively insensitive in this situation. The co-existence of multiple subtypes and the existence of rare subtypes has previously been reported in Oceania by Mazzur (1976). Yet another possibility is that, as HBV is endemic in the population, subjects become re-infected with different strains during their life-time and the antibody response elicited is largely to the common antigen of the core.

Perhaps the most interesting aspect of the epidemiology of HBV in endemic areas is the tremendous variation in carrier rates in populations with similar infection rates. The reasons for this variation are not known and may represent biological differences between HBV strains, genetically determined differences in host response or the effect of chronic infections which alter immune responses. Alternatively, they may reflect cultural or social factors which influence transmission of the virus, particularly in the first few years of life. The successful unravelling of these causative factors institutes a major challenge to our understanding of the natural history of hepatitis B infection and to its eventual control.

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REFERENCES

AUSTIN, F. J., MAGQUIRE, T. & MILES, J. A. R. (1974). The occurence of hepatitis B antigen and antibody in some population groups in the south-west Pacific region. *American Journal of Tropical Medicine and Hygiene* **23**, 489–94.

BLUMBERG, B. S., MAZZUR, S., HERTZOG, K., MILLMAN, I., BLOOM, J. & DAMON, A. (1974). Australia antigen in the Solomon Islands. *Human Biology* **46**, 239–62.

GUST, I. D., DIMITRAKAKIS, M. & LUCAS, C. R. (1980). Changing patterns in the distribution of hepatitis B subtypes. *Vox Sanguinis* (in press).

GUST, I. D., DIMITRAKAKIS, M. & ZIMMET, P. (1978). Studies of hepatitis B surface antigen and antibody in Nauru. I. Distribution amongst Nauruans. *American Journal of Tropical Medicine and Hygiene* **27**, 1030–6.

GUST, I. D. & LEHMANN, N. I. (1975). The detection of hepatitis B surface antigen by radioimmunoassay. *Pathology* **7**, 285–92.

GUST, I. D., LEHMANN, N. I. & DIMITRAKAKIS, M. (1979). A seroepidemiologic study of infection with HAV and HBV in five Pacific islands. *American Journal of Epidemiology* **110**, 237–42.

GUST, I. D., LEHMANN, N. I., DIMITRAKAKIS, M. & ZIMMET, P. (1979). Seroepidemiology of infection with hepatitis A and B viruses in an isolated Pacific population. *Journal of Infectious Diseases* **139**, 559–63.

MAZZUR, S. (1976). Subtypes of HBsAg in Oceania. *Bibliotheca Haematologica* **42**, 48–52.

MAZZUR, S. & JONES, N. (1977). Distribution and persistence of hepatitis B surface antigen and antibody in a Melanesian population. *American Journal of Epidemiology* **105**, 107–12.

VITARANA, T., KANAPATHIPILLAI, M., GUNASEKERA, H. D. N., LEHMANN, N. I., DIMITRAKAKIS, M. & GUST, I. D. (1978). A seroepidemiological study of hepatitis A and hepatitis B infection in Sri Lanka. *Asian Journal of Infectious Diseases* **2**, 247–52.

WONG, D. C., PURCELL, R. H. & ROSEN, I. (1979). Prevalence of antibody to hepatitis A and hepatitis B viruses in selected populations of the South Pacific. *American Journal of Epidemiology* **110**, 227–36.