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Community Health Assessment by Urine Dipstick Screening in Relation to the Variety of Lifestyles in the Solomon Islands

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Urine dipstick screening has clarified the overall health conditions of Melanesians who inhabit four less-modernized societies of Solomon Islands and shows that there is a slight inter-village difference in dietary conditions, which may be prognostic of health transitions in relatively modernized villages.

Key Words: urine dipstick test; community health; urinary tract infection; diabetes; modernization; urinary pH; dietary habit.

From the viewpoint of international health and public health, community health assessment is important, especially in the process of modernization, since it has been reported that the epidemiologic structure is in transition from infectious diseases to chronic diseases through improvements of hygienic conditions including maternal and child health, changes of dietary habits, and changes in lifestyles. The transition is called the epidemiologic transition (Omran, 1971), and if occurred in most Polynesian and Micronesian countries in the 1970s and 1980s (Crews, 1988; Schooneveldt *et al.*, 1988; Vigneron, 1989), while less-developed Melanesian societies have not experienced it (Taylor *et al.*, 1989).

There is less information about community health status in developing countries including those in Melanesia, partly because laboratory facilities needed for disease screening are inadequate. Western Province of the Solomon Islands is one such area. Urine dipstick testing is known as a useful screening device in traditional societies, because it requires no modern laboratory facilities and is relatively cheap.

The aim of the present study is to evaluate community health status by urine dipstick testing in four villages of Western Province, Solomon Islands, which differ from one another in ethnohistory and modernizing status. Community health is recognized as one of the basic human needs, to be achieved by sustainable community management under the pressure of globalization or external developing forces.

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Subjects

The study area is in the Western Province of Solomon Islands, and the four study villages, called Paradise, Olive, Biche, and Bopo, are located 30-50 km apart from each other (Fig. 1). The four villagers share an Austronesian Phylum in language, tropical rainforest vegetation and climatic zone, dependence on horticulture and fishery, and less development economically, but they differ in several aspects, such as population size, religion (Christianity sect), staple food, and forestry activities (Table 1).

Paradise village is the headquarters of the Christian Fellowship Church (CFC). The Paradise villagers originally lived in a mountainous area and moved to the northern coast of New Georgia Island in 1918, in response to the Goldie party of Methodist evangelists. In 1958, Silas Eto, who learned the Methodist teachings, founded the CFC and led the people to the present site of Paradise village. Since then, Silas's family has administered the Paradise people, who speak the Kusage language, which is spoken only in some villages of the northern coast of New Georgia. Silas's descendants, as a "holy family", live apart from the other villagers, and their lifestyle is much more modernized. The ordinary villagers are asked to keep a strictly outlined religious lifestyle, e.g. to do community work (about 2 hours a day), to eat only sweet potatoes as a staple food, to avoid staying in the sleeping house during the daytime, and so on. In the 1980s, the village area suffered from logging by an overseas company. The holy family obtained royalty though the remaining villagers did not, but this caused no economic conflict. In the 1990s and later, the holy family stopped inviting the logging company and started replantation in the destroyed areas through community work.

In Olive village, the inhabitants' first contact with Methodist evangelists took place in 1902, much earlier than that of the Paradise people, but the establishment of Olive village in the current place was in 1972, when the people had already become devoted to CFC. Despite the fact that they are CFC followers, religious rule is not strict because there is no "holy family" in the village. The people must do community work three days a week, from Tuesday to Thursday, but not on Monday and Friday. Fishing is mainly done on Saturday, and their activities are devoted to church services on Sunday. The community work consists mainly of planting and school-building; planting is not exclusively done on community land, but also on 1 ha private (individually owned) land which is assigned to each household. The private land is exploited by community work, but any income from it goes to each household. On weekdays the villagers get up at around 7:00, but have no specific work until they go to the garden or planting zone in the afternoon. Usually they come back home at around 18:00. They have two meals (lunch and supper) a day. Olive is not equipped with electricity as is Paradise, so the people go to bed at around 21:00. Since trepangs, trochoids, and garden products are the source of cash income in addition to royalties for logging, the people eat purchased rice two or three times a week on average and some of them eat rice every day.

In Biche village, there are about 100 individuals, who are Seventh Day Adventists (SDA). SDA has strict food taboos: believers cannot eat pork, scaleless fish like eels, spiny lobster, and so on. However, SDA encourages the people to undertake economic activities, so they earn considerable cash by selling garden products to the workers of external logging companies, or by selling fish to the trader boats from Honiara. Therefore, the Biche

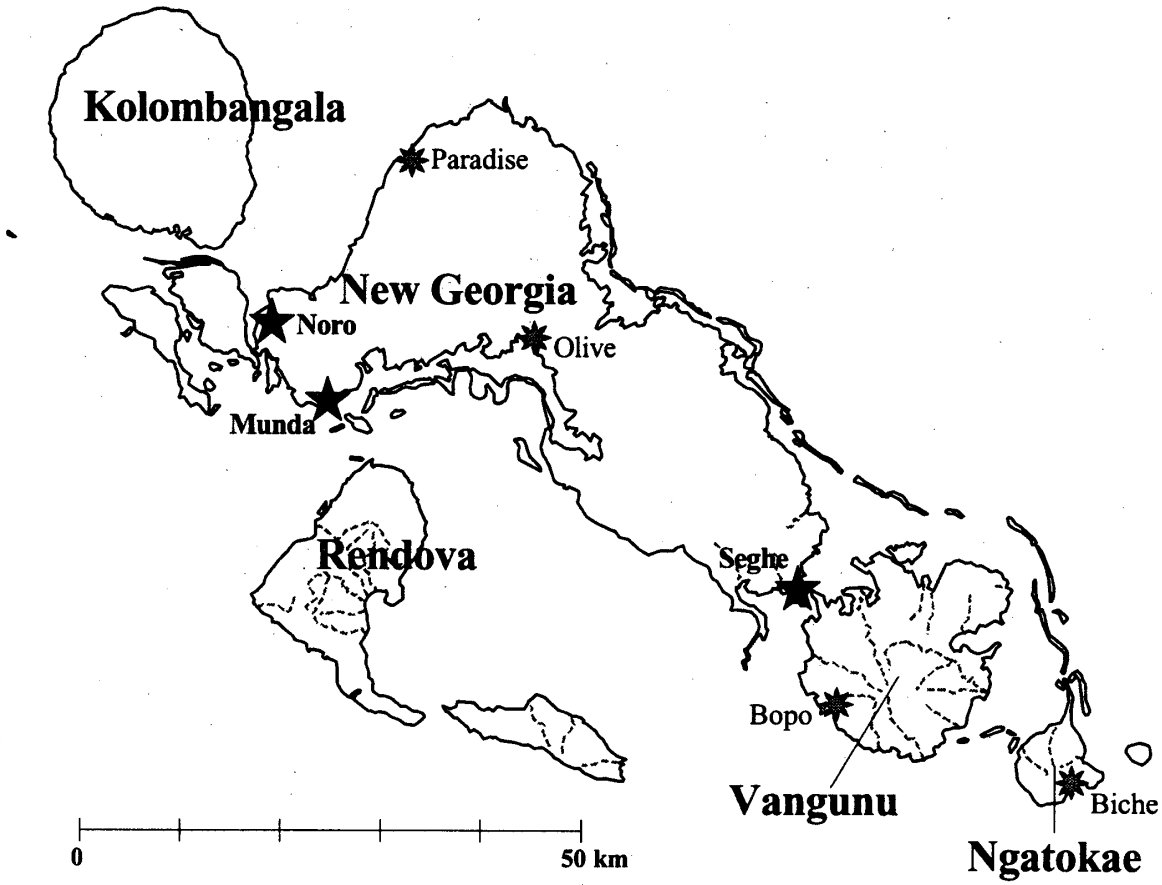

Figure 1. The Location of the Study Villages in Western Province, Solomon Islands.

Table 1. Basic Characteristics of Four Villages in Western Province, Solomon Islands

Village	Paradise	Olive	Biche	Bopo
Ethnic group[1]	Kusage	Roviana	Marovo	Vangunu
Establishment time	1958	1972	≥100 years ago	1924-6
Christianity[2]	CFC	CFC	SDA	UC
No. of tribes	4	3	1	1
de facto population	783	382	101	52
No. of households	84	49	23	9
Logging activities	In 1980s	2 companies	neighbor	none
Planting	CW[3]/private	CW[3]/private	none	none
Rice consumption	none	2-3 times/wk	3-4 times/wk	3-4 times/wk
Subjects	adults	adults	all	all
No. of males[4]	119/140	73/79	38/44	27/29
No. of females[4]	127/139	67/68	39/44	17/21

[1] All four groups are of Austronesian stock.

[2] CFC: Christian Fellowship Church; SDA: Seventh Day Adventist; UC: United Church of Christ.

[3] CW: Community Work.

[4] Number of samples collected and tested. / Number of subjects given urine cups.

people usually eat rice and tinned meat. They gain some advantages from the presence of the external logging companies, through exploiting new gardens after logging or obtaining royalties even when the logging takes place on the land of neighboring villages. Since SDA prohibits working from 18:00 on Friday to 18:00 on Saturday, they go to the gardens and harvest sweet potatoes on Thursday. Including this Thursday visit, they usually go to the gardens two or three times a week. Fishing is mainly done on Sundays, because the trader boat comes on that day.

Bopo village is the smallest of four Vangunu-speaking villages located on the south-western coast of Vangunu Island. Vangunu speakers originally lived scattered all over southern Vangunu. After accepting Christianity, they moved to the southern coast and established the sedentary village named Zaira. As the population increased, some people moved to establish new villages; the present Bopo village was established around 1922-1924. The people belong to the United Church (UC), whose commandments are relatively looser than those of the other religions, so they have no community work or food taboos. Vangunu people refused to allow logging, but earned cash by selling trochoids and fish, so they had relatively large amounts of purchased food like rice and tinned fish. In addition, one household, whose head and his wife worked at Honiara, has come back to the village with many goods like rice and tinned food, to escape the ethnic tension between Guadalcanal and Malaita, and consequently the material wealth of the people has increased.

In summary, there are considerable differences in religion and in the level of the cash economy among the villages, but basic lifestyle based on slash-and-burn horticulture and fishery is common to all four villages.

Methods

The present study was conducted from January to October 2001. Each village has accepted one of the authors (TM for Paradise, TF for Olive, MT for Biche, and DI for Bopo) for more than 6 months. Long-term fieldwork clarified, as partly mentioned above, the extent of modernization (detailed information for each village will be published elsewhere).

Urine collection was done through sequential patrol of the four villages by two of the authors (MN and TY), who conducted urine dipstick testing and anthropometry. Urine dipstick testing was done by the same single author (MN) for all four villages to avoid bias in judgment (inter-rater differences are sometimes reported). In the two more populated villages (Paradise and Olive), only adults were handed disposable urine cups on the day before collection, while in the other two villages (Biche and Bopo), which were thinly populated, all residents including children were tested similarly. In Paradise and Olive, adults were judged based on their appearance at first. More than 95% of those selected by appearance were 20 years old or above, and none of them was younger than 17 years old. Thus the criterion to distinguish adults from children was set at 17 years old. Using this criterion, the proportions of children in Biche and Bopo were 57% and 46%, respectively. Nonetheless, based on the urinary test items listed below, there was no difference between adults and children statistically, so they were not analyzed separately.

Urine collection was, in practice, done as follows. Village people were asked to col-

Table 2. Urinary Glucose Status by Village and Sex

	Males						Females					
Village	Normal	±	+	++	+++	++++	Normal	±	+	++	+++	++++
Paradise	118	0	1	0	0	0	124	0	0	0	3	0
Olive	71	1	0	0	1	0	64	2	0	0	0	1
Biche	38	0	0	0	0	0	39	0	0	0	0	0
Bopo	27	0	0	0	0	0	17	0	0	0	0	0

Table 3. Urinary Ketone Body Status by Village and Sex

	Males			Females		
Village	Normal	±	+	Normal	±	+
Paradise	112	6	1	126	1	0
Olive	73	0	0	67	0	0
Biche	36	1	1	39	0	0
Bopo	26	1	0	17	0	0

lect their early morning first urine. The aim was explained by the authors and village leaders, and the villagers gave their consent. Urine samples were collected in paper disposable cups by the villagers themselves. To avoid degradation of samples, just after the collection, dipsticks (N-Multistix SG-L, Sankyo Co., Tokyo) were applied to check glucose for diabetes, bilirubin and ketone body for hepatic function, occult blood, protein and urobilinogen for renal function, nitrite and leukocyte status for urinary tract infection, and pH in relation with diet (Remer and Manz, 1995). Recovery rates of urine collection by sex/village groups ranged from 81% to 99%.

The positive proportion for other items than pH and the mean levels of pH were analyzed by sex/village groups, and compared among them at a significance level of 0.05. All statistical analysis was done using R (version 1.3.1 for Windows, R Project [http://www.r-project.org/]) (Ihaka and Gentleman, 1996).

Results

The result for urine glucose is shown in Table 2. Except for three Paradise women whose glucose level was '+++', most people showed normal levels (glucose negative). In particular, all Biche and Bopo people tested normal. Even when '±' individuals were recognized as positive, the positive proportion by sex/village was at highest 3/67 (lower than 5%), in Olive females. Inter-village difference, when males and females were pooled, was not significant ($p = 0.26$ by Fisher's exact test).

A positive result for bilirubin was obtained from only one male in Olive village. Six males in Paradise village showed '±' for ketone bodies. Even when '±' individuals are judged as positive, inter-village difference in the prevalence of positive ketone body was not significant (Table 3). A significant difference was found between males and females in Paradise (Fisher's exact test; $p = 0.03$), but it was not significant for other villages.

Table 4. Urinary Occult Blood Status by Village and Sex

	Males						Females					
Village	Normal	±(NH)	±(H)	+	++	+++	Normal	±(NH)*	±(H)*	+*	++*	+++*
Paradise	116	1	0	1	0	1	116	4	0	1	2	4
Olive	68	1	1	3	0	0	54	5	0	1	5	2
Biche	35	2	1	0	0	0	32	5	1	1	0	0
Bopo	23	2	0	1	1	0	14	2	0	1	0	0

*Those may include the effect of menstruation.

Table 5. Urinary Protein Status by Village and Sex

	Males					Females				
Village	Normal	±	+	++	+++	Normal	±	+	++	+++
Paradise	115	3	0	1	0	123	1	1	2	0
Olive	71	2	0	0	0	67	0	0	0	0
Biche	37	0	1	0	0	39	0	0	0	0
Bopo	26	0	1	0	0	15	1	0	0	1

Table 6. Urinary Nitrite Status by Village and Sex

	Males					Females				
Village	Normal	±	+	++	+++	Normal	±	+	++	+++
Paradise	118	0	0	0	1	125	0	1	1	0
Olive	72	0	1	0	0	65	0	2	0	0
Biche	38	0	0	0	0	39	0	0	0	0
Bopo	27	0	0	0	0	16	0	1	0	0

Nonetheless, considering that '±' for ketone bodies does not necessarily indicate morbidity, hepatic function is not severely damaged in most individuals.

The results of occult blood testing is shown in Table 4. For females, the data are biased due to menstruation, so that only the males' data were analyzed. Prevalences including '±' as positive varied from 2.5% in Paradise to 14.8% in Bopo. Inter-village difference was significant ($p = 0.0498$), but when '±' individuals were excluded from the positives, the difference was not significant ($p = 0.219$). For urine protein, '±' should be excluded from the positives to avoid false-positive due to orthostatic proteinuria, so that prevalences, which were highest (5.9%) in Bopo females, did not differ by village, and the Olive people showed zero prevalence (Table 5). Positive urobilinogen was found only in one Olive male and one Biche female, with no inter-village difference of prevalence. Therefore, renal function is also good in most subjects.

Prevalences of nitrite were highest (5.9%) in Bopo females. Females showed relatively but not significantly higher prevalence than males, and inter-village difference was not significant (Table 6). Prevalences of leukocytes including '±' as positive varied from 0% in Bopo males to 12.8% in Biche females, but inter-group difference was not significant. Sex

Table 7. Urinary Leukocyte Status by Village and Sex

	Males					Females				
Village	Normal	±	+	++	+++	Normal	±	+	++	+++
Paradise	116	0	1	2	0	115	0	3	2	2
Olive	68	0	2	3	0	60	2	2	3	0
Biche	37	1	0	0	0	34	1	1	3	0
Bopo	27	0	0	0	0	16	1	0	0	0

Table 8. Mean Levels of PH by Village and Sex

	Males			Females		
Village	N	Mean	SD	N	Mean	SD
Paradise	119	6.91	0.95	127	6.89	0.85
Olive	73	6.52	0.70	67	6.60	0.73
Biche	38	6.16	0.80	39	5.95	0.43
Bopo	27	6.22	0.66	17	6.12	0.49

difference for all villages pooled was significant (Fisher's exact test; $p = 0.034$), but the difference disappeared when '±' was treated as negative (Table 7).

As shown in Table 8, the mean levels of pH significantly differed among the four villages (one-way ANOVA; $F = 11.0$, $p < 0.01$ for males; $F = 18.7$, $p < 0.01$ for females). Pairwise comparison adjusted by Holm's method showed that Paradise samples showed significantly higher pH than others for either sex, and that Olive female samples showed significantly higher pH than those of Biche and Bopo. The distribution of pH levels clearly shows inter-village differences (Fig. 2).

Discussion

Overall prevalences of urine dipstick testing positives are relatively low in the study population. Paradise people have been checked for blood glucose, including the glucose tolerance test done by Eason *et al.* (1987). The results showed that prevalence of diabetes was 0% in males; in females, it was 1% in 18-34-year-olds, 0% in 35-54-year-olds, and 7.7% in those over age 55. Such similar prevalence with the present result by urine glucose testing is reasonable, partly because the lifestyle in Paradise has not largely changed over the past 30 years due to strict religious commandments. Since the other villages showed no significantly different prevalence of positive urine glucose from that in Paradise, none of the four villages has suffered from modernization of dietary habits to an extent great enough to cause diabetes.

The result for urinary tract infections was contradictory. One male with '+++' nitrite and four females with '+' nitrite showed negative leukocyte results. Considering the report that nitrite is a more sensitive and more specific measure to detect urinary tract infection than leukocyte (Bachman *et al.*, 1993), there is a possibility of false-positives in the leukocyte results, so the prevalence of urinary tract infection may be low.

Some previous reports of urine dipstick testing for the indigenous people in develop-

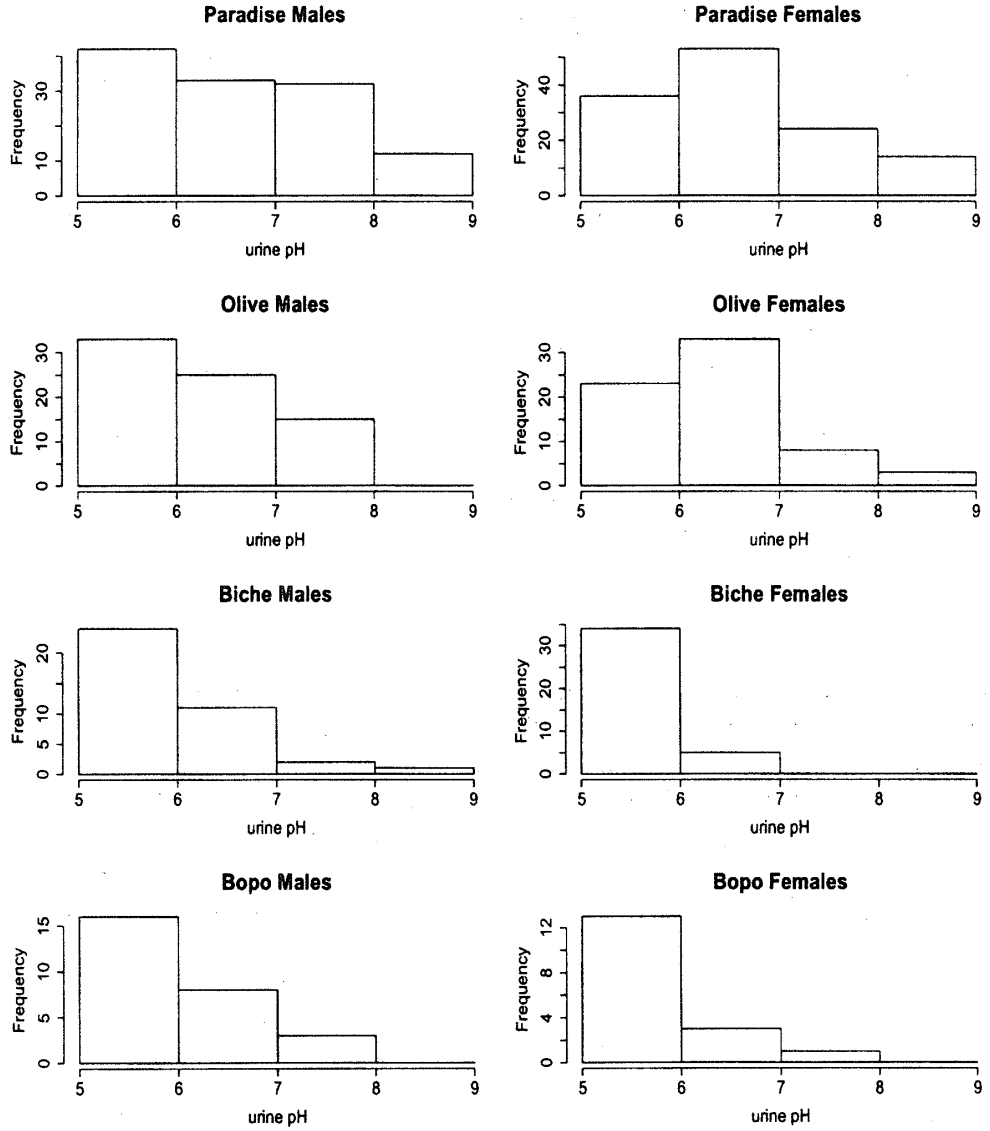

Figure 2. The Distribution of Urinary PH Levels by Sex and Village.

ing countries showed a relatively high prevalence of urinary tract infections or renal dysfunction. For instance, in the northeastern Guadalcanal villages, which are more developed than the present study area, one of the authors (MN) did urine dipstick testing in 1995, and the results showed that the prevalences of proteinuria were more than several percent in each village, and the highest prevalence of occult blood was more than 40% (Nakazawa *et al.*, 1998). Australian aboriginal people in the Western Desert had prevalences of 39% for proteinuria, 49% for occult blood, and more than 30% for urinary tract infection (Gracey *et al.*, 1996). In Papua New Guinea, less urbanized people showed relatively high (12-16%) proteinuria prevalence (Hongo *et al.*, 1994). Even considering the publication bias, the prevalence of urinary abnormalities such as proteinuria and occult blood in the present study subjects was relatively low. There might have been the sampling bias that ill people

selectively tended not to bring their urine in the early morning due to logistic limitations, but the recovery rates were sufficiently high, and thus the sampling bias could not critically distort the results. Consequently, it is plausible that overall community health has successfully been maintained in the present study area.

The reason for significant inter-village difference of pH level can be considered to be the different dietary habits. Paradise people eat almost no purchased food; they consume primarily sweet potatoes as staple food and local fish caught in the sea as protein resources. Lewandowski *et al.* (2001) reported that mean pH levels were 6.50 and 6.21 in a South African black population with high oxalate intake and a white population in the same place, respectively. The value of about 6.9 in Paradise village is higher than most reported data at the community level. If urine pH is inversely correlated with renal net acid excretion (NAE), in which pH 6.9 means almost zero NAE (Remer and Manz, 1995), and the experimental fact that a lactovegetarian diet causes lower NAE levels (mean level was 24.1 mEq/day) than a moderate to high-meat diet (mean levels were from 69.7 to 135.5 mEq/day) are applicable to the present study population, it is plausible that the Paradise people have almost zero NAE due to a mostly vegetarian diet with fish. In the Mountain Ok people of Papua New Guinea it was reported that the mode of pH level distribution was 8 (Hongo *et al.*, 1994); the Mountain Ok had notably low protein intake, so that the present result is consistent with their case. Considering that renal oxalate excretion is a risk factor for stone formation (Parivar *et al.*, 1996), a possible scenario is that the Paradise people do not eat meat or any purchased food, but mainly eat sweet potatoes and fish, resulting in low NAE, low oxalate excretion, and high pH level. This hypothesis agrees with the fact that the Paradise people suffered from the lowest prevalence of occult blood, which sometimes indicates stones in the urinary tract.

In summary, in the four villages of Solomon Islands, where modernization has not proceeded, community health levels are almost equal. However, among the four villages, the Paradise people retain the most traditional dietary habits and have the highest urinary pH. This is probably due to the influence of CFC, because their overall development level is not much lower than that of other villages, and it implies the significance of religious influence on various aspects of life. The situation described in this paper may not be specific to the study population; it seems widely applicable to other villages in Melanesia.

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References

Bachman, J.W., R.H. Heise, J.M. Naessens, and M.G. Timmerman (1993) A study of vari-

ous tests to detect asymptomatic urinary tract infections in an obstetric population. *J. American Medical Association*, 270: 1971-1974.

Crews, D.E. (1988) Multiple causes of death and the epidemiological transition in American Samoa. *Social Biology*, 35: 198-213.

Eason, R.J., J. Pada, R. Wallace, A. Henry, and R. Thornton (1987) Changing patterns of hypertension, diabetes, obesity and diet among Melanesians and Micronesians in the Solomon Islands. *Medical J. Australia*, 146: 465-9, 473.

Gracey, M., R.M. Spargo, P. Smith, R.M. Smith, V. Burke, L.J. Beilin, J. Beilby, and C. Chin (1996) Risk factors for ill-health in a remote desert-dwelling Aboriginal community in Western Australia. *Australia and New Zealand J. Medicine*, 26: 171-179.

Hongo, T., R. Ohtsuka, T. Inaoka, T. Kawabe, T. Akimichi, Y. Kuchikura, K. Suda, C Tohyama, and T. Suzuki (1994) Health status comparison by urinalysis (Dipstick test) among four populations in Papua New Guinea. *Asia-Pacific J. Public Health*, 7: 165-172.

Ihaka, R. and R. Gentleman (1996) R: A language for data analysis and graphics. *J. Computational and Graphical Statistics*, 5: 299-314.

Nakazawa, M., H. Ohmae, J. Leafasia and A. Ishii (1998) Malaria and its human ecological relations in East Tasimboko, Solomon Islands. In A. Ishii, N. Nihei, and M. Sasa (eds.), *Malaria Research in the Solomon Islands*, Tokyo: Inter Group Corporation, pp. 132-146.

Omran, A.R. (1971) The epidemiologic transition: A theory of the epidemiology of population change. *Milbank Quarterly*, 49: 509-538.

Page, L.B., J.G. Rhoads, J.S. Friedlaender, J.R. Page, and K. Curtis (1987) Diet and nutrition. In J.S. Friedlaender (ed.), *The Solomon Islands Project: A Long-term Study of Health, Human Biology, and Culture Change*. Oxford: Clarendon Press, pp.65-88.

Parivar, F., R.K. Low, and M.L. Stoller (1996) The influence of diet on urinary stone diseases. *J. Urology*, 155: 432-440.

Remer, T. and F. Manz (1994) Estimation of the renal net acid excretion by adults consuming diets containing variable amounts of protein. *American J. Clinical Nutrition*, 59: 1356-1361.

Remer, T. and F. Manz (1995) Potential renal acid load of foods and its influence on urine pH. *J. American Dietetic Association*, 95: 791-797.

Schooneveldt, M., T. Songer, P. Zimmet, K. Thoma (1988) Changing mortality patterns in Nauruans: An example of epidemiological transition. *J. Epidemiology and Community Health*, 42: 89-95.

Taylor, R., N.D. Lewis and S. Levy (1989) Societies in transition: Mortality patterns in Pacific Island populations. *International J. Epidemiology*, 18: 634-646.

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