THE NEW ZEALAND MEDICAL JOURNAL
Journal of the New Zealand Medical Association

Communicable and non-communicable diseases in the Solomon Islands villages during recovery from a massive earthquake in April 2007

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Abstract

Aim The major causes of mortality and morbidity have changed from infectious diseases and malnutrition conditions to non-communicable diseases (NCDs) in Melanesian societies. However, a massive earthquake and its related changes might have disturbed the patterns. This study aimed to explore which health problems were likely to be prevalent during the recovery process from the 2 April 2007 earthquake in the Solomon Islands.

Methods Participants were recruited in Titiana, a severely damaged village located near a town; Tapurai, a severely damaged remote village; Mondo, a severely damaged, medium urban village; and Olive, a control village. Health indicators measured were classified into communicable and nutritional conditions (malaria, malnutrition, infection status and child growth) and NCDs (overweight/obesity, hypertension and diabetes).

Results Titiana residents were more at risk of infectious conditions (C-reactive protein $\geq$ 1 mg/dL) and obesity (BMI $\geq$ 30 kg/m^2). Tapurai and Mondo residents were at risks of infectious conditions and becoming overweight (BMI $\geq$ 25 kg/m^2), respectively. Titiana and Mondo residents complained about insufficient subsistence production.

Conclusion The urban communities were found to be at risks of both communicable and NCDs. Controlling the urbanisation as well as providing continuous support against infectious conditions during the recovery process would be beneficial.

In the Solomon Islands, there was little clinical evidence of non-communicable diseases (NCDs) until the 1960s,[1] but research conducted in the 1980s revealed that a substantial portion of adults were classified as suffering from obesity, diabetes or hypertension.[2] On the other hand, mortality and morbidity by malaria, respiratory infections, diarrhoea and other infectious diseases, which had once been the main causes of deaths, have decreased due to improved hygienic conditions and health services.[3,4]

In 2002, deaths due to communicable, maternal, perinatal and nutritional conditions were 254.8 per 100,000 population, while those due to NCDs were 363.9.[5] Thus, although people are still under the double burden of both types of etiological diseases, the epidemiological transition has already been shifted toward higher prevalence of NCDs.

On 2 April 2007, at 7:40 local time, a massive earthquake (Richter magnitude 8.1), the epicentre of which was 10 km deep and 45 km south-southeast of Gizo (the provincial capital of the Western Province), struck the country (Figure 1).[6,7]

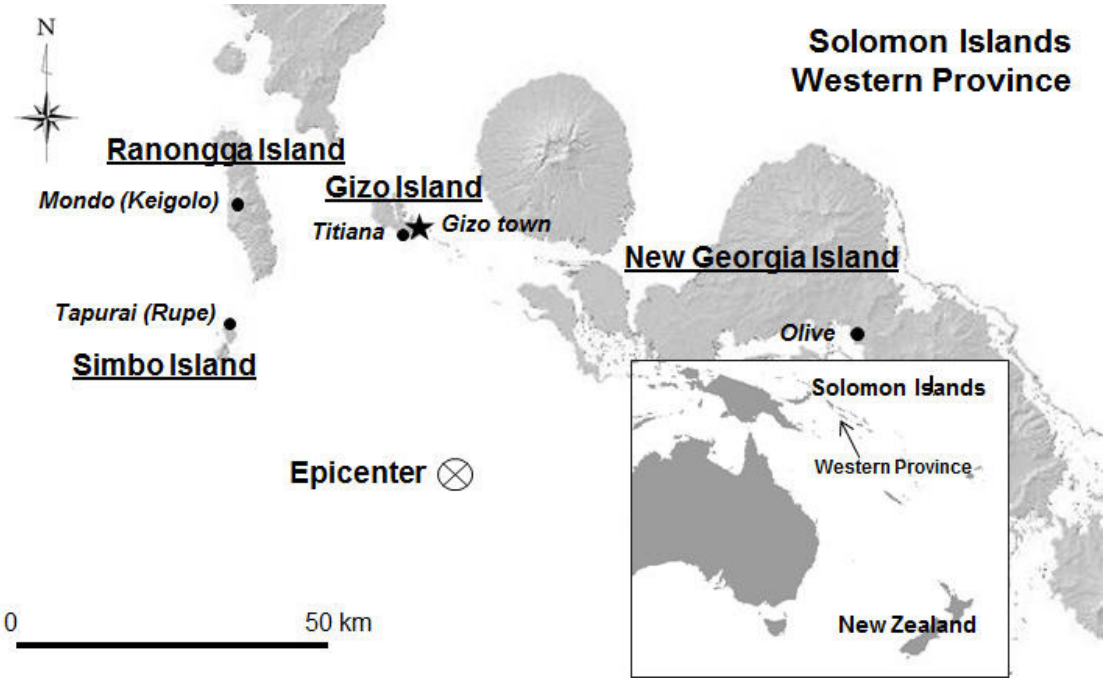
This earthquake and the related tsunami and landslides killed 52 people, wrecked 3150 houses and left behind an affected population of 24,059 in the Western and Choiseul Provinces.[8] The greatest damage was inflicted upon the residents of the town and neighbouring semi-urban villages in Gizo Island, followed by coastal fishermen and horticulturalists on several small islands.

In the devastated areas, people took refuge on mountain ridges, since houses and infrastructure, including water supply, hygiene and subsistence tools (e.g. fishing canoes and agricultural tools) were severely affected.[9]

National, international and non-governmental efforts delivered relief goods and sufficient food, and tried to control disease incidences.[8,10–12] While these efforts were successful in avoiding severe outbreaks of infectious diseases and shortage of food and drinking water, disease risks and dietary shortage remained an issue at the local level.

In addition, during this time, the population experienced a lifestyle change; some of the residents became increasingly dependent on imported foods and cash economy because subsistence economy and local food production were interrupted. Therefore, this disaster could potentially be related to risks of communicable and nutritional conditions as well as NCDs.

Figure 1. Locations of epicentre and study villages in the Western Province, Solomon Islands



This study aimed to explore the type of health and nutritional problems that were likely to be prevalent during the recovery process from the 2007 earthquake in the

Solomon Islands. Special attention was paid upon the effects of levels of damages, recovery and urbanisation.

The research was conducted 2 years after the disaster. This time period was ideal to assess medium-term influences, since the adverse effects of the initial phase are usually treated by emergency relief operations. The effects remaining after withdrawal of intensive operations were little studied. A greater understanding of these effects is necessary for implementing or assessing long-term recovery action plans at the grass-root level.

Methods

Study area—Out of 53 deaths caused by the disaster, 33, including at least 29 Micronesians, occurred on Gizo Island, followed by 11 on Simbo.

This study was conducted in August 2009 in the following four villages (Figure 1; Table 1) in the Western Province. Titiana village, where almost all houses were lost in the tsunami and all residents had evacuated to the top of a hill and built a camp; both original settlement and the camp were located at walking distances from the centre of the Gizo town (approximately 45 minutes on foot).

During the study period, a portion of households had returned to the original settlement, but the majority was still living in the camp. Tapurai village, in the remote Simbo Island, had also been totally destroyed by the tsunami. All residents, except only for a couple of households, were living in a new settlement in Rupe, where subsistence gardens were located before the disaster. Mondo village in Ranongga Island had lost about half of the settlement due to landslides.

The majority of the residents moved into an inner mountainous area and built a new settlement called Keigolo. Although this village was geographically remote from the town, the lifestyle was manifestly more modern than Tapurai, since it had been one of the biggest villages in the island before the disaster, and even after the disaster, it had received overseas aids for setting-up a clinic and rebuilding hygienic infrastructure.

Olive village in New Georgia Island was affected by the quake but the sea level increased only slightly and did not change the settlement.

Table 1 Characteristics of the study villages

Village	**Titiana**	**Tapurai (Rupe)**	**Mondo (Keigolo)**	**Olive**
Island	Gizo	Simbo	Ranongga	New Georgia
Major effects	Tsunami	Tsunami	Land slides	Sea level rise
Damage	Severe	Severe	Severe	Minimum
Population	366 [7]	234 [7]	341 [7]	365[a]
No. of deaths (% population)	13 (3.6%) [7]	7 (3.0%) [7]	2 (0.6%) [7]	0 (0%)[a]
Recovery stage	Majority still live in campsite on a hill near the Gizo town*	Building a new settlement without new infrastructure*	Building a new settlement with new hygiene equipments in inner mountain*	Same*
Distance to the nearest town	1 km	38 km	34 km	32 km
No. of participants (% Female)				
Infants (<5 years)	49 (44.9%)	21 (33.3%)	23 (39.1%)	27 (37.0%)
Children (5–17 years)	81 (51.9%)	34 (58.8%)	52 (57.7%)	60 (40.0%)
Adult (18–49 years)	63 (77.8%)	53 (52.8%)	36 (77.8%)	36 (66.7%)
Elders (≥50 years)	17 (52.9%)	15 (60.0%)	24 (33.3%)	23 (52.2%)
Total	210 (58.1%)	123 (52.0%)	135 (55.6%)	146 (48.0%)
No. of participating households	61	34	30	35

[a]**Source:** The authors' field observations; *At August 2009.

We therefore assumed that Titiana represented a village severely damaged and located near the town, Tapurai represented a severely damaged remote village, Mondo represented a severely damaged, medium urban village and Olive represented a control village.

It should be noted that almost all residents in Titiana were Micronesians who had migrated from the Gilbert Islands in 1960s,[2] while those in the remaining three villages were indigenous Melanesians.

Participants and interview survey—In each village, all residents were invited to participate in the study; measurements were made for three days in Titiana and two days in Tapurai, Mondo and Olive. All participants who, based on their free will, agreed and provided informed consent were included in the study; the consent was obtained from a parent or a legal guardian in case of children less than 18 years of age.

This study has been conducted in full accordance with the ethical principles of the World Medical Association Declaration of Helsinki (as amended by the 59th General Assembly in Seoul, 2008) and was approved by the University of Tokyo Ethics Committee, Japan, and the Solomon Islands National Health Research Ethics Committee.

Every participant, or a parent or legal guardian in case of children, was asked to report the date of birth, settlement place and housing type; birth records were referred to in case of children to calculate their exact age in months. Every adult was asked to report on his/her lifestyle by replying yes or no in the questionnaire.

Health check-ups—Body height was measured to the nearest 1 mm using a field anthropometer (TTM, Japan) and weight was recorded to the nearest 0.1 kg using a portable digital scale (Tanita model HD-654, Japan) according to a standard protocol.[13]

Height was measured only for participants of 5 years of age or older. Blood pressure of participants aged 18 years or older was measured using a blood pressure monitor (HEM-7051-HP, Omron, Japan); readings were obtained twice for every participant and averaged.

For malaria active case detection, thick and thin blood films were collected by the finger prick method. All slides were taken to the Malaria Department of the National Gizo Hospital to be examined under a microscope; each slide was checked by at least two technicians. Malaria detection was also made with a rapid detection test using the ICT Malaria Combo Cassette Test (ICT Diagnostics, South Africa) on site.

The blood obtained from the finger prick method was also used to measure haemoglobin A1c (HbA1c) and C-reactive protein (CRP) using NycoCard HbA1c (Axis Shield, Norway) and NycoCard CRP tests, respectively, and read using a NycoCard Reader II on site. HbA1c is a glycated haemoglobin that reflects plasma glucose concentration over the past two to three months and is an indicator of diabetes mellitus.[14-16] CRP is a component of acute innate immunity that increases in concentration in response to a range of pathogenic agents and inflammation.[17,18]

Statistical analyses—The health indicators measured in this study were conceptually classified into (i) communicable and nutritional conditions and (ii) NCDs. Indicators for communicable and nutritional conditions included malaria infection (positive or negative), adult malnutrition (BMI < 18.5 kg/m^2), adult and child infection status (CRP ≥ 1.0 mg/dL),[18] child stunting (height-for-age *z*-score (HAZ) < −2), child underweight (weight-for-age *z*-score (WAZ) < −2) and child malnutrition (BMI-for-age *z*-score (BMIZ) < −2). Those for NCDs included adult overweight (BMI ≥ 25 kg/m^2), obesity (BMI ≥ 30 kg/m^2),[19] hypertension (SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg) and diabetes (HbA1c ≥ 6.5%).[16]

Standardisation of measures (i.e. *z*-score calculation) for children was performed based on the CDC/WHO 1978 growth curves recommended by the WHO using Epi Info version 3.5 software (Centers for Disease Control and Prevention, Atlanta, USA). Associations between the villages and the health or life level indicators were tested using Fisher's exact test.

Multiple logistic regression analyses were performed to detect the effects of villages, individual-level settlement and housing styles, age and gender on the health indicators; settlement was treated as an environmental factor, while ownership and style of housing as factors of socioeconomic status. In this study, a *P* value of less than 0.05 was considered to be statistically significant. All statistical analyses were performed using SAS 9.2 (SAS Institute, Cary, USA).

Results

Almost all participants from Tapurai and Mondo villages lived in settlements that were established after the disaster (Table 2); the majority of Titiana participants lived in a camp, but the remaining had returned to the old settlement. As opposed to 16.4% of participants from Titiana, only 6.7% and 2.9% of participants from Tapurai and Mondo, respectively, still lived in tents or temporary houses.

Regarding subsistence activities, almost all households were engaged in horticulture (making traditional gardens) in Tapurai, Mondo and Olive villages compared to only 75.4% of the peri-urban Titiana village households. The proportion of Mondo households engaged in fishing was as low as that of households in the urban Titiana. The proportion of households having a running business and employment or remittance for cash income was high in Titiana and Olive.

Table 2. Socioeconomic status of the participant households

Village	Titiana	Tapurai (Rupe)	Mondo (Keigolo)	Olive
No. of participating households	61 (100%)	34 (100%)	30 (100%)	35 (100%)
Settlement style				
Living in old settlement	21 (34.4%)	1 (2.9%)	2 (6.7%)	100 (100%)
Living in temporary camp site	40 (65.6%)	–	–	–
Living in new settlement	–	33 (97.1%)	28 (93.3%)	–
House ownership				
Living in own house	59 (96.7%)	29 (85.3%)	26 (86.7%)	34 (97.1%)
Living in a relative/friend's house	2 (3.3%)	5 (14.7%)	4 (13.3%)	1 (2.9%)
Housing style				
Tent/temporary house	10 (16.4%)	0 (0%)	2 (6.7%)	1 (2.9%)
Leaf house/Western house	51 (83.6%)	34 (100%)	28 (93.3%)	34 (97.1%)
Economic activities				
Horticulture	46 (75.4%)	33 (97.1%)	30 (100%)	35 (100%)
Fishing	38 (62.3%)	32 (94.1%)	19 (63.3%)	34 (97.1%)
Business (store)	13 (21.3%)	2 (5.9%)	0 (0%)	7 (20.0%)
With employment/remittance	36 (59.0%)	15 (44.1%)	14 (46. 7%)	25 (71.4%)

Regarding health indicators, microscopy analyses of blood films found only one *Plasmodium vivax*-positive case (Table 3). Malaria rapid detection test also rarely found positive cases: two *P. falciparum* cases and six *P. vivax* cases. In addition, adult malnutrition was very rare (ranged 0–2.5%) (Table 3).

Infection or inflammation condition measured by CRP was found in higher proportion in Titiana and Tapurai than in Mondo and Olive (Fisher's exact test $P = 0.0179$). The prevalence was high among participants younger than 18 years old; the prevalence was 14.6% and 9.5% in Tapurai and Titiana, respectively, and only 2.7% and 5.8% in Mondo and Olive, respectively (*N.S.*). The proportion of children with low height-for-age *z*-score was the highest in Tapurai, followed by Mondo, Olive and Titiana ($P < 0.0001$). Children with low weight-for-age z-score were less frequent in Titiana than in the other three villages without significant inter-village differences. Regardless of the prevalence of low body height and/or weight, low BMI-for-age *z*-score was rare (0%–5.8%).

Table 3. Prevalence of communicable and nutrition diseases and non-communicable diseases (the number of participants examined are in parentheses)

Variables	Titiana	Tapurai (Rupe)	Mondo (Keigolo)	Olive
Communicable and nutritional conditions				
Malaria microscope (all age groups)[a]	1 Pv (207)	Nil (123)	Nil (135)	Nil (146)
Malaria ICT (all age groups)[a]	1 Pv (207)	1 Pf, 1 Pv (123)	1 Pf, 1 Pv (135)	3 Pv (146)
Adult malnutrition (BMI < 18.5 kg/m^2; ≥18 years)	2.5% (80)	0% (68)	1.7% (60)	1.7% (59)
CRP ≥ 1.0 mg/dL (all age groups)[*]	9.2% (207)	8.1% (123)	2.2% (135)	3.4% (146)
Child CRP ≥ 1.0 mg/dL (0–17 years)	9.5% (127)	14.6% (55)	2.7% (75)	5.8% (87)
Child height-for-age z-score < −2 (5–17 years)[***]	17.3% (81)	61.8% (34)	48.1% (52)	33.3% (60)
Child weight-for-age z-score < −2 (0–17 years)	8.5% (130)	14.3% (56)	20.0% (75)	14.9% (87)
Child BMI-for-age z-score < −2 (5–17 years)	2.5% (81)	0% (34)	5.8% (52)	1.7% (60)
Non-communicable diseases				
Adult overweight (BMI ≥ 25 kg/m^2; ≥18 years)[***]	62.5% (80)	39.7% (68)	51.7% (60)	23.7% (59)
Adult obesity (BMI ≥ 30 kg/m^2; ≥18 years)[***]	32.5% (80)	10.3% (68)	10.0% (60)	3.4% (59)
Adult hypertension (SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg ; ≥18 years) [***]	12.7% (79)	7.4% (68)	45.8% (59)	11.9% (59)
Adult diabetes (HbA1c ≥ 6.5%; ≥18 years)[*]	8.9% (79)	0% (68)	1.7% (60)	1.7% (59)

[a]Pv: *Plasmodium vivax*, Pf: *P. falciparum*

[*] $P < 0.05$ [***]$P < 0.0001$.

Also, as shown in Table 3, the prevalence of overweight adults was high with a large inter-village variation; the prevalence was highest in Titiana (62.5%), followed by Mondo (51.7%), Tapurai (39.7%) and Olive (23.7%) ($P < 0.0001$). Obesity with BMI ≥ 30 kg/m^2 was also most frequently found in Titiana ($P < 0.0001$). Hypertension was most prevalent in Mondo, followed by Titiana, Olive and Tapurai ($P < 0.0001$). Diabetes was found in 8.9% of Titiana population, but was seldom observed in other villages (0%–1.7%) ($P = 0.0156$).

Multiple logistic regression analyses were performed to identify the effects of villages and life-related factors on these health indicators (Table 4). Infectious or inflammation conditions were more prevalent in Titiana and Tapurai, whereas they were referenced as minimum damage in Olive village; children in Tapurai were also referenced at risk. At the individual level, younger participants and children who lived in the old settlement were at risk.

Tapurai children were likely to have low height for a given age. Adults in Titiana and Mondo villages were at risk for being overweight, but obesity was found only in Titiana and not in Mondo. Hypertension was more prevalent among the older residents and female gender; Mondo village was not at risk when these risk factors were controlled. House ownership and housing style were not related with NCDs.

It should be noted that no significant model was found when adult malnutrition, child low body weight and adult diabetes were used as dependent variables due to small numbers of positive cases.

Table 4 Effects of community difference and living conditions on communicable and non-communicable health indicators in the devastated Western Solomon Islands communities; odds ratios (*P* value in italics) by logistic regression analyses

Health indicator	Village (Olive as reference)			Age (months)	Gender (Male = 1; Female = 0)	Settlement (old = 1; others = 0)	House ownership (Own = 1; others = 0)	Housing style (tent/temporary = 1; others = 0)	Model Wald statistics *model P value* (N)
	Titiana	Tapurai (Rupe)	Mondo (Keigolo)						
Communicable and nutritional conditions									
CRP ≥ 1.0 mg/dL (all age groups)	4.31 [1.42:3.07] *0.0100*	5.89 [1.46:23.80] *0.0129*	1.48 [0.29:7.64] *NS*	0.998 [0.996:1.000] *0.0262*	1.33 [0.67:2.66] *NS*	2.36 [0.97:5.72] *NS*	0.85 [0.24:3.03] *NS*	1.01 [0.32:3.23] *NS*	18.94 *0.0152* (611)
Child CRP ≥ 1.0 mg/dL (0–17 years old)	2.62 [0.77:8.94] *NS*	9.44 [1.72:51.78] *0.0097*	1.59 [0.21:12.14] *NS*	0.98 [0.97:0.99] *0.0007*	1.38 [0.58:3.27] *NS*	3.60 [1.05:12.35] *0.0416*	0.95 [0.19:4.85] *NS*	1.09 [0.26:4.56] *NS*	21.69 *0.0055* (344)
Child low height (HAZ < −2; 5–17 years old)	0.53 [0.20:1.44] *NS*	4.18 [1.14:15.34] *0.0310*	2.48 [0.73:8.41] *NS*	1.00 [0.99:1.01] *NS*	0.81 [0.45:1.46] *NS*	1.41 [0.52:3.83] *NS*	1.03 [0.36:2.98] *NS*	0.65 [0.22:1.95] *NS*	24.32 *0.0020* (227)
Non-communicable diseases									
Adult overweight (BMI ≥ 25 kg/m^2; ≥18 years old)	5.45 [2.00:14.81] *0.0009*	2.56 [0.81:8.27] *NS*	3.60 [1.24:10.45] *0.0187*	1.001 [0.999:1.002] *NS*	0.31 [0.18:0.55] *<0.0001*	0.96 [0.42:2.19] *NS*	1.06 [0.40:2.83] *NS*	1.15 [0.37:3.55] *NS*	34.28 *<0.0001* (267)
Adult obesity (BMI ≥ 30 kg/m^2; ≥18 years old)	15.88 [2.91:86.63] *0.0014*	4.13 [0.61:28.03] *NS*	3.04 [0.47:19.53] *NS*	1.002 [1.000:1.002] *NS*	0.50 [0.22:1.139] *NS*	0.92 [0.35:2.44] *NS*	1.32 [0.28:6.35] *NS*	0.87 [0.25:3.06] *NS*	26.18 *<0.0001* (267)
Adult hypertension (SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg; ≥18 years old)	0.99 [0.17:5.77] *NS*	0.53 [0.07:3.79] *NS*	5.08 [0.92:28.23] *NS*	1.01 [1.01:1.01] *<0.0001*	0.21 [0.08:0.55] *0.0014*	0.39 [0.09:1.61] *NS*	1.42 [0.29:7.02] *NS*	0.61 [0.10:3.58] *NS*	52.43 *<0.0001* (265)

Note: Logistic regression models for adult malnutrition (BMI < 18.5 kg/m^2; ≥18 years old), child low body weight (WAZ <−2.0; 0–17 years old), low child BMI (BMIZ < −2; 5–17 years old), and adult diabetes (HbA1c > 6.5%; ≥18 years old) are shown since no matching model were detected at the model *P* value < 0.05.

As shown in Table 5, a majority of residents (63.8%–78.7%) complained about their cash income. Compared to the Titiana and Mondo residents, the majority of Olive and Tapurai residents were satisfied with productions from horticulture (88.1% and 94.2%, respectively) and fishing (94.9% and 94.2%) ($P < 0.0001$).

Table 5. Adult participants' perceptions of their standard of living

Questions	Answers	Percentage of the adult participants			
		Titiana	Tapurai (Rupe)	Mondo (Keigolo)	Olive
Do you have enough money to meet your needs?	Yes	32.1	31.9	21.3	36.2
	No	67.9	68.1	78.7	63.8
Do you have enough foods from gardens?***	Yes	50.0	94.2	77.1	88.1
	Unsure	0	1.5	0	0
	No	50.0	4.4	22.9	11.9
Do you have enough foods from fishing?***	Yes	44.6	94.2	45.9	94.9
	Unsure	1.2	1.5	0	0
	No	54.2	4.4	54.1	5.1

***: Fisher's exact test $P < 0.0001$

Discussion

This study examined the prevalence and risks of communicable diseases and NCDs in Solomon Islands villages where fishermen and horticulturists as well as urban dwellers experienced environmental changes, i.e. a massive earthquake, and related socioeconomic changes. This is also one of the few studies which report NCD prevalence in rural Melanesian societies.

A limitation of this study was that our data were available only for cross sectional analysis, and thus, the direct effects of disaster and relevant effects of the recovery could not be distinguished from the progress of socioeconomic conditions. However, the inter-village differences found in this study are adequate to interpret ecological and socioeconomic effects related to the disaster and urbanisation.

Since previous studies from Melanesia have suggested that obesity, hypertension and diabetes were increasing in urban areas,[2,20-22] it is likely that the urbanised lifestyle in Titiana is related with the high prevalence of obesity and diabetes; although there was a potential confounding factor that Titiana people had a different ethnicity (Micronesian) from other three villages.

High prevalence of overweight people in Mondo was thought to reflect a progress of urbanisation in remote areas; Mondo was more affected by modernisation than Tapurai and Olive before the disaster and had received more aid. Another potential factor was that they were not frequently engaged in fishing since they were now settled in inner and mountainous area; this lifestyle might have decreased their physical activities and energy expenditure.

From the viewpoint of other life factors, Tapurai and Olive residents had sufficient local food production (garden crops and fishes), while Titiana and Mondo residents

did not. It is interesting to note that NCD prevalence was low in the former two villages, suggesting that lifestyles with sufficient local production, subsistence and physical activities could have decreased NCD risks. This suggestion is partly supported by a previous finding that abundance and availability of natural resources, e.g. fishes, were directly related with health status in this area.[23]

From the longitudinal viewpoint, our previous study reported that obesity (BMI $\geq$ 30 kg/m^2) prevalence was 2.4%, 18.6% and 30.1% in rural Melanesian, urban Melanesian and peri-urban Micronesian villages, respectively, in 2004 in the Western Province.[24] The obesity prevalence was 10.0% and 10.3% in Mondo and Tapurai, respectively, suggesting that the risk for rural residents might have gradually increased.

Child body weight is an indicator for short-term sufficiency of food, while child body height (e.g. stunting) reflects a chronic effect of nutrition and infectious conditions. Since body height of Tapurai children was lower than that of children from other villages, although body weight did not differ, it is possible that children in Tapurai might have experienced chronic malnutrition or infectious risks.

Since Tapurai residents, especially children, had high CRP values, while they admitted that they had sufficient subsistence production, it is reasonable to hypothesise that they were living under a risk of chronic infection by pathogens. Note that although a chronic ulceration secondary to diabetes is a possible confounding factor to the increased CRP value, diabetes prevalence was quite low in the study villages.

Health statistics have suggested that malaria prevalence in the Western Province had decreased from a peak of 506 patients per 1,000 population per year in 1994 to 58 patients in 2005; although a mass administrative survey was conducted soon after the disaster in 2007, only 78.5 patients per 1000 population were found to be positive for malaria (Malaria Department, National Gizo Hospital, personal communication). However, our results suggested that even if outbreaks of malaria and other major infectious diseases were avoided, minor infectious risks remained in some rural villages.

Interestingly, Titiana residents who bear the risks of NCDs also bear risk factors of infectious conditions. Epidemiological transition theory have usually assumed that NCDs increase as urbanisation progresses while replacing infectious diseases,[25] but our findings suggest that urban people experienced both kinds of diseases. In fact, a previous study reported that 12 out of 14 drinking water samples from Titiana were contaminated with *E. coli*.[9] Thus, public health concern should be focused on in urban areas as well.

The data demonstrating that children living in households in the new settlements had a lower risk of having a high CRP value is thought to reflect a delay in constructing improved hygienic living conditions in old settlements.

Previous public health research on the disaster have suggested that large natural disasters are usually followed by increased incidences of complex injuries and outbreaks of infectious diseases in victims within a short-term period.[26-28] Therefore, priority has been given to the prevention of health disaster.[29]

In the case of the Western Solomon Islands, appropriate relief and aids were successful enough to interrupt the infectious outbreaks in the initial stage of the disaster. However, public health risks remained after two years.

On the other hand, NCDs have been reported to be increasing in the Pacific societies,[30] and were found at a high frequency in the devastated areas. Controlling the NCDs during recovery operations will efficiently improve the health status.

Since massive earthquakes continue to occur in the Pacific—e.g. 1998 Papua New Guinea Earthquake; 2009 Samoa Earthquake and Tsunami; January 2010 M7.2 and M6.9 Earthquakes in the Western Solomon Islands; 2010/2011 M7.1 and M6.3 Earthquakes in Canterbury, New Zealand; and March 2011 M9.0 Tōhoku Earthquake and Tsunami in Japan—the data reported in this study will be useful for implementing appropriate recovery actions.

Recommendations resulting from this study are

- Recovery of local subsistence;
- Minimising urbanisation of lifestyle and dietary habit; and
- Long-term follow-up of and support for hygienic and nutritional conditions in both urban and remote villages.

Competing interests: None.

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Acknowledgements: The Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan (KAKENHI Grant-in-Aid) and United States National Science Foundation (NSF) financially supported this study. We are also grateful to the staff members of the Ministry of Health and Medical Services of the Solomon Islands, in particular Ms Josephine Watoto and Ms Connie Panisi. Lastly our sincere thanks to all the people of the villages studied.

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