A SURVEY OF GOITER MORBIDITY IN BAN MAE TOEN, NORTHWEST THAILAND

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Abstract. A number of cases of goiter have been reported from Ban Mae Toen (BMT) northwestern Thailand, therefore we carried out this study to evaluate the prevalence and severity of goiter in BMT. We suspected fluoride toxicity as a factor in this phenomenon, therefore we used a WHO model using photographs to carry out a non-medical survey for teeth discoloration and limb deformity at the same time as the goiter survey. Every resident of BMT and a sampled population from two nearby control villages were surveyed in 2007. The overall prevalence of goiter among both sexes was 11%; 20% in women and 3% in men. No cases of goiter were recognised in the two control villages. Twenty-four percent of the BMT population and 5% of the sampled population of the control villages had lower limb deformities. Sixty-three percent of the BMT population had discoloration of teeth, especially among those >35 years old. The control villages had significantly (p<0.01) fewer cases of discoloration of teeth than the BMT population. The morbidity seen in Ban Mae Toen suggests the need for urgent enquiry into the etiology of this morbidity.

Key words: goiter, northwest Thailand

INTRODUCTION

The rural village of Ban Mae Toen (BMT) in northwestern Thailand lies 15 km northwest of the town of Thoen in the province of Lampang, 170 km south of Chiang Mai. The village is surrounded by hill country about 5 km west of the main north road (N1) which passes through Thoen on its way between Bangkok and Chiang Mai. The village population have long been known to suffer from high rates of goiter (Nopakun *et al*, 2002; Takeda and Takizawa, 2008), deformed lower extremities and discoloration of teeth.

In 2006 these localized health problems came to the notice of the D'Entrecasteaux Rotary Club of Tasmania who financed two projects towards ameliorating these problems. The first was a piped and tanked potable water supply to every home in the village, which was designed, paid for and built (Rajchagool and Rajchagool, 2008). Second, a survey was carried out by questionnaire to quantitatively assess the prevalence of goiter, lower limb deformities and teeth discoloration among the population of BMT.

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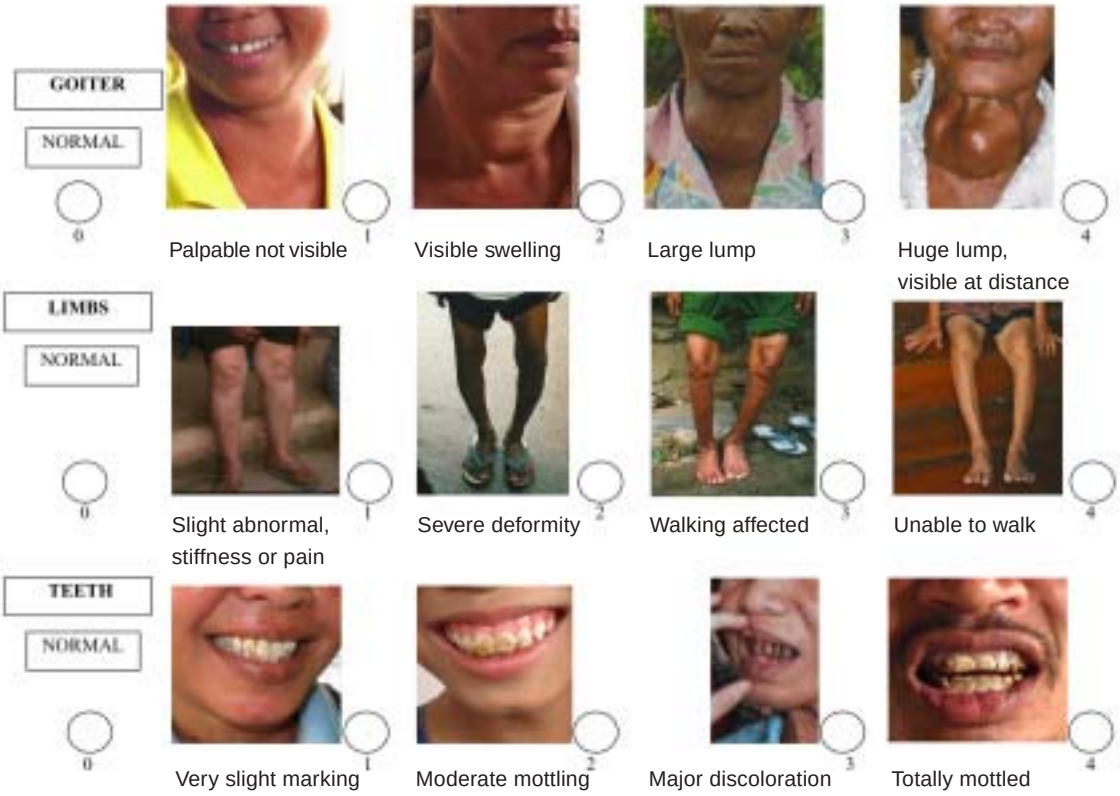

Fig 1–Diagnostic pictures of levels of morbidity (Photographs courtesy of KJ Goodsell).

MATERIALS AND METHODS

The survey of the prevalence of goiter, leg deformity and tooth discoloration was carried out in 2007 by printed questionnaire, taken to all 245 houses in BMT village and taken randomly to every fifth house in two control villages, by college-educated students under the supervision of a trained nursing sister. A WHO model of goiter gradation (Stanbury and Hetzel, 1980) was used to assess the subjects on a scale 1 to 4, with 4 being very large goiter. Leg deformity and tooth discoloration were graded similarly to the goiters using locally photographed examples (Fig 1) as a guide to assist non-medical interviewers. Age and sex of each subject were also recorded. The total population of BMT, 1,092 residents, was surveyed (Fig 2) as well as two control villages near Phrik Town, Nong Mae Lang and Klong Mai Daeng, where one-in-five residents in each village 202 and 250, respectively, were evaluated. Each control village is rural and has a similar population size and age distribution to BMT but differs by being situated on the Wang River, 35 km to the south of BMT. Fig 2 and 3 show demographic information for BMT and the control villages. Both BMT and the control villages had few children compared with potential parent age groups. In BMT 25% of the population was under 20, and 63% were aged 20-59. In the control villages 23% of the population was under 20 and 66%

Table 1
Cases of specified morbidity in Ban Mae Toen and Two control villages.

		Ban Mae Toen[a]		Two control villages[b]	
		Male	Female	Male	Female
A. Goiter	Grade 1	10	40	-	-
	Grade 2	2	52	-	-
	Grade 3	2	8	-	-
	Grade 4	1	7	-	-
	Total	15[c]	107[c]	Nil (Exp 6.2)	Nil (Exp 44.2)
B. Lower limb deformity	Grade 1	51	101	3	6
	Grade 2	39	39	4	3
	Grade 3	7	13	1	1
	Grade 4	3	10	1	3
	Total	100	163	9 (Exp 41.3)	13 (Exp 67.3)
C. Dental discoloration	Grade 1	170	179	10	8
	Grade 2	112	100	4	1
	Grade 3	45	54	-	-
	Grade 4	11	14	-	-
	Total	338	347	14 (Exp 139.6)	9 (Exp 143.3)

[a]Total village population included 544 males and 548 females.
[b]Random sampled population, sample size: 452 persons.
[c]Peak age of prevalence, 50+.
Exp, expected values if at BMT prevalence rates.

Table 2
Cases of specified morbidity from random samples from two control villages.

	Ban Nhong Mae Lang		Ban Khlong Mai Daeng	
	Male	Female	Male	Female
A. Goiter	0	0	0	0
B. Lower limb deformity	8	10	1	3
C. Dental discoloration	14	7	0	2
Sample size	99	103	129	121

were aged 20-59. The population over age 60 in both areas made up 12% of the total.

RESULTS

The results of the surveys in BMT and the two control villages are shown in Tables 1 and 2. Table 1 shows the results of the survey at BMT for (A) goiter, (B) lower limb deformity and (C) dental discoloration, divided into 4 grades of severity (Fig 1). Table 2 shows the results of the survey at the two control villages for the same morbidity.

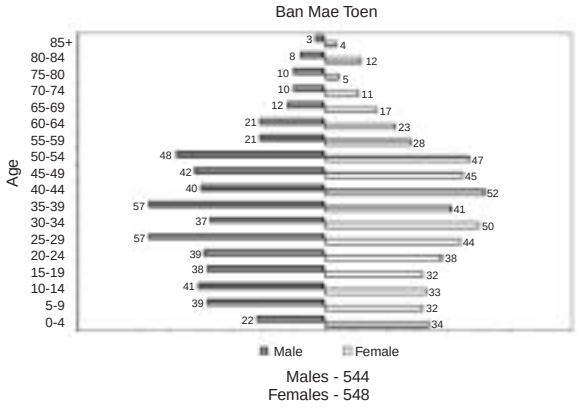

Fig 2–Population; age and sex structure: Ban Mae Toen village.

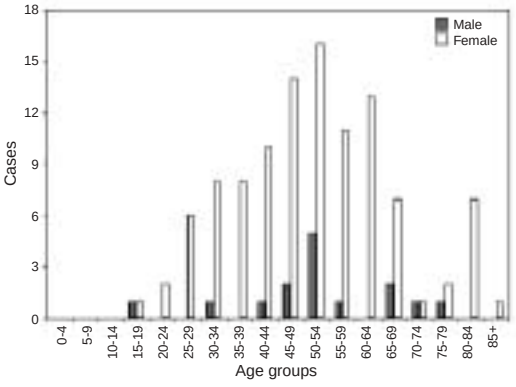

Fig 4–Goiter cases, numbers by age.

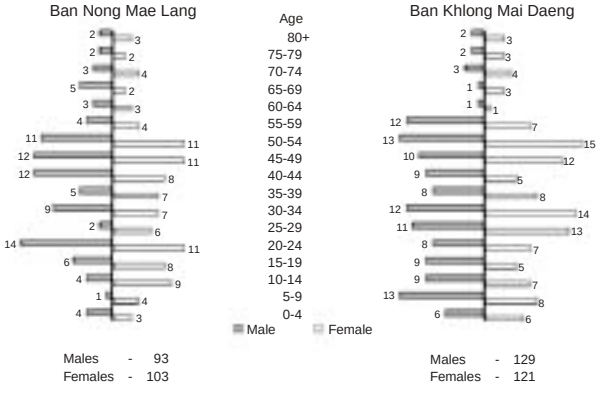

Fig 3–Sample population structures: two control villages.

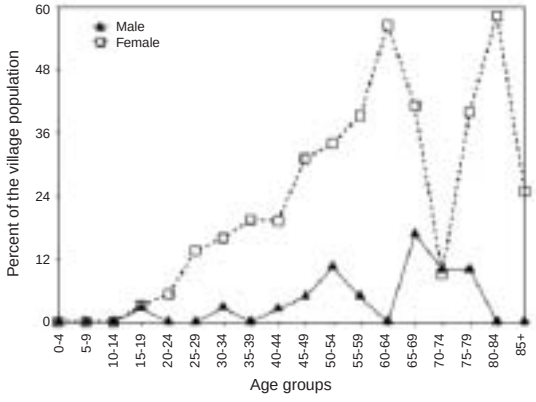

Fig 5–Goiter percentages in each age group.

Goiter

The questionnaire included all forms of goiter, most were assumed to be due to hypothyroidism. Goiter was found in 122 subjects, 11.2% of the total population of BMT (Fig 4). The proportion of women with goiter was greater than 1 in 3 for those aged >30 years and nearly 2 in 3 for those aged 60 to 80 years old (Fig 5). Goiter was found in 19.5% of females and 2.8% of males in BMT.

A grade 1 goiter (in our survey) was defined as only "palpable"; these might not indeed be early stage goiters. Only those persons with grades 2, 3 and 4 goiters were obvious cases of goiter. We found 72 persons (6.6%) in BMT out of a population of 1,092 with these obvious goiters (Fig 6). Of these, 67 (12.2%) were females, out of a total female population of 548 in all age groups, and the remaining 5 (1.1%) were male out of a population of 544. There was thus twelve-fold female predominance in obvious goiter cases in BMT. No cases of goiter were reported among subjects in the control villages.

Lower limbs deformity

One hundred males (18.4%) had lower limb deformity and 163 females (29.7%) had lower limb deformity in BMT (Fig 7).

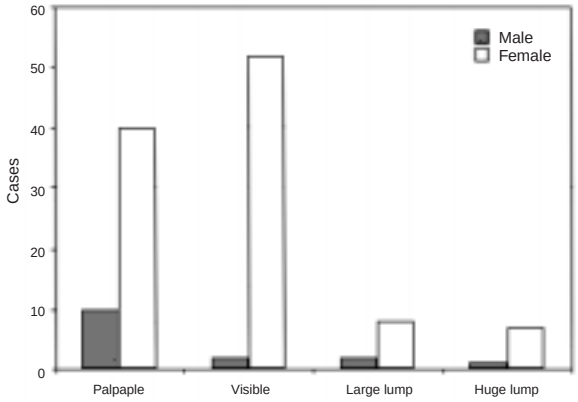

Fig 6–Goiter severity levels.

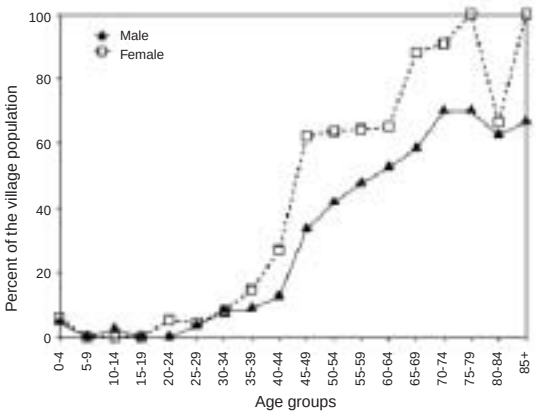

Fig 8–Deformity of lower limbs, percentages in each age group.

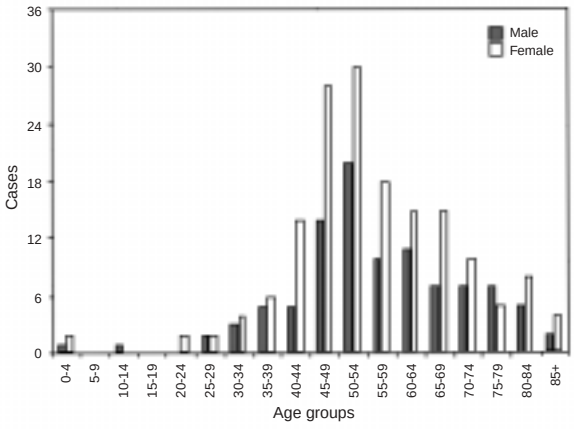

Fig 7–Deformity of lower limbs, numbers by age.

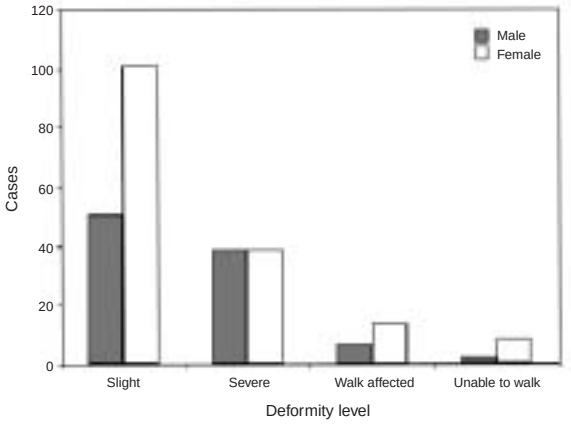

Fig 9–Deformity of lower limbs, severity levels.

Fig 8 shows at an age of 45 years, more than 1 in 3 males and 2 in 3 females have some degree of limb deformity. Among persons suffering from the most advanced lower limb deformity, 12 were unable to walk and 21 had difficulty in walking (Fig 9). Three persons in BMT used wheelchairs and two claimed to need them. One individual used crutches, 12 used walking sticks and a further 25 claimed to need to use walking sticks (Fig 9). Only 4% of males and 5.8% of females in the control villages had lower limb deformities.

Dental discoloration

Six hundred eighty-five residents of BMT (63%) (338 males and 347 females) had discolored teeth (Fig 10). Those over age 35 in BMT were more likely to have teeth with a major degree of staining (Figs 11 and 12). The severity and ages of those with tooth discoloration were similar between males and females. Dental discoloration was reported in only 6% of the sampled male population and 4% of the sampled female population from the control villages.

Table 3
Cases with multiple signs of ill health in BMT village. Cross tabulation of (A) goiter with (B) lower limb deformity, and (A) goiter with (C) dental discoloration by grade (defined in Fig 1).

(A) Goiter		(B) Lower limb deformity Grade				
	Total	4	3	2	1	Total
Grade 4	8	1	3	2	2	8
Grade 3	10	0	2	4	1	7
Grade 2	54	0	2	13	19	34
Grade 1	50	4	3	2	19	28
	122	5	10	21	41	77

(A) Goiter		(C) Dental discoloration Grade				
	Total	4	3	2	1	Total
Grade 4	8	1	3	1	1	6
Grade 3	10	0	2	6	0	8
Grade 2	54	1	16	20	12	49
Grade 1	50	2	4	20	19	45
	122	4	25	47	32	108

DISCUSSION

The high prevalence rate of goiter in BMT at all levels of severity resulted in this survey. Fig 13 shows the layout of the 245 houses in BMT. The shaded houses are those with at least one subject with a goiter. In terms of absolute numbers, more goiter cases occurred in people living near the lake. However, this apparent clustering did not reach a statistically significant level.

Goiters were significantly more common among females ($p< 0.01$); 107 females versus 15 males. The female predominance (7:1 among females: males) is a frequent finding in thyroid dysfunction studies, there was an even greater female predominance (12:1 females: males), in BMT if only severe goiters are considered. No goiters were seen in the control villages (Table 2).

Nearly half the BMT population suffers from leg discomfort; 18% of males and nearly 30% of females. The gender difference was not statistically significant. Some of the cases of lower limb deformity were severe, resulting in an economic impact. The number of cases of lower limb deformity in the control villages were significantly fewer ($p<0.01$) than in BMT.

The high numbers (>60% of the population) and ages affected by tooth discoloration were similar between males and females. Tooth discoloration rates were significantly fewer in the control villages than in BMT ($p<0.01$) (Table 1).

We compared goiter cases with limb deformity and tooth discoloration cases (Table 3). Of 122 goiter sufferers, 77 (63%)

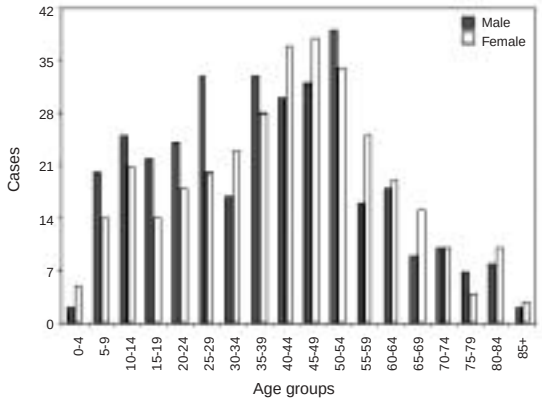

Fig 10–Dental discoloration cases, numbers by age.

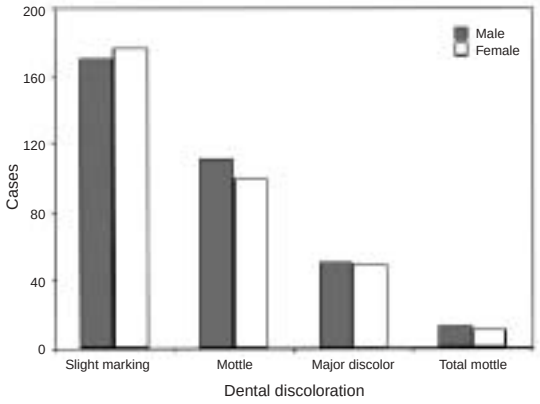

Fig 12–Dental discoloration severity levels.

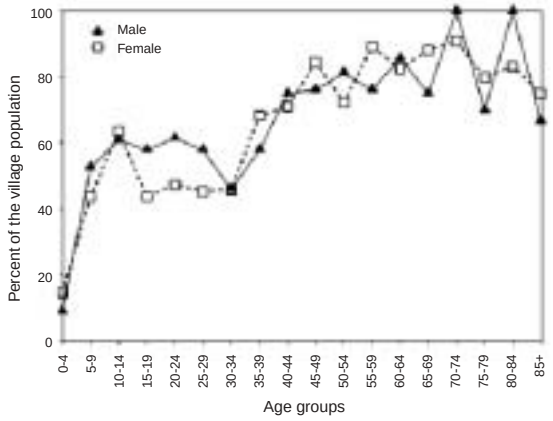

Fig 11–Dental discoloration, percentages in each age group.

had limb deformities and 108 (89%) had tooth discoloration. This cross-tabulation showed the more severe the goiter the more severe the limb deformity. Fifteen out of 18 persons with grade 3-4 goiter had major limb deformity (Table 3). The relationship between goiter cases and tooth discoloration cases was less clear since the majority of individuals in BMT had discolored teeth. Not all persons with discolored teeth suffered from limb deformity.

There were zero instances of goiter in the control villages and the figures for limb deformity and tooth discoloration were very low in the control villages compared to BMT (Table 1 shows the values expected if BMT prevalence rates had occurred). The absence of goiter in the two control villages implies a limiting geographic boundary of the described problems.

The seriousness and pervasiveness of the health problems studied in BMT demand further efforts to ameliorate these problems. The diagnoses and etiologies of the problems need to be made.

Several chemical agents, mostly consumed in the diet, have been suggested as an etiology of the problems observed (Ozsvath, 2009). Excess fluoride leads to clinical manifestations such as those seen in BMT: goiter, limb deformity and teeth discoloration (WHO, 2004; Doull *et al*, 2006). Two previous studies have suggested excess fluoride may be an etiology of the problems observed in BMT. The first was a professional dental survey carried out in July 2007 among 80 children at BMT primary school showing 32 children (40%) had fluorosis of their teeth of "mild" to

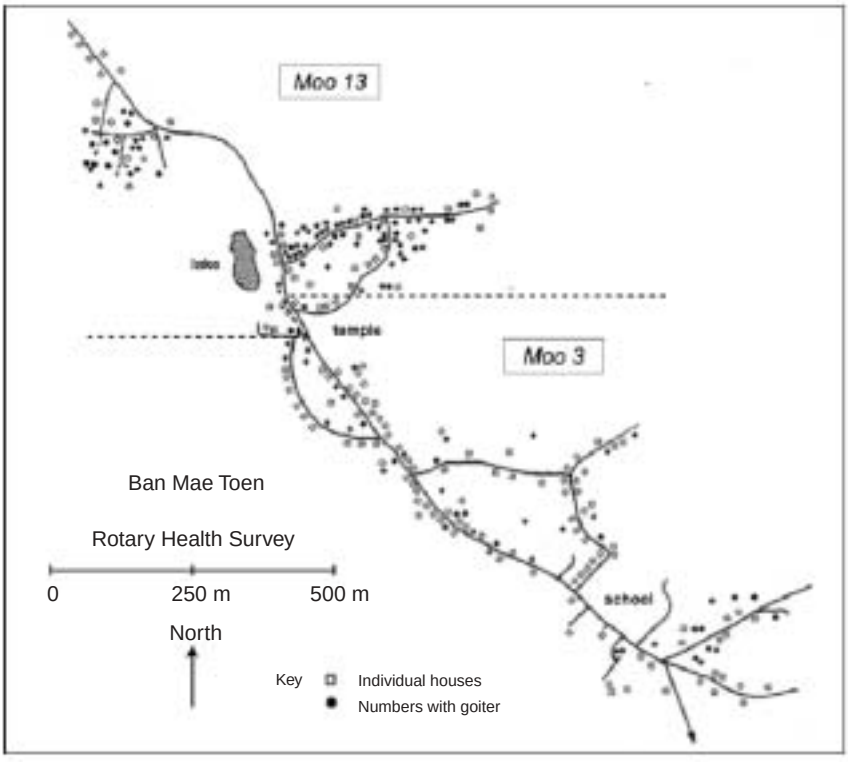

Fig 13–House lay-out of Ban Mae Toen, goiter cases shown.

"moderate" severity, another 14 had an "uncertain" level of severity; only 34 (42%) had normal teeth (Jutarat J and Choompolkul W, Unpublish report of Theon Community Hospital, 2007). The second study was of cases of bone fluorosis identified in Chiang Mai in 1972 (WHO, 2009). Water tested from a tank installed by the Rotary Club showed 0.34 mg/l of fluoride in 2009, compared to 4 mg/l in the lake water measured in 2002. Both sources had iodine below a detection level of 0.1 mg/l in 2009 [Central Laboratory (Thailand), 2009].

Iodine deficiency has been proved to be a direct cause of goiter (Delange, 1994). A major program (Eastman, 2009) to produce and distribute iodized salt to the Thai population has been in place since 2004, but "there has been little progress in eliminating IDD (Iodine deficiency diseases) in Thailand". The report states endemic goiter in Thai children has been controlled, however the Intelligence Quotient of children in the north fell from 87.9 to 84.2 between 1996 and 2002 (measured on the WHO-recommended average of 90-110). The province of Lampang, which includes BMT (which was visited by the ICCID team) is not included in the coverage of iodized salt at the household level. Other chemical imbalances, such as selenium, calcium, silicon, and magnesium, may also play a role in goitrogenesis (Hetzel and Maberly, 1986). To recognise and correct such an imbalance would require a well designed study of the geochemistry of BMT water supply and dietary intake.

In conclusion, this quantitative assessment of goiter, leg deformity and tooth

discoloration among residents of BMT in both prevalence and severity, raises public health concerns. The need is to take these problems seriously to protect not only the people of BMT but other similarly affected areas of Thailand.

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