Department of Health
REPUBLIC OF CHINA

25 August 1991/Vol. 7/No. 8

Epidemiology Bulletin

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Goiter in Fu-Teh Census Tracts of Ta-Chia Township, Taichung County (Continue)

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Discussion:

Endemic goiter is an important public health issue. Although goiter at one time was highly prevalent in Taiwan, the average prevalence rate of goiter dropped to below 5%[3] after the general iodization of salt in 1967. The goiter prevalence rate of school children in Putai and Peimen townships was found to be around 5%,[5] the goiter prevalence rates of school children of Kaomei and Hsichi primary schools were found to be 6.6% and 8.8% respectively in the present survey.

Many studies have tried to explain the causes of endemic goiter. Three theories seem to be most supportive of the experimental evidence: the iodine deficiency in nutrition, the existence of goitrogens in foods, and the quality of drinking water.[6]

The most important cause of endemic goiter is iodine deficiency. Hetzel estimated in 1983 that around 400 million people in Asia were still seriously affected by the deficiency of iodine.[7]

Around 97% of school children of Hsichi and Kaomei primary schools replied that they took iodized salt. Studies show that the T3/T4 ratio in non-iodine-deficiency area is 15:1, whereas in the iodine-deficiency area, the T3/T4 ratio goes up to 29-34:1.[8] The T3/T4 ratio found in the present survey is 15:1, showing that both areas are not iodine-deficient.

Excessive amounts of iodine in foods may also cause goiter. A good example is the endemic coast goiter in Hokkaido of Japan. Residents of that area consume for years iodinerich foods such as the edible giant seaweed (Laminaria japonica) abundantly available in that area.[9] Although Hsichi and Kaomei are along the coast, they do not produce kelp and seaweed in large quantities. One-quarter of students replied that they consumed seaweed on average once every 17 days. Therefore, the excess intake of iodine is not a concern.

Substances in foods that may cause goiter are called goitrogens. In 1929, Chesney succeeded in inducing goiter from mice by feeding them with cabbage. Other vegetables of the Cruciferae family have also been proved to be goitrogenic. The goitrogenic chemi-

cals are sulfocyanate and hetero-sulfocyanate. Yams, corn, and bamboo shoots contain cyanogen which may turn into sulfocyanate after consumption.[10] In a study in Darfur Province of Sudan, some ingredient of millet is found to have goiter-inhibitive action and goitrogenic function under conditions of iodine deficiency.[11] Because cabbages and corn are not the staple foods of students of Hsichi and Kaomei, their goiter is not related to these foods.

In 700 B.C., there was already in China some mention of the relationship between goiter and drinking water. Endemic goiters in Colombia (Caldas in 1808 and Camacho in 1810) were considered to be attributable to the quality of drinking water of these areas. High mineral content, particularly of calcium and magnesium, and bacterial contamination of drinking water are considered the most important goitrogenic factors.[10] A study conducted by Day and Powell-Jackson in a village in the Himalayas in 1972 found that the prevalence rate of goiter was positively related to the low-iodine, high-fluoride, high-calcium, high-magnesium and the total hardness (calcium carbonate content) of the drinking water.[12] However, a study in Greece by Malamos found that the prevalence rate of goiter was negatively related to the calcium content of soil, and was not related to the calcium content of drinking water.[13] Though the two findings are inconsistent, the general belief is that the goitrogenic effect of calcium and magnesium may become active in areas of iodine deficiency. A study by Das in Nigeria in 1989 also supports this viewpoint, the calcium carbonate content of the underground water of Fu-Teh census tracts does not exceed the upper limit (see Table 7), while that of Tungan census tracts is higher than Fu-Teh census tracts. But because the two areas are not iodine deficient, this theory does not apply.

Kawada, by feeding female mice with high-manganese water, found that mice developed goiter and slight inhibition of the thyroid hormone.[15] Though the manganese content of water in Fu-Teh, Tungan and Chien-hsing is higher than other areas, the epidemiological investigation failed to establish such a relationship. However, no research has ever reported the relation between iron and goiter.

A study of 41 areas in Colombia found a significant relationship between the prevalence rate of goiter and the geological composition of water strata and watersheds. Villages located in the lower stream of high organic rocks such as coals and shales tend to have higher prevalence rates. On the contrary, areas collecting drinking water from rivers going through low organic rocks such as igneous rocks have lower prevalence rates of goiter. Thus, the high organic sedimentary rocks in east Kentucky is perhaps the source of goitrogens in the water.[6]

Some bacteriological studies indicate that bacterial contamination is the pathogenesis of endemic goiter. In some villages in Greece, more Escherichia coli or bacillary microbes in drinking water are found in high endemic areas than in low endemic areas.[13] Vought et al in a study in a high endemic area in Richmond, Virginia, identified some goitrogenic substances from the E. coli isolated from drinking water, the molecular weight being around 100,000.[16] In laboratories, some immunoglobulins promoting the growth of the thyroid gland have been found on some goiter patients. In addition, the serous cells of thyroid gland in men and the antigen determining factors of E. coli are immunologically interactive.[18,19] By this, antibodies of some bacteria may promote the

growth of the thyroid gland, they play an important role in the pathogenic mechanism of endemic goiter. The study in Colombia also shows that a high prevalence rate of goiter is also related to the total number of bacteria in the water pipe.[20] The water quality testings conducted by the Environmental Protection Administration of the Republic of China show that the number of baterial colonies is higher in Fu-Teh, Tungan and Chienhsing. The prevalence rates of both Hsichi and Kaomei compared with that of students of Putai Primary School, which is in a coastal township with similar socio-economic characteristics in the non-blackfoot endemic area with public water supply in Chayi county are 8.8% vs 2.1% and 6.6% vs 2.1%,[5] respectively the differences are statistically significant [$p < 0.0001$ for both]. The levels of thyroid hormone of the two schools are higher than that of the Putai Primary School; that of Hsichi is higher than Kaomei.

One may thus infer from the above empiricalevidence that the goiter in Hsichi and Kaomei is primarily related to the quality of the underground water. The high total number of bacterial colonies in drinking water may lead to more goitrogens and thyroid gland stimulators in the drinking water. The above discussion also shows that calcium, magnesium, manganese and iron may not be attributable to the goiter in these areas. Though the prevalence rates of Hsichi and Kaomei are not significantly different, significant difference is found among female students. In selecting control groups, such factors as the depth of wells, the source of spring water, the composition of soil, and the water source around the industrial area which are considered to be relevant to goiter were not compared. Thus, further analysis is needed to study the relationship between the industrial zoning and the goiter of these areas before a final conclusion can be reached.

In the present survey, thyroid antibody is found in only 4% of the goiter students. According to a study by T.C. Chang,[21] serum antithyroglobulins or antithyroid microsomal antibodies can be found in 98.6% of the Hashimoto thyroiditis and 79% of the Griffiths goiter patients. Therefore, the major reason of goiter of these students is not autoimmune but rather simple goiter.

Conclusion and Recommendations:

The prevalence rates of goiter in Hsichi and Kaomei primary schools are 8.8% and 6.6% respectively. The prevalence rate of goiter in the Taiwan Area as a whole has dropped to 4.3% after the general iodization of salt. In comparison, the prevalence rates of these two schools are higher, though the difference between the two schools is not statistically significant. The pathogenic factors are considered to be the quality of the underground water consumed by students of these schools. The number of baterial colonies perhaps is high, thus leading to more goitrogens and thyroid gland stimulators in the water.

An important measure for the prevention of goiter in these areas is to improve the quality of drinking water through adequate sterilization and filtration of water. Local residents of those areas should also be encouraged to continue to take iodized salt. The survey once again reminds us of the importance of protecting the sources of water supply.

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References:

1. Perez C, Scrimshaw NS, Munoz JA: Technique of endemic goitre surveys. In: Endemic Goitre. WHO monograph series, NO. 44, Geneva: WHO, 1960:369-383.
2. Chen KP, Wu HY, Lin CC et al: A study on the distribution of endemic goiter of school children in Taiwan. In: Memoirs of the College of Medicine, National Taiwan University, Vol 17, Taipei, National Taiwan University, 1972: 61-72.
3. Chen KP, Lee TY, Hsu DY et al: Studies on the effect of salt iodization on endemic goiter, Taiwan. I. Mass survey on goiter of school children. J Formosan Med Assoc 1976; 75:471-482.
4. Thilly CH, Delange F, Stanbury JB: Epidemiologic surveys in endemic goiter and cretinism. In: Stanbury JB, Hetzel BS eds. Endemic goiter and Endemic Cretinism. New York; John Wiley Sons, 1980: 157-183.
5. Chang TC, Hong MC, Chen CJ: Higher prevalence of goiter in a blackfoot disease-endemic area in Taiwan. J formosan Med Assoc (in press).
6. Gaitan E: Goitrogens in food and water. Ann Rev Nutr, 1990; 10:21-39.
7. Hetzel BS: Iodine deficiency disorders (IDD) and their eradication. Lancet, 1983; 2:1126-9.
8. Hershman JM, Due DT, Sharp B et al: Endemic goiter in Vietnam. J Clin Endocrinol Metab, 1983; 57:243-9.
9. Suzuki H, Higuchi T, Sawa K, Otaki S, Horinchi Y: Endemic coast goitre in Hokkaido, Japan, Acta Endocrinol, 1965; 50:161.
10. Gaitan E: Goitrogens in the etiology of endemic goiter. InL Stanbury JB, Hetzel BS eds. Endemic Goiter and Endemic Cretinism. New York, John Wiely Sons, 1980: 219-236.
11. Eltom M, Hofrander Y, Torelm I: Endemic goiter in the Darfur region (Sudan). Acta Med Scan, 1984; 215:467-475.
12. Day TK, Powell-Jackson PR: Fluoride, water hardness and endemic goiter. Lancet, 1972; 1:1135.
13. Malamos B, Koutras DA, Pigopoulos GA et al: Endemic goiter in Greece, some new epidemiologic studies. J Cli Endo, 1971; 32:130-9.
14. Das SC, Isichei UP, Egbuta JO, Banwo AI: Cations and anions in drinking water as putative contributory factors to endemic goiter in Plateau State, Nigeria. Trop Geogr Med, 1989; 41:346-352.
15. Kawada J, Nishida M, Yoshimura Y, Yamashita K: Manganese ion as a goitrogen in the female mouse. Endocinol Jpn, 1985; 32: 635-643.
16. Vought RL, Brown FA, Sibinovic KH: Antithyroid compound(s) produced by Escherichia coli: preliminary report. J Clin Endocrinol Meta, 1974; 38:801-865.
17. Drexhage HA, Bottazzo GF, Doniach D, Bitensky L, Chanyen J: Evidence for throid-

growth-stimulating immunoglobulins in some goitrous thyroid diseases. Lancet, 1980; 2: 187-192.

18. Weiss M, Ingbar SH, Winbold W, Kasper DL: Demonstration of a saturable binding site for throtropin in Hersinia enterolitica. Science, 1983; 219: 1331-33.
19. Weiss M, Kasper DL, Ingbar SH: A specific saturable binding site for thyrotropin (TSH) in Yersinia enterolitica and E. coli. Clin Res. 1982; 30:494.
20. Gaitan E, Medina P, Derouen TA, Zia MS: Goiter prevalence and bacterial contamination of water supplies. J Clin Endocrinol Meta, 1980; 51: 957-961.
21. Chang TC, Chang CC, Chen FW: Serum antithyroglobulin and anti-thyroid mi-

Table 7. Testings for Water Quality
(Environmental Protection Administration, the Executive Yuan)

Well No.	Site	Depth (m)	No. of Colony (per ml)	Lead mg/L	Mn mg/L	As	Fe	Cr	Sn	Hg
L92	Lungchuan	10	0	ND	0.354*	ND	0.105	ND	ND	0.001
L93	Tungan	25	5	0.006	1.316*	0.001	0.731*	ND	ND	ND
L94	Tungan	6	90	ND	0.318*	0.004	2.788*	ND	ND	ND
L95	Tungan	8	30	ND	0.686*	0.006	5.988*	ND	ND	0.001
L96	Tungan	6	110*	ND	0.353*	0.001	0.135	ND	ND	ND
L96	Tungan	6	453*	ND	0.493*	0.002	2.985*	ND	ND	ND
L98	Futeh	10	1598*	ND	0.311*	0.003	4.090*	ND	ND	ND
L99	Hsichi	30	20	ND	ND	0.001	0.023	ND	ND	0.001
L100	Chienhsing	6	370*	ND	0.176*	0.002	0.158	ND	ND	0.001
L101	Tungan	10~20	35	ND	1.569*	0.033	4.949*	ND	ND	ND
L102	Lungchuan	730	5	ND	0.002	0.001	0.044	0.021	ND	0.001
L103	Chienhsing	10~20	760*	ND	0.132*	0.001	0.419*	ND	ND	ND
Normal Value			100	0.05	0.05	0.05	0.3	0.05	0.01	0.002

Well No.	Site	Chloride mg/L	Fluoride mg/L	Cyanide mg/L	Phenol mg/L	Amino-Nitrate mg/L	Ionization Amine N mg/L	Total Solution Volume mg/L	Total Hardness $Caco_3$ mg/L	pH Value
L92	Lungchuan	69.4	0.138	0.002	0	3.72	0.157	776	365	6.85
L93	Tungan	22.9	0.088	0.001	0.101*	0.09	0.732*	843*	521*	6.66
L94	Tungan	54.2	0.173	ND	0.069*	0.16	0.405	1054*	557*	6.76
L95	Tungan	64.5	0.183	0.002	ND	0.17	0.304	1084*	539*	6.77
L96	Tungan	577*	0.195	0.002	0.083*	0.58	0.288	914*	513*	6.65
L96	Tungan	56.3	0.169	0.002	0.069	1.10	0.625*	1434*	491	6.75
L98	Futeh	13.4	0.148	ND	ND	0.38	0.177	548	362	6.82
L99	Hsichi	8.9	0.060	0.001	ND	1.94	0.035	424	338	7.03
L100	Chienhsing	8.4	ND	ND	ND	0.69	0.131	554	363	6.83
L101	Tungan	57.6	0.265	0.002	0.445*	0.087	0.046	704	389	6.55
L102	Lungchuan	35.9	0.941*	ND	ND	3.66	0.155	569	317	6.82
L103	Chienhsing	12.5	0.162	ND	ND	1.09	0.157	445	525	7.13
Normal Value		250	0.8		0.001	10	0.5	800	500	6.5-8.5

* Higher than normal value; ND lower than normal value