

RECORDING WATER CONSUMPTION AND DENTAL FLUOROSIS AMONG CHILDREN IN HIGH FLUORIDE AREAS IN NORTHERN PART OF THAILAND BY GEOGRAPHIC INFORMATION TECHNOLOGY

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Abstract :

A policy of water provision for the rural population in Thailand has effected in dental fluorosis all over the country. The 14% of the total deep wells dug to serve as new water sources has exceeded fluoride concentration in drinking water. Fluoride excessive intake may result in several adverse health effects. The first sign of fluoride toxicity is dental fluorosis. Some areas in northern part of Thailand, fluoride concentrations in public water sources are higher than 10.0 mg/l. The objective of this study was to record water consumption and dental fluorosis among children who live in high fluoride areas in northern part of Thailand by geographic information technology. This study was carried out in 2021-2022. The subjects (n=537) were all the school children in aged 6–12 years that high fluoride areas in Chiangmai, Lamphun, Lampang and Phayao provinces. Samples of drinking water were collected and their fluoride concentration determined using the standard method. The results showed that 77.7% of the subjects consume bottled water and 13.6% from piped water. Unsafe water was drunk by 27.9% of the subjects. The village waterworks at Muang district, Lamphun province had the highest fluoride concentration of 14.0 mg/l. The prevalence of dental fluorosis (moderate-severe) in the children was 11.3% also in Lamphun province. Fluoride mapping is <https://sites.google.com/view/fluoridemapping/home>. There are many approaches or methods to solve the problem of high fluoride in drinking water, such as reverse osmosis technology, replacement of water sources with new ones and join another water system in other town or region. When piped water was provided by the government, people always considered it to be safe. Piped water is convenient to use clean and clear. However, it must be safe and not contain excessive fluoride concentration. Thailand needs a law to ensure that only safe water can enter the piped water system. In addition, the routine surveillance of water quality is also important.

Introduction :

Naturally occurring high fluoride levels in groundwater is a complicated issue for drinking water providers in many regions of the world¹. Fluorides in small quantities have a practical role in the protection against dental caries. However, its excessive intake may result in several adverse health effects. The first sign of fluoride toxicity is dental fluorosis. The risk of dental fluorosis is mainly related to the systemic consumption of fluorides during the first six years of age². Enamel fluorosis is a mottling of the tooth surface that is attributed to fluoride exposure during tooth formation. The process of enamel maturation consists of an increase in mineralization within the developing tooth and concurrent loss of early-secreted matrix proteins. Exposure to fluoride during maturation causes a dose-related disruption of enamel mineralization resulting in widening gaps in its crystalline structure, excessive retention of enamel proteins, and increased porosity³.

The severity of dental fluorosis is also dependent upon fluoride dose and the timing and duration of fluoride exposure Besides dental fluorosis, chronic excessive consumption of fluoride may lead to skeletal fluorosis and hip fractures among the elderly⁴.

A well-intentioned policy of water provision for the rural population in Thailand has resulted in bringing a developmental disturbance of dental enamel, dental fluorosis, to over 8,500 communities all over the country. This has involved approximately 14% of the total deep wells dug to serve as new water sources during 1981–1990, a period known as the International Drinking Water Supply and Sanitation Decade.

Dental Fluorosis in Thailand occurs in specific locations scattered from north to south. People who live in these locations have lived with the fluorosis problem for generations. The nature of this problem differs from one locality to another in terms of severity, geographic location, fluoride concentration, socio-economic and culture dimensions. There are several regions in Thailand with fluoride concentration in public water supplies higher than 10.0 mg/l. The objective of this study was to record water consumption and dental fluorosis among children who live in high fluoride areas in northern part of Thailand by geographic information technology.

Methodology :

This study was conducted in 2021-2022. This study used purposive sampling. The subjects (n=537) were all the school children in aged 6–12 years who live in areas with fluoride concentration higher than 0.70 mg/l in Chiangmai, Lamphun, Lampang and Phayao provinces. Samples of drinking water were collected and their fluoride concentration. They were collected and their fluoride concentration determined using the standard method and analyzed the concentration of fluoride with the Ion Selective Electrode (ISE) method and using an ORION model 4 star at laboratory of ICOH.

A total of 537 school children were screened for dental fluorosis. Classification and was carried out by a dentist. The presence and severity of dental fluorosis was recorded using Dean’s Index in affected and non-affected area school children. Based on the symptoms, dental fluorosis was classified into 6 categories.

Dean’s Index Criteria⁵

Criteria	Definition
0 = Normal	Enamel surface is smooth, glossy and usually a pale creamy white color.
1 = Questionable	The enamel shows slight aberrations in the translucent normal enamel and which may range from a few white flecks to occasional spots
2 = Very Mild	Small, opaque, paper-white areas scattered irregularly over the tooth but involving less than 25% of the labial tooth surface
3 = Mild	White opacities of the enamel involving more than 25% but less than 50% of the tooth surface
4 = Moderate	The enamel surfaces show marked wear, and brown staining is frequently a disfiguring feature
5 = Severe	The enamel surfaces are severely affected and the hypoplasia is so marked that the general form of the tooth may be affected. There are pitted or worn areas and brown stains are widespread; the teeth often have a corroded appearance

Inclusion Criteria :

- Children aged 6-12 years who were born and live in this areas
- Without ever moving in or moving out of the area
- Thai Nationality
- Volunteered to participate in the research

Exclusion Criteria :

- A congenital disability and wearers of prosthetic limbs
- People with neurological problems

Statistical analysis :

All statistical analysis will be performed by using computer program. The data were analyzed statistically; number, percentage, mean, standard deviation.

Results and Discussion :

Table1 Number and percentage of drinking water by province and source of water

Source of water	Province			
	Lamphun	Chiangmai	Lampang	Phayao
bottled water	150(73.9)	142(85.0)	67(74.4)	59(77.6)
piped water	32(15.8)	16(9.6)	19(21.1)	6(7.9)
vending machine	12(5.9)	9(5.4)	-	-
rain water	6(3.0)	-	-	10(13.2)
shallow well water	-	-	2(2.2)	-
ground water	3(1.5)	-	2(2.2)	1(1.3)
Total	203	167	90	76

Table2 Number and percentage of drinking water and fluoride concentration(mg/l)

Province	Drinking water		
	F≤0.70 (mg/l)	F>0.70 (mg/l)	min-max (mg/l)
Lumphun	144(75.4)	47(24.6)	0.10-14.0
Chiangmai	104(62.3)	63(37.7)	0.10-6.74
Lampang	54(60.0)	36(40.0)	0.10-10.8
Phayao	76(100)	-	0.10-0.70
Total	378(72.1)	146(27.9)	0.10-14.0

The results showed that 77.7% of the subjects consume bottled water and 13.6% from piped water. Unsafe water was drunk by 27.9% of the subjects. The main sources of public water were from village tap water and waterworks, and fluoride concentration were between 0.10-14.0 mg/l. Lamphun province had the highest fluoride concentration of 14.0 mg/l.

Table 3 Number and percentage of severity of dental fluorosis by province

province	N	number of normal teeth	questionable	very mild	mild	moderate	severe
Lumphun	204	121(59.3)	25(12.3)	21(10.3)	14(6.9)	9(4.4)	14(6.9)
Chiangmai	167	141(84.4)	5(3.0)	10(6.0)	5(3.0)	-	6(3.6)
Lampang	90	55(61.1)	13(14.4)	7(7.8)	7(7.8)	5(5.6)	3(3.3)
Phayao	76	69(90.8)	3(3.9)	1(1.3)	2(2.6)	-	1(1.3)
Total	537	386(71.9)	46(8.6)	39(7.3)	28(5.2)	14(2.6)	24(4.5)

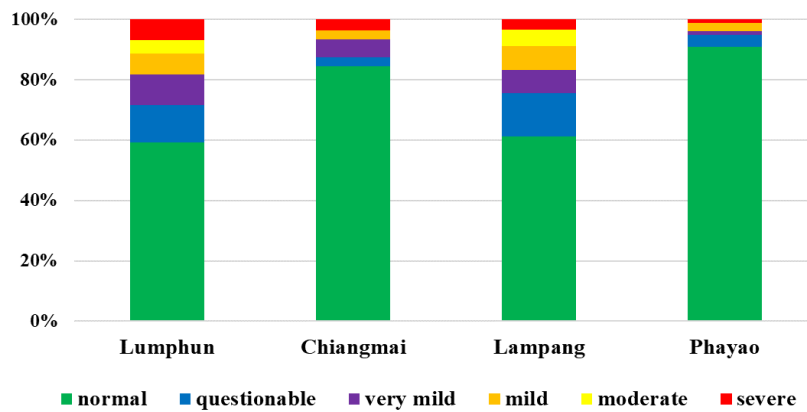


Figure1. Percentage of severity of dental fluorosis by province

The prevalence of dental fluorosis in children was 28.1%. The distribution of these severity in the province of Lamphun, Lampang, Chiangmai, Phayao was 40.7%, 38.9%, 15.6% and 9.2% respectively. When classified by severity, it was found that Lamphun had the most severe level of dental fluorosis at 6.9%. The enamel surfaces are affected and hypoplasia is so marked that the general form of the tooth may be affected. The major diagnostic sign of this classification is discrete or confluent pitting. Brown stains are widespread and teeth often present a corroded-like appearance.

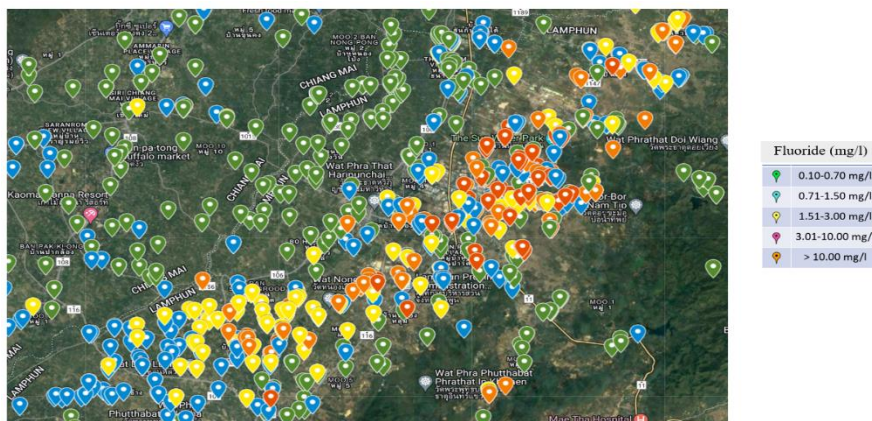


Figure2. Fluoride Mapping (<https://sites.google.com/view/fluoridemapping/home>)

Conclusion :

This study suggests that dental fluorosis is a public health problem. Excessive intake of fluoride during enamel development can lead to enamel fluorosis, a condition of the dental hard tissues in which the enamel covering of the teeth fails to crystallize properly, leading to defects that range from barely discernable markings to brown stains and surface pitting.

The villages water contained fluoride concentration more than standard (fluoride standard in Thailand ≤ 0.70 mg/l) and need to be removed fluoride or else alternative sources of drinking water provided for the community. A sustainable solution to the problem of fluoride contamination in drinking water is to change the drinking water source is as follow ; reverse osmosis technology, replacement of water sources with new ones and join another water system in other town or region.

Although drinking water is the main source of fluoride intake, fluoride intake from foods could also be high, depending on cooking methods. Soaking and boiling foods in fluoride containing water increases fluoride intake. Therefore, it is necessary to re-evaluate the fluoride intake from food and drinking water considering the methods used for cooking food in each country and region⁶.

When piped water was provided by the government, people always considered it to be safe. It is convenient to use, clean, clear, and never causes diarrhea. However, it must be safe and not contain excessive fluoride concentration. Thailand needs a law to ensure that only safe water can enter the piped water system. Adequate information and recommendations help people themselves to make informed decisions and regulate health risks from drinking water. Strategic plans and public awareness campaigns on fluorides in drinking water and health impact should be implemented. In addition, the routine surveillance of water quality is also important.

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