

Does drinking water with raised fluoride content affect the thyroid hormone status: A study from Tharparker Pakistan

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Abstract

Objective: To determine the effect of consuming water with high fluoride content on thyroid hormone status.

Method: The comparative cross-sectional study was conducted at Sammu Rind village of district Tharparkar, Pakistan, where ground water was the only source of drinking and had fluoride content >6-8mg/dL, and another set of people from Gadap Town, Karachi, where ground water had fluoride level of 0.3mg/L. Thyroid profile, including serum thyroid stimulating hormone, free triiodothyronine and free thyroxine, were checked for both the exposed and the unexposed groups, and data was cross-tabulated with thyroid profile to check statistical significance. Data was analysed using SPSS 20.

Result: Of the 242 subjects, 121(50%) each were in the exposed and the unexposed group. Among the exposed, 15(12.4%) people had hypothyroidism, 104(86%) had euthyroid and 2(1.6%) had hyperthyroid. Corresponding values in the unexposed group were 10(8%), 105(87%) and 6(5%). The difference was not statistically significant ($p>0.05$).

Keywords: Desert, Thyroid hormones, Fluorosis, Iodine, Hypothyroid, Hyperthyroidism. (JPMA 72: 228; 2022)

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Introduction

The widespread presence of fluoride in the environment and the threat it poses to millions globally is an endemic issue in many countries, including Pakistan.^{1,2} The World Health Organisation (WHO) endorses that the fluoride quantity in drinking water should not be >1.5mg/L.³ It is known that fluoride is more electronegative than iodine, and it can easily displace iodine within the body by affecting the function of the thyroid gland and affecting the pituitary thyroid axis. The link between fluoride and raised thyroid stimulating hormone (TSH) has been established even when triiodothyronine (T3) and thyroxine (T4) levels remain normal, suggesting that fluoride can play a part in subclinical hypothyroidism.⁴ Thyroid is essential for the functional and neurological development of an individual. Fluoride is found to impair thyroid function, but it remains difficult to predict at what concentration and under what circumstances these effects can occur.⁵ Sequence of fluoride impact on thyroid was first reported 150 years ago.⁶ The collection of fluoride in the thyroid tissue is predominantly more than any other tissue except kidney. In certain cases, mild atrophy of the follicular epithelium, swelled endoplasmic reticulum in follicular cells, and morphological changes lead to the belief of decreased hormonal function.⁶ Nonetheless, many studies disclosed that fluoride therapy does not

influence weight and morphology of the thyroid gland.⁷

To date, there are no published studies in Pakistan to evaluate the effect of drinking water with raised fluoride content on thyroid function test. The current study was planned to determine the effect of consuming water with high fluoride content on thyroid hormone status.

Subjects and Methods

The comparative cross-sectional study was conducted at Sammurand village (exposed area) and Gadap town (unexposed area). After approval from the institutional ethics review board (2008) Dow university of health sciences, the study started (2008-2016) The sample size was calculated using the WHO calculator for matched case-control studies using the formula for calculating the difference between two population proportions.⁸ Confidence level 95% and margin of error 10% were used in the formula:

$$n = (p_1(1-p_1) + p_2(1-p_2)) * (Z_{\alpha}/E)^2$$

The final sample (242 ,121 each group) was inflated to cover up for non-respondents and dropouts. The sample was raised using probability systematic sampling technique from among people selected from Sammu Rind village, which is located 40km southeast of Chachro Town of district Tharparkar, Pakistan, where ground water was the only source of drinking and had fluoride content >6-8mg/dL, and another set of people from Gadap Town, which is situated in northwest Karachi close to Hub River

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that separates the two provinces of Sindh and Balochistan. The ground water in Gadap had fluoride level of 0.3mg/L. In all samples taken from wells in the area six months apart fluoride level was <1mg/litre which is the WHO recommended level.³

In case of the exposed group, every one in 15 villagers was selected. In case of denial of consent, the next villager was approached. Among the unexposed, as the total population was double than that of the exposed group, one out of every 30 residents was selected randomly.

Permanent residents of the villaged aged >12 years of either gender were included, while those who were immigrants were excluded. In Gadap, those aged >12 years were selected and the sample was matched for gender and age with the exposed group.

As there were limited facilities available in the remote area, the participants moved to a tertiary care hospital in Karachi for further tests and analysis after providing informed consent. Venous blood samples were acquired under aseptic condition. The sample was investigated for thyroid profile at the institutional laboratory. For fluoride estimation in water, Fluoride Ion Selective Electrode (FISE) method was used. T3, T4, TSH were analysed on semiautomatic immunoassay analyser (Immulite 2000 and Eley 2010).

Serum TSH <0.4 was considered hyperthyroid and level >4 was taken as hypothyroid. Reference values for free T4 and free T3 were taken as 4.5-12.5ug/dL and 1.2-2.8nmol/L respectively.

All participants were interviewed in the regional language and demographic variables, including age and gender, were recorded, Data was analysed using SPSS 20. Frequencies and percentages were calculated for qualitative variables. Chi-square test was used where necessary. P<0.05 was taken as statistically significant.

Result

Of the 242 subjects, 121(50%) each were in the exposed and the unexposed group. Among the exposed, 15(12.4%) people had hypothyroidism, 104(86%) had euthyroid and 2(1.6%) had hyperthyroid. Corresponding values in the

Table-2: Thyroid status in the two groups.

Subjects	TSH Levels			Total	P value
	Low	Normal	High		
Exposed	2	104	15	121	0.223
Unexposed	6	105	10	121	
	8	209	25	242	

unexposed group were 10(8%), 105(87%) and 6(5%). The difference was not statistically significant (p>0.05).

The mean age in the exposed group was 33.82±14.10 years, while in the unexposed group it was 33.33±11.67 years. In the exposed group, there were 90(74.4%) males compared to 84(69.4%) in the unexposed group.

Serum TSH, free T3 and free T4 values were compared between the two groups (Table-1).

Among the exposed, 15(12.4%) subjects had hypothyroidism, 104(86%) had euthyroid and 2(1.6%) had hyperthyroid. Corresponding values in the unexposed group were 10(8%), 105(87%) and 6(5%). The difference was not statistically significant (p>0.05) (Table-2).

Discussion

The current study found no noticeable change in thyroid hormone between those exposed to higher fluoride content in water than those who were unexposed. Similar results were found in a study done on the general population in Canada.⁹ One study did not detect altered levels of thyroid hormone in 65 individuals living in India with dental fluorosis.¹⁰

Iodine transporter found in the thyroid gland acquire negatively-charged ions alongside iodide, while the fluoride ion is generally smaller and does not give the impression of being the iodide ion.¹¹ It has been proposed that a specific virulence of fluoride for thyroid gland does not exist for the reason that fluoride does not accumulate in the thyroid gland.¹² In addition, several studies have raised the likelihood that the goitrous outcome cannot exclusively be due to fluoride. It can be attributed to certain additional substances in the water, like calcium or other elements that can enhance the effect of fluoride.¹³ The current study was conducted in an area

Table-1: Thyroid profile of the subjects.

Thyroid Profile	Exposed				Unexposed			
	Minimum	Maximum	Mean	Std.deviation	Minimum	Maximum	Mean	Std.deviation
Serum TSH	0.02	10.1	2.59	1.69	0.01	6.5	1.94	1.29
Serum T4	1.21	18.46	10.43	2.34	3.04	18.21	8.28	2.16
Serum T3	1.34	4.37	2.59	0.56	1.25	4.24	2.04	0.49

TSH: Thyroid stimulating hormone, T3: Triiodothyronine, T4: Thyroxine.

where water was checked for other elements and all were found to have standard levels except fluoride.

Results of the current study also showed there was no significant difference between the exposed and the unexposed groups. Thyroid function tests remained constant even regardless of the with the fluoride content in the drinking water. However, there are certain studies that showed positive association between thyroid hormone and fluorosis.¹⁴ A comparative study of fluoride ingestion level, serum thyroid hormone and TSH level derangement among schoolchildren from endemic and non-endemic fluorosis areas done in remote areas of India showed significantly altered thyroid levels.¹⁵ In a group of youngsters, aged 8-12 years living in an endemic fluorosis area in China, TSH levels were appreciably raised.¹⁶ Another study done in India's Gaya region showed that fluoride toxicity resulted in thyroid dysfunction, especially in children, with or without dental fluorosis.¹⁷ A study in Iran also favoured hypothyroidism with higher fluoride concentration in drinking water.¹⁸ An experimental study on rats revealed that extended low-dose vulnerability to fluoride affects the anatomy and physiology of the thyroid gland, leading to hypothyroidism.¹⁹ Drinking water with increased fluoride content has negative health outcomes, but as far as thyroid level is concerned, the current study did not find any such impact. More prospective studies are, however, required to conclusively establish the findings.

There are certain limitations of the current study as there was no estimation of the prevalence of hypothyroidism or hyperthyroidism in the study areas. Also, family history of thyroid illness and iodine status was not taken. Children and those with crippling injuries had to be left out as they could not travel to the city. There was also a disproportionately low number of female subjects as most of them were not allowed to travel alone owing to cultural norms in the area.

Conclusion

Drinking water with raised fluoride level was found to have no effect on thyroid profile. Majority of the study population had euthyroid despite drinking water with high fluoride content.

Disclaimer: The text is based on a PhD thesis submitted at the Dow University of Health Sciences (DUHS), Karachi.

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