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Is water fluoridation correlated with hypothyroidism?

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Summary:

Introduction: Hypothyroidism is a global health problem. Primary thyroid hormone deficiency may be caused by a wide spectrum of health problems, e.g. chronic autoimmune thyroiditis, postpartum thyroiditis, iodine deficiency, thyroid or parathyroid surgery and drugs. In recent years, scientific studies have also been published indicating a correlation between excessive intake of fluoride and hypothyroidism. Fluoride is added to the water sources of many countries.

Objective: The purpose of the study was to review and compare currently available data on PubMed about fluoride-induced hypothyroidism.

A brief description of the state of knowledge: Evidence based knowledge suggests that there is a potential relationship between water fluoridation and endocrine system disorders, especially hypothyroidism. Current studies indicate that TSH hormone levels get elevated with increased fluoride intake. The reason is supposed to be that fluorine is more electronegative than iodine and therefore easily displaces iodine from the body, thus affecting thyroid function.

Conclusions: Current studies do not clearly show a simple correlation between excessive fluoridation of drinking water and the occurrence of hypothyroidism. However, inconclusive scientific evidence and the prevalence of hypothyroidism in the population indicate the need for further research in this area.

Key words: drinking water fluoridation; fluoride; hypothyroidism;

1. Introduction:

Thyroid deficiency

Hypothyroidism is a global health problem. It is caused by thyroxine (T4) deficiency, which leads to triiodothyronine (T3) level decrease and general metabolism decrease. Clinical manifestation includes: fatigue, low energy, tiredness, weight gain, constipation or memory changes and paraesthesia [1]. This dysfunction of thyroid is widespread over the world, more frequently in women. The prevalence of hypothyroidism is estimated between 2-4/1000 in the total population worldwide [2]. Chronic autoimmune thyroiditis, iodine deficiency, postpartum thyroiditis, thyroid surgery and drugs are the most common causes of primary thyroid deficiency [1].

Fluoride

Fluorine is an element with significant distribution in nature. Due to the high chemical activity it does not occur in the free state, its compounds are components of rocks and soil. It can penetrate into water and crops and into the atmosphere as a result of coal combustion and processing of other minerals [3]. Fluoride is an inorganic, monatomic fluorine anion (F⁻) [4]. It naturally occurs in foods and in drinking water. Physiologically, it is considered a microelement that is necessary to prevent dental caries [5]. Fluoride is added to the water sources of many countries, including Poland. In 1999 CDC (Centres for Disease Control and Prevention) named water fluoridation one of the top ten greatest public health achievements [6]. Fluoride was first added to the public water supply in Grand Rapids, Michigan in 1945 as a method of caries prevention [5]. Fluoride deficiency in bones makes them weaker and more prone to fractures [5]. Tooth enamel rich in fluoride reveals resistance to food acids. Fluoride may inhibit the metabolism of sugars by bacteria as well. Fluoride is also believed to be an essential element for the formation of normal bone tissue [4]. It stimulates the proliferation of osteoblasts while inhibiting the activity of osteoclasts, in effect inducing a progressive increase in bone mass [4]. Fluorine compounds are used in the treatment of osteoporosis because of the improvement of calcium balance by F⁻ ions [7]. Treatment with low doses of fluoride reduces vertebral fractures, and the use of combined doses of fluoride and vitamin D is recommended as protection against bone mass loss in people taking steroids. In recent years, scientific studies have also been published indicating a correlation between excessive intake of fluoride and hypothyroidism [8–13].

- 2. Objective:** The purpose of the study was to review and compare currently available data on PubMed about the correlation between fluoride and hypothyroidism. In our brief review we only considered articles from years 2015 to 2020 written in English that contained only original data and were conducted on humans.

3. State of knowledge

Adding fluoride to public water was a contributor to decreasing risk of dental problems. It has been estimated that water fluoridation reduces the risk of caries incidences by 30–60% through enamel replacement and killing of plaque-causing bacteria [5]. Evidence based knowledge suggests that there is a potential relationship between water fluoridation and endocrine system disorders, especially hypothyroidism [8–13]. The recommended fluoride concentration in drinking water was set at 0,7-1,5 ppm (parts per million) [5]. The identification of fluoridation-induced thyroid toxicity should be highlighted, due to following mechanisms of fluoride toxicity on a cellular level, including: the thyroid DNA damage, membrane disruption, mitochondrial and endoplasmic reticulum stress, and oxidative stress signalling during fluoride exposure. However, it should be noted that a significant decrease of fT3 and fT4 by fluoride typically involving either patients with dental fluorosis, or mammals exposed to 30–80 ppm was reported [5]. There are also reports that fluoride water also may contribute to thyroid problems [8–13] (table 1).

Table 1. Articles where the correlation between fluoride concentration and thyroid function problems were analysed.

Authors	Year	Observed correlation
Barberio et al. [10]	2017	No
Malin et al. [8]	2018	Yes
Shaik et al. [13]	2019	No
Wang et al. [9]	2020	Yes
Peckham et al. [12]	2015	Yes
Kharedpisheh et al. [11]	2018	Yes

The association between fluoride exposure and diagnosis of a thyroid condition and indicators of thyroid functioning among the population of Canadians was examined in an article by Barberio et al. Researchers analysed whether an association between fluoride exposure and thyroid-stimulating hormone (TSH) level existed. Mean fluoride concentrations in urine and tap water were compared with a diagnosis of hypothyroidism and in those with low, normal or high TSH level. In the study by Barberio et al. no evidence of a relationship between fluoride exposure (from urine and tap water) and the diagnosis of a thyroid condition was observed [12].

The use of a different research method contributed to different results than in the study by Barberio et al. [12]. In the paper by Malin et al. the data from Cycles 2 and 3 of the Canadian Health Measures Survey was utilised. The objective of this study was to determine whether urinary iodine status modifies the effect of fluoride exposure on thyroid stimulating hormone (TSH) levels. Multivariable regression analyses examined the relationship between urinary fluoride concentrations measured in spot samples using an ion selective electrode and adjusted for specific gravity (UFSG) and TSH, controlling for covariates. Approximately 17.8% of the participants had moderate to severe iodine deficiency as well as 1 mg/L increase in UFSG was associated with a 0.35 mIU/L increase in TSH. This study concluded that moderate-to-severe iodine deficiencies in adult Canadians in association with higher urinary fluoride levels may increase risk of hypothyroidism [8].

The aim of study by Shaik et al. was to estimate the association between T3, T4, TSH level and fluoride concentration in children aged between 9 and 13 years consuming naturally fluoridated water of three different levels of drinking water fluoridation: 0.01–0.6 ppm, 0.7–1.2 ppm and 1.3–1.8 ppm, respectively. This study indicated that fluoridated drinking water consumption does not have influence on the thyroid function in the children with normal nutritional status and optimal iodine intake [13].

Research group by Wang et al. verified thyroid function in children, aged 7–13 years, randomly from endemic and non-endemic fluorosis areas in Tianjin, China. Fluoride level in drinking water and urine was measured using the national standardised ion selective electrode method. TSH, T4, T3 and free isoforms of T3 and T4 were examined. This study revealed that increased levels of water fluoride and urinary fluoride were associated with changes connected with hypothyroidism [9].

Peckham et al. examined if fluoride levels in drinking water are associated with hypothyroidism prevalence in England. The results of this study presented that in fully fluoridated areas the probability of hypothyroidism is twice as frequent than in the non-fluoridated region of England [12].

Kharedpisheh et al. assessed correlation between TSH, fT3, fT4 levels in population with or without thyroid disorders and fluoridated water drinking. This study revealed that fluoride may impact TSH, fT3 hormones even in the standard concentration of less than 0.5 mg/L in group with or without hypothyroidism [11].

Current studies indicate that TSH hormone levels are elevated with increased fluoride intake. The reason is supposed to be that fluorine is more electronegative than iodine and therefore easily displaces iodine from the body, thus affecting thyroid function [14].

4. Conclusions

Current studies do not clearly show a simple correlation between excessive fluoridation of drinking water and the occurrence of hypothyroidism. Some authors suggest that there is a relationship between excessive fluoride concentration in the body and hypothyroidism. It seems that select populations of individuals, e.g. those exposed to iodine deficiency or those with aggravating risk factors for thyroid dysfunction, have a greater predisposition to increased TSH levels and decreased fT4 levels when exposed to excessive amounts of fluoride. It should be highlighted that the majority of researchers analysed laboratory-diagnosed hypothyroidism. It is not clear that in presented studies a relationship between clinically manifested hypothyroidism and water fluoridation was considered. However, inconclusive scientific evidence and the prevalence of hypothyroidism in the population indicate the need for further research in this area. Determination of risk factors could contribute to the prevention of hypothyroidism.

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