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The Impact of Drinking Water Fluoride on the Risk of Hypothyroidism Development: A Review of the Latest Research

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Abstract

Introduction and purpose: Thyroid diseases are common endocrine disorders, with hypothyroidism being the most frequently diagnosed condition of the gland. Water fluoridation is an effective strategy for preventing dental caries, as confirmed by epidemiological studies. Despite the reported benefits, there are concerns about the risk of thyroid dysfunction with high fluoride exposure. The aim of this paper is to review the latest research on the impact of fluoride in drinking water on the risk of developing hypothyroidism.

Materials and methods: A literature search was conducted using the medical databases PubMed and Google Scholar. Articles were retrieved in English, employing the keywords: "hipothyroidism", "thyroid function", "water fluoridation", "fluoride", "iodine".

State of Knowledge: Hypothyroidism affects approximately 4% of Europeans, with an annual incidence of 226 cases per 100,000 people. Drinking water is the main source of chronic fluoride exposure, and over 500 million people live in areas of endemic fluorosis. Numerous studies indicate a clear correlation between fluoride concentration in water and TSH levels, suggesting that excessive fluoride exposure increases the risk of hypothyroidism, which can have serious health implications, especially for pregnant women.

Summary: Recent studies confirm the correlation between fluoride exposure and the development of hypothyroidism, emphasizing the need to monitor the impact of fluoride on health.

Keywords: hypothyroidism; thyroid function; water fluoridation; fluoride; iodine

INTRODUCTION AND PURPOSE

Thyroid diseases are among the most common endocrine disorders worldwide, and their increasing prevalence in the population poses a significant burden on public health institutions. Hypothyroidism is the most frequently diagnosed thyroid gland disorder in both young and older individuals. Dental caries remains a major health challenge in many countries, particularly industrialized ones, where it affects 60-90% of school-aged children. Due to the beneficial properties of fluoride, which strengthens tooth enamel and prevents caries, numerous countries have implemented water fluoridation as a key strategy to improve oral health. Research over the past decades has confirmed the effectiveness of this measure in preventing caries in both children and adults, and this intervention has been widely supported by numerous international health organizations, including the World Health Organization (WHO) , and recognized as one of the most important public health achievements of the 20th century [1,2,3].

Despite its advantages, water fluoridation is controversial and raises concerns due to potential negative health effects. There is evidence that excessive fluoride exposure can adversely affect health, leading to dental and skeletal fluorosis. Medical reports also suggest that excessive exposure to this halogen may contribute to the development of hypothyroidism [1,4,5]. The aim of this paper is to review the latest research on the impact of fluoride in drinking water on the risk of developing hypothyroidism.

MATERIALS AND METHODS

A comprehensive review of the literature was conducted by searching databases such as PubMed and Google Scholar. Articles were retrieved using the keywords: "hypothyroidism," "thyroid function," "water fluoridation," "fluoride," and "iodine." Only publications in English were considered for inclusion. Materials were collected over the period from May to June 2025, and more than 75% of the cited works were published after 2016. The study included meta-analyses and systematic reviews evaluating the impact of fluoride exposure from drinking water on the risk of developing hypothyroidism. Additionally, a systematic and comprehensive search of the aforementioned online databases was conducted, analyzing cross-sectional, case-control, double-blind observational, and cohort studies that assessed the impact of fluoride in drinking water on thyroid function among children, adults, and pregnant women.

STATE OF KNOWLEDGE

Basics of Thyroid Physiology

The thyroid gland plays a key role in maintaining homeostasis, growth, and development of the body, as well as in the proper functioning of the cardiovascular, nervous, and reproductive systems. Its activity is regulated by the hypothalamic-pituitary-thyroid axis, with the most important hormones of this pathway being the hypothalamic thyrotropin-releasing hormone (TRH), thyroid-stimulating hormone (TSH), triiodothyronine (T3), and thyroxine (T4) [6]. The regulation of thyroid hormone production (T3, T4) occurs through a negative feedback mechanism, wherein a decrease in their levels increases TRH synthesis, stimulating the pituitary gland to secrete TSH, which, in turn, stimulates the thyroid gland to produce the prohormone T4. The main source of biologically active T3 is the peripheral deiodination of T4, catalyzed by the enzyme iodothyronine deiodinase [7].

Iodine is an essential element in the biosynthesis of thyroid hormones, serving as a key substrate for the production of T3 and T4, and it plays a crucial role in maintaining euthyroidism by regulating their synthesis. In thyrocytes, iodine is actively transported by the sodium-iodide symporter (NIS), which is responsible for the uptake and accumulation of this element [8].

In clinical practice, the assessment of thyroid function is performed by measuring laboratory levels of TSH and free hormones (FT3, free triiodothyronine, and FT4, free thyroxine) [9]. It is important to emphasize that TSH is a sensitive marker of thyroid gland dysfunction, and small changes in circulating T4 concentrations can result in relatively significant deviations in TSH values. Moreover, a normal TSH level has a high negative predictive value, which is why its measurement is recommended as the first step [10,11].

Hypothyroidism

Hypothyroidism is a clinical condition characterized by a deficiency of hormones secreted by the thyroid gland, and it can be classified into overt and subclinical forms. Both forms are diagnosed based on elevated TSH levels (above the upper limit of normal), with overt hypothyroidism also showing decreased FT3 and FT4 levels, while in subclinical hypothyroidism, these values remain normal. It is noteworthy that a TSH level above 2.5 mIU/L may increase the risk of developing hypothyroidism. Hypothyroidism usually results from thyroid gland dysfunction, known as primary hypothyroidism, which is most commonly caused by chronic autoimmune thyroiditis (Hashimoto's disease) and iodine deficiency. The prevalence of this disease in the European population is estimated at 3.8% for subclinical and 0.37% for overt hypothyroidism, while in the USA, these values are 9% and 0.4%, respectively. The condition is about five times more common in women than in men (5.1% vs. 0.92%). The annual incidence of hypothyroidism in Europe is 226 cases per 100,000 people [12,13,14].

The clinical manifestations of hypothyroidism include fatigue, apathy, cold intolerance, weight gain, constipation, and dry skin, with the presentation of the disease varying significantly depending on age, sex, and duration of the condition [15]. It is important to note that in areas with iodine deficiency, the occurrence of endemic goiter is a characteristic symptom [16]. In additional investigations, primary hypothyroidism resulting from thyroid gland destruction (e.g., due to an autoimmune process) is characterized by reduced iodine uptake; however, conducting this test is not recommended in the routine diagnosis of hypothyroidism [17].

Pregnant women with hypothyroidism represent a special group of patients because this condition can lead to serious consequences for both their health and the fetus. These include an increased risk of miscarriage and preterm birth, gestational hypertension, low birth weight, and developmental disorders of the nervous system as well as cognitive dysfunction in the child. Therefore, every case of overt and subclinical hypothyroidism in pregnant women should be properly diagnosed and treated [18].

Fluoride

Fluoride is a well-known chemical element, particularly valued for its role in the prevention and treatment of dental caries. Research has shown that the key mechanism for protecting enamel involves limiting demineralization and supporting the remineralization process. This action is primarily based on fluoride's ability to stimulate the conversion of enamel hydroxyapatite into fluorohydroxyapatite and fluorapatite, which makes the tissue more resistant to acids produced by bacteria in dental plaque [19,20]. This element belongs to the halogens and is characterized by the highest electronegativity in the periodic table, which accounts for its high chemical reactivity. As a result, it does not occur in free form on Earth but as chemically bound fluoride. In terms of elemental abundance in nature, it ranks 13th, constituting about 0.06-0.09% of the Earth's crust by mass [4,21].

The main source of chronic fluoride exposure is drinking water, with other sources including tea plants, processed foods, dental products, supplements, medications, and industrial sources (phosphate fertilizers, fluorinated insecticides, and pesticides) [22,23]. It is estimated that 500 million people live in areas affected by endemic fluorosis, where elevated levels of this halogen in the environment pose significant implications for individual and public health. Symptoms of fluorosis can range from mild dental enamel changes, headaches, and loss of appetite to more severe effects, including dental and skeletal fluorosis, sleep disturbances, increased incidence of pathological fractures, kidney stones, as well as neurodevelopmental deficits and lower intelligence quotient (IQ) in children [24,25,26].

Due to the significant impact of fluoride in the prevention of dental caries and the increasing risk of dental and skeletal fluorosis at higher concentrations, the WHO has set the maximum recommended fluoride concentration in drinking water at 1.5 mg/L, with the caveat that other sources of fluoride should be considered. This value is higher than the recommended standard for artificial fluoridation of drinking water, which is 0.5-1.0 mg/L. It should be emphasized that artificial water fluoridation, involving the controlled addition of fluoride to the public water supply, was introduced years ago by some countries (including the United Kingdom, USA, Ireland, Australia, Brazil, and Malaysia) as a beneficial public health intervention for the prevention of dental caries. It currently covers approximately 400 million people in over 25 countries, representing the largest source of fluoride exposure for children and adults in these communities [3,23,27,28]. The advantages of water fluoridation include long-term protection against caries, economic benefits, and reducing health inequalities by reaching a large number of people worldwide [29].

This practice has been controversial since its inception, and there is still no clear consensus regarding the relationship between fluoride concentrations exceeding WHO recommendations and potential toxicity. However, some studies indicate that this process may pose a threat to public health. It is important to consider that the optimal dose of fluoride in drinking water depends on the total intake of this element from other sources. Moreover, climate changes, the region of residence, and local environmental pollution have a significant impact [19,30]. It is worth noting that a considerable amount of fluoridated water enters the environment, and contamination with this halogen is considered a potential biological risk for plants, animals, and humans [4].

The WHO has estimated that approximately 260 million people worldwide currently live in areas where the fluoride concentration in drinking water exceeds the recommended 1.5 mg/L. Recently, attention has been drawn to the fact that excessive exposure to this element may disrupt hormonal balance, including thyroid function. Studies conducted on animals have shown that exposure to fluoride in rats resulted in decreased levels of T3 and T4 and increased TSH values [4,22]. It is worth noting that in the 1950s, fluoride compounds were used in the pharmacotherapy of hyperthyroidism as thyrostatic drugs to normalize thyroid gland function. This information suggests the significant potential of fluoride as an environmental factor contributing to thyroid hormonal disorders [5].

The Impact of Fluoride on Iodine Metabolism and Thyrocytes

The proper functioning of the thyroid gland is closely related to iodine metabolism, and interactions between fluoride and iodine may be one of the possible causes of the negative impact of fluoride on thyroid function. It is estimated that under normal conditions, the thyroid uses approximately 60-80 µg of iodine daily. Iodine ingested from food is absorbed in the intestines in the form of iodide anion by NIS and transported into the bloodstream, then taken up by thyrocytes via the same symporter. The action of NIS allows for iodine concentration in thyroid cells to be approximately 20-50 times higher than in plasma, which is crucial for the iodination of thyroglobulin and the synthesis of T3 and T4 hormones. The efficiency of NIS and effective iodine transport depend on the activity of the sodium-potassium pump (Na+/K+ ATPase) and the sodium pump [8,31].

Fluoride, as an element with chemical properties similar to iodine but with higher electronegativity and lower atomic mass, translates into greater reactivity of fluoride ions compared to iodide ions, displacing iodine from its chemical compounds and causing disruptions in the biosynthesis of thyroid hormones [7]. The mechanisms critical to the reduction of iodine absorption by fluoride include the inhibition of its absorption from the gastrointestinal tract and transport to thyrocytes through the inhibition of NIS gene expression and Na+/K+ ATPase activity. Excessive exposure to fluoride can lead to iodine deficiency or exacerbate an existing deficiency in the body. During critical periods of iodine demand, such as fetal life and childhood, insufficient amounts of this element caused by excessive fluoride intake can lead to irreversible health effects [8].

It is suggested that fluoride may disrupt normal thyroid function through various mechanisms described in the literature. It has been shown that ions of this element can interfere with the conversion of T4 to T3 by affecting iodothyronine deiodinase [4,7]. Additionally, in the presence of trace amounts of aluminum cations, fluorides form aluminum-fluoride complexes that mimic the action of TSH, disrupting signaling through G proteins associated with the TSH receptor, leading to reduced sensitivity and, consequently, decreased thyroid function [24]. Absorbed high concentrations of fluoride also exhibit cytotoxic properties, causing damage to thyrocytes by altering their morphology and promoting apoptosis. The mechanisms of this action include mitochondrial dysfunction, accumulation of reactive oxygen species, inhibition of proteins and enzymes, and induction of DNA damage [4,32].

Exposure to High Fluoride Concentrations and Thyroid Function

Assessing the relationship between excessive environmental fluoride exposure and thyroid dysfunction is a significant challenge due to difficulties in accurately determining the total fluoride intake by the body. Additionally, a comprehensive assessment requires considering the potentially modifying influence of iodine on fluoride toxicity. Equally important is the high prevalence of hypothyroidism in the population, which complicates the unequivocal identification of fluoride as an etiological factor for this disease. For these reasons, researchers conduct various analyses to understand the impact of this halogen on thyroid gland function [4]. Peckham et al. conducted an observational study in England, comparing the incidence of documented hypothyroidism reported by general practitioners in clinics in areas with water fluoridation and those without this practice. Based on the collected data, the authors demonstrated that healthcare practices in regions with fluoridated water had nearly twice the rate of diagnosed hypothyroidism [33]. In contrast, Barberio et al., analyzing data collected from 12,180 individuals aged 7-79 years, representing a national population sample of Canada, found no evidence of a relationship between fluoride exposure and the diagnosis of thyroid disease [34].

In recent years, numerous studies have been conducted to assess the impact of fluoride exposure on thyroid function in children living in endemic areas characterized by elevated fluoride concentrations in drinking water (FCW) and a higher prevalence of fluorosis. The analyses also utilized biomarkers of exposure, such as fluoride concentration in urine (FCU) and serum (FCS). In 2019, Zulfiqar et al. studied 134 children from the endemic village of Rukh Mudke (mean FCW = 4.6 mg/L) and the village of Ottawa (mean FCW = 0.54 mg/L), which served as the control group. The authors noted significantly higher TSH values in children from the study group and confirmed a strong positive correlation between FCW and TSH (Pearson's correlation coefficient, $r = 0.8$). Additionally, 22% of children from Rukh Mudke were diagnosed with thyroid dysfunction, with 11% showing a hormone pattern consistent with subclinical hypothyroidism [35]. A similar correlation was confirmed the following year in a study of children from the town of Talab Sari, with a mean FCW of 6.23 mg/L, also showing a strong association between FCW and TSH ($r = 0.9$). Subclinical hypothyroidism was diagnosed in 23.85% of individuals in the study group [36].

Singh et al. evaluated the impact of chronic excessive fluoride intake on thyroid function in children from endemic (FCW = 1.6-5.5 mg/L) and non-endemic fluorosis areas (FCW < 1 mg/L). The study results indicated that the percentage of thyroid hormone abnormalities in the study and control groups was 72% and 10%, respectively. Moreover, almost all children from endemic regions (98%) had FCS values exceeding the norm, whereas in the control group, this parameter was slightly elevated in half of the children. The analysis showed higher TSH concentrations in the study group and a significant positive correlation between FCW and FCS (Spearman's correlation coefficient, $R = 0.529$; $p < 0.01$), as well as between FCS and TSH ($R = 0.552$; $p < 0.01$). The authors also found a strong negative association between FCW concentration and FT3 ($R = -0.711$; $p < 0.01$) [7].

In a study conducted in India, thyroid function disorders were evaluated in 90 children with dental fluorosis associated with excessive fluoride concentrations in drinking water (mean FCW = 4.37 mg/L) and in 21 children from control groups. In the study group, 54.4% of the children exhibited abnormalities in TSH, FT3, and FT4 levels, with 46.9% having subclinical hypothyroidism. Similar hormonal disorders were found in 50% and 45.4% of children from the two control groups, and most had elevated FCS, despite consuming water with a "safe" fluoride concentration, suggesting exposure from other sources. The results indicated that children with and without dental fluorosis exposed to excess fluoride might have subclinical thyroid dysfunction. This highlights the importance of monitoring thyroid hormone levels in children from areas with high fluoride exposure [37]. Measurements collected from 1,934 children and adolescents in India by Khandare et al. indicated that higher FCW and FCU values are associated with elevated TSH levels and lower T3 concentrations [38].

In 2018, two Iranian studies were published, which demonstrated a tendency for higher TSH values with increasing FCW levels. Furthermore, Kheradpisheh et al. observed that greater daily water consumption, and thus higher daily fluoride intake, significantly increased the risk of elevated TSH levels (odds ratio OR = 4.1; 95% CI: 1.2-14; $p = 0.024$) [30,39]

There are also studies available that did not confirm the above-described relationships. In a double-blind cohort study, Shaik et al. evaluated children with normal nutritional status and optimal iodine intake residing in three areas with different FCW values, specifically 0.01-0.6 mg/L, 0.7-1.2 mg/L, and 1.3-1.8 mg/L, showing no significant correlation between FCW levels and deviations in TSH, T3, and T4 concentrations [1]. The analysis by Hosur et al., conducted on 65 children with endemic dental fluorosis and 10 children without fluorosis residing in regions using iodized salt, revealed that TSH, FT3, and FT4 concentrations were normal in almost all study participants [40].

The medical literature also includes studies evaluating the impact of fluoride on thyroid dysfunction by analyzing other indicators of hypothyroidism, such as the presence of goiter, reduced iodine uptake, and impaired intellectual function as a clinical consequence of hypothyroidism.

In 2021, Du et al. evaluated the role of iodine in mitigating thyroid dysfunction caused by fluoride exposure in 446 children. The authors found that an increase in FCU by one standard deviation (SD) resulted in an increase in thyroid volume (Tvol) by 0.22 cm^3 (95% CI: 0.14-0.31), with high urinary iodine levels reducing this effect. Furthermore, a negative correlation was observed between T3 concentration and FCW at moderate urinary iodine levels (≤ 300 μg/L) [41].

Kutlucan et al. also analyzed changes in thyroid volume in children living in regions with high fluoride exposure and similar iodine intake. The results noted that Tvol is greater in children with fluorosis after puberty compared to the control group [42]. Meanwhile, Yang et al. demonstrated a higher prevalence of goiter, elevated TSH levels, and reduced iodine uptake in the study group ($p < 0.01$), which consisted of children living in areas with high concentrations of iodine and fluoride in the drinking water [43].

The study by Zhang et al. involving 180 children assessed the impact of fluoride exposure from drinking water on thyroid function and IQ. It revealed that TSH values were significantly elevated in the high fluoride exposure group ($p = 0.03$). Additionally, compared to the control group, these children had lower IQ scores and a higher percentage of children with IQs below 90 [44]. A similar analysis was conducted by Wang et al. with 571 children, showing that each 1 mg/L increase in FCW was associated with a 0.13 uIU/mL increase in TSH levels and a 1.578-point decrease in IQ test scores. Furthermore, a negative correlation was observed between FCW and TT4 and FT4 ($p = 0.036$ and $p < 0.01$, respectively), as well as a positive correlation with TSH ($p = 0.019$) [22]. The key findings from these studies are presented in Table 1.

Table 1. Studies Analyzing the Impact of Fluoride on Thyroid Function

Study	**Participants**	**Country**	**Key results / conclusions**
Susheela et al. [37] (2005)	111 children (7-18 years)	India	Excessive fluoride exposure may cause subclinical thyroid dysfunction.
Yang et al. [43] (2008)	1518 children (8-14 years)	China	Higher incidence of goiter, elevated TSH levels, and lower iodine uptake values in the study group.
Hosur et al. [40] (2012)	75 children (7-18 years)	India	Normal concentrations of TSH, FT3, FT4 in both the study and control groups.
Kutlucan et al. [42] (2013)	559 children (10-15 years)	Turkey	Increased thyroid volume in children with fluorosis after puberty compared to the control group.
Singh et al. [7] (2014)	70 children (8-15 years)	India	Higher incidence of thyroid dysfunction in the study group.
Peckham et al. [33] (2015)	7935 General Practices	UK	Higher incidence of hypothyroidism in areas with fluoridated water.
Zhang et al. [44] (2015)	180 children (10-12 years)	China	Higher TSH values, lower IQ levels, and a higher percentage of children with low IQ in the study group.
Barberio et al. [34] (2017)	12 180 subjects (7-79 years)	Canada	No association between fluoride exposure and the diagnosis of thyroid disease.
Khandare et al. [38] (2018)	1934 children (8-14 years)	India	Higher TSH values and lower T3 levels in the study groups.
Kheradpisheh et al. [30] (2018)	228 adults (20-60 years)	Iran	Higher TSH values correlate with higher daily fluoride intake from drinking water.
Kumar et al. [39] (2018)	400 children (8-15 years)	India	Higher TSH values in the study groups.

Shaik et al. [1] (2019)	293 children (9-13 years)	India	No significant correlation between FCW levels and TSH, T3, T4 values.
Zulfiqar et al. [35] (2019)	134 children (7-18 years)	Pakistan	Higher TSH values in the study group. Positive correlation between FCW and TSH, and negative correlation between FCW and FT4.
Zulfiquar et al. [36] (2020)	190 children (7-18 years)	Pakistan	Higher TSH values in the study group. Strong positive correlation between FCW and TSH.
Wang et al. [22] (2020)	571 children (7-13 years)	China	An increase in FCW by 1 mg/L was associated with a rise in TSH by 0.13 uIU/mL and a decrease in IQ test scores by 1.578 points.
Du et al. [41] (2021)	446 children (7-12 years)	China	Increase in thyroid volume by 0.22 cm^3 with a 1 SD increase in FCU. Negative correlation between T3 concentration and FCW.

In recent years, three systematic reviews and one meta-analysis have addressed the impact of fluoride on thyroid function. In 2018, Chaitanya et al., based on a review of the literature covering 10 scientific articles, confirmed a positive correlation between fluoride exposure and hypothyroidism. In 2024, Ferreira et al. conducted an analysis of seven studies, five of which showed an association between high fluoride exposure and modulation of thyroid function. However, they noted that the available evidence is insufficient to draw definitive conclusions. Similarly, Taher et al. in the same year concluded that existing studies provide moderate evidence of a relationship between fluoride exposure and thyroid gland dysfunction [5,19,45]. In 2024, Iamandii et al. published a meta-analysis that included 33 studies, confirming a clear relationship between FCW and TSH levels. They demonstrated that this relationship is a positive, nonlinear, and dose-dependent correlation at FCW levels above 2 mg/L. Regarding biomarkers of fluoride exposure, such as FCU and FCS, the authors did not confirm a similar relationship. This suggests that assessing chronic fluoride exposure may be more reliable through a long-term, stable indicator of intake, such as fluoride in drinking water. They also highlighted the limitations of short-term measurements (FCU, FCS) due to individual differences in fluoride absorption, metabolism, and excretion, as well as the influence of demographic factors such as age, gender, lifestyle, smoking, alcohol consumption, and frequency of tooth brushing. Additionally, the authors referred to the limited availability of studies evaluating FCS and FCU and the possible differences between analytical methods used.

Despite the strong association between fluoride exposure and TSH levels, the meta-analysis did not confirm an equally clear relationship between peripheral thyroid hormone concentrations (free and total) and FCW. Therefore, the authors concluded that the assessment of overall thyroid function in individuals exposed to excessive fluoride concentrations should be conducted on an individual basis, especially among groups with an increased risk of developing hypothyroidism. It is important to note that most studies did not account for individual confounding effects, such as the modifying influence of iodine on fluoride toxicity, the overall nutritional status concerning iodine and other trace elements, and environmental pollutants. Additionally, early-stage thyroid diseases and genetic factors may also affect the results. Therefore, further research considering multiple variables is necessary to definitively determine the impact of fluoride on thyroid function and the increased risk of developing thyroid diseases [4]. The key findings from these systematic reviews and meta-analysis are presented in Table 2.

Table 2. Systematic Reviews and Meta-analyses Evaluating the Impact of Fluoride on Thyroid Function

Study	**Study Type**	**Number of Analyzed Articles**	**Conclusion**
Chaitanya et al. [5] (2018)	Systematic Review	10	Six out of ten studies demonstrated a significant increase in TSH levels with excessive fluoride exposure.
Ferreira et al. [19] (2024)	Systematic Review	7	Five out of seven studies demonstrated a positive association between fluoride exposure and thyroid dysfunction.
Taher et al. [45] (2024)	Systematic Review	7	Six out of seven studies demonstrated a positive association between fluoride exposure and thyroid dysfunction.
Iamandii et al. [4] (2024)	Meta-analysis	33	Clear association between FCW and TSH concentration, characterized by a positive, nonlinear, and dose-dependent correlation at FCW above 2 mg/L.

Fluoride Exposure in Pregnant Women and Hypothyroidism

Some studies on the impact of fluoride exposure on thyroid gland function focus on pregnant women, which is particularly important because complications related to maternal hypothyroidism during this period can lead to serious health consequences for the offspring.

Hall et al. in 2023 assessed the relationship between fluoride intake from drinking water and hypothyroidism in a Canadian cohort of pregnant women, where the mean FCW was 0.42 mg/L, and 60.5% of women used fluoridated water. They found that an increase in FCW by 0.5 mg/L was associated with a 1.65-fold greater risk of primary hypothyroidism (95% CI: 1.04-2.60). Furthermore, women with normal levels of anti-TPO antibodies (antibodies against thyroid peroxidase) had a 2.85 times greater risk of developing the disease for every 0.5 mg/L increase in FCW (95% CI: 1.25-6.50). Boys born to mothers with hypothyroidism also showed significantly lower IQ test scores. Thus, the authors demonstrated that higher fluoride exposure through drinking water in pregnant women was associated with an increased risk of developing hypothyroidism. They highlighted that these maternal disorders might play a role in fluoride-induced developmental neurotoxicity in offspring [26].

Considering that FCU is an indicator of short-term fluoride exposure, allowing for the estimation of total intake of this element from various sources, Hall et al. in a subsequent study published a year later found a significant association between FCU and TSH levels in pregnant women with female fetuses. They demonstrated that an increase in FCU by 1 mg/L was associated with a 35% increase in TSH concentration in these pregnant women (95% CI: 0.08-0.51; $p = 0.01$) [28]. However, earlier studies published in 2022 in the USA and Sweden did not show a relationship between FCU and TSH values and thyroid hormones in pregnant women [46,47].

Based on the presented conclusions, it can be assumed that there is a certain susceptibility of pregnant women to fluoride-induced hypothyroidism. However, the number of available studies is still limited. These findings are important for replicating previous findings in future studies assessing the correlation between fluoride exposure and thyroid dysfunction in pregnant women.

SUMMARY

The cited studies largely confirm the existence of a relationship between fluoride exposure and the development of hypothyroidism. These findings provide important guidance for public health institutions, emphasizing the need to monitor the impact of fluoride as an environmental factor on human health and to approach water fluoridation strategies cautiously. It is important for physicians practicing in areas with high fluoride levels in drinking water to be aware of its impact on thyroid function and remain vigilant regarding the risk of hypothyroidism, especially among children and pregnant women.

Disclosure

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