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HYGIENIC ASSESSMENT OF FLUORIDE CONTENT IN ENVIRONMENTAL OBJECTS AND ITS IMPACT ON CHILDREN'S HEALTH IN THE REPUBLIC OF TAJIKISTAN

The importance of fluoride for human health, particularly in dental caries prevention and bone growth, is well-recognized, yet its optimal balance is crucial to avoid adverse effects like dental and skeletal fluorosis. In Tajikistan, misconceptions exist about high fluoride levels in drinking water; however, recent studies reveal a widespread deficiency, except near industrial areas like the Tajik Aluminum Plant in Tursunzade city, where fluoride exposure risks are heightened. This research aims to assess fluoride's environmental impact and its effects on children's health across Tajikistan, focusing on the Bohtar region and Tursunzade city, to inform public health policy and interventions.

The study aims to assess the impact of environmental fluoride exposure on children's health in Tajikistan by analyzing fluoride levels in water, air, and food, and their relation to dental health outcomes. For our study on fluoride's impact on children's health in Tajikistan, we employed a multifaceted research methodology. The investigation included collecting and analyzing samples from various environmental sources–water, air, and food–in different regions, with a focus on the Bohtar region and the city of Tursunzade. Water samples were tested for fluoride content using ion-selective electrode analysis, while air and food samples were analyzed for fluoride concentration through spectrophotometric methods. Health assessments, including dental examinations of children aged 6-12 years, were conducted to identify dental caries and fluorosis, correlating these findings with fluoride exposure levels. The study also reviewed the sanitary and hygienic state of water supply systems. Data analysis incorporated both quantitative and qualitative methodologies, including statistical analysis to determine the correlation between fluoride exposure and health outcomes, ensuring a comprehensive understanding of fluoride's effects on children's health within the studied areas.

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This study highlights the necessity of balancing fluoride levels in drinking water to protect child dental health in Tajikistan. It calls for targeted fluoride management strategies tailored to regional needs, emphasizing the importance of public health interventions, system improvements, and awareness campaigns to prevent dental issues and enhance children's health.

Key words: Fluoride, dental health, public health, environmental exposure, fluorosis, child health, Tajikistan.

Introduction

The importance of fluoride for human health is a subject of significant academic and public health interest. Fluoride, a critical microelement, is essential for the normal development and maintenance of human health, particularly in preventing dental caries and ensuring bone growth. However, the dual nature of fluoride–beneficial in optimal quantities but harmful when excessive–presents a complex challenge for environmental health and public health policy, especially concerning children's health. This challenge is pronounced in the Republic of Tajikistan, where the fluoride content in environmental objects such as drinking water, atmospheric air, and food varies significantly across different regions.

Recent studies highlight a paradox in the scientific community's perception of fluoride levels in Tajikistan, with some mistakenly classifying the country as having high fluoride concentrations in its drinking water. Contrary to these claims, domestic research over the last five years indicates a prevalent fluoride deficiency in most of the Republic's regions, except in areas influenced by industrial activities, such as near the Tajik Aluminum Plant in Tursunzade city, where fluoride exposure risks, including dental and skeletal fluorosis, are elevated.

This study aims to provide a comprehensive evaluation of the water supply system and investigate the fluoride content in the external environment and its impact on children's health across Tajikistan, with a specific focus on the Bohtar region and Tursunzade city. Our research tasks encompass examining the sanitary and hygienic state of water supply and provisioning systems; determining fluoride levels in the air, water, and food; establishing causal links between fluoride exposure and dental health outcomes in children; and developing hygienic recommendations to optimize access to clean drinking water and prevent fluoride-associated health issues among the pediatric population.

This research represents a pioneering effort in Tajikistan to apply an internationally recognized health risk assessment methodology to study fluoride's effects on children. Our findings offer new insights into the natural sources of drinking water, provide a sanitary assessment of water supply systems, and establish a link between fluoride exposure and the prevalence of dental caries and fluorosis among children. Based on these outcomes, we propose scientifically grounded recommendations for public health interventions to mitigate these risks.

Given the existing gap in comprehensive studies on water quality's impact on health in Tajikistan, particularly concerning fluoride, this work is of paramount importance. It contributes to the development of public health systems, enriches the academic discourse on environmental hygiene, and underscores the critical need for targeted preventive measures to safeguard children's health against the backdrop of varying environmental fluoride exposure.

Materials and methods

Analysis of Fluoride Content in Food Products

The determination of fluoride ions in food was conducted using an electrochemical method with fluoride-selective electrodes, utilizing a potentiometer PI-1 Mi and the "Expert-001" liquid analyzer. This approach allowed for the precise measurement of fluoride ions in various food samples, accounting for a 15% methodological error margin at a 95% confidence interval. To minimize measurement errors, three samples were taken from each food item, and three parallel measurements were conducted for each sample. The methodology ensured that the error in determining fluoride concentrations was significantly reduced, making the data highly reliable for assessing dietary fluoride exposure.

Establishing Cause-and-Effect Relationships

This stage of the research evaluated the dose-effect relationship (cause-and-effect links) between fluoride content in drinking water and the prevalence of dental caries and fluorosis among children in selected areas. Given the significant cost and complexity of this research phase, the study focused on Tursunzade and Bohtar cities. These areas were selected based on their proximity to fluoride emission sources and varying water fluoride concentrations. The target population for this stage consisted of 12-year-old schoolchildren, identified as particularly susceptible to environmental factors.

Risk Assessment and Characterization of Dental Caries and Fluorosis

Following the establishment of cause-and-effect relationships, this research phase assessed the risk of dental caries and fluorosis among the target population. This analysis exclusively considered the fluoride content in drinking water as a variable, with risk expressed as an odds ratio (OR) of disease occurrence.

Statistical Analysis

The collected data were processed using SPSS Statistics 21.0 and Statistica 10 software. The analysis employed descriptive statistics to summarize the data and analytical statistics to explore the relationships between independent variables. The research utilized various statistical tests, including ANOVA, the Kruskal-Wallis test, and the Mann-Whitney U-test, to compare the fluoride content across different environmental mediums and its impact on health outcomes. A binary logistic regression model was applied to adjust for the influence of variables, while factor analysis with linear correlation was used to examine the effect of waterborne fluoride on the incidence of dental caries and fluorosis.

Results

Fluoride in Atmospheric Air

The investigation into the fluoride content in the atmospheric air revealed significant findings, especially in areas proximate to the aluminum plant located in Tursunzade. The primary emissions from the plant, gaseous hydrogen fluoride, and solid fluoride compounds were detected, demonstrating the industrial impact on air quality.

The results, particularly concerning the fluoride levels in the air during different seasons and directions of the wind, are summarized in Tables 3.3 and 3.4. The maximum concentration of hydrogen fluoride in the experimental zone (Dzh.Navobod) was observed during the autumn period, exceeding the maximum allowable concentration (MAC) up to 0.08 mg/m³ for hydrogen fluoride. Meanwhile, the concentration of fluoride salts varied, remaining below the MAC standards, with the highest levels recorded in the autumn.

In contrast, the control zone (Dzh. Dzh.Rahmonov), aside from lower levels of hydrogen fluoride which did not exceed the MAC, did not show detectable levels of other fluoride compounds, highlighting the localized impact of industrial emissions based on wind direction and geographical location.

Fluoride concentrations were affected significantly by the wind's direction, with the highest levels recorded during autumn when the wind blew from the west. The spring sampling showed a decrease in fluoride levels, yet certain areas still recorded measurements slightly above the MAC. This seasonal fluctuation underscores the varying impact of industrial activities and environmental factors on air quality concerning fluoride contamination.

The data presented in Table 3.5 further illustrate the annual average fluoride content, taking into account the wind direction. It was observed that fluoride levels were generally lower or just slightly above the MAC, with the exception of certain areas during the autumn when wind conditions favored the dispersion of pollutants from the aluminum plant.

Regional Comparisons in the Bohtar Region

Table 3.6 offers a comprehensive overview of the fluoride content in the atmospheric air across 15 administrative cities and districts within the Bohtar region. Notably, the investigation revealed an absence of fluoride salts in all sampled locations, with only trace amounts of hydrogen fluoride detected in certain areas. These findings indicate a low fluoride impact in regions without fluoride-emitting industrial activities, aligning with Tajikistan's broader characterization as a region with fluoride deficiency.

The observed atmospheric fluoride concentrations, particularly in proximity to industrial sources like the aluminum plant in Tursunzade, necessitate ongoing monitoring and potentially targeted public health interventions to mitigate exposure risks. While the broader Bohtar region shows minimal fluoride presence in the air, highlighting the localized nature of industrial impact, it's critical to balance industrial activities with environmental health considerations to ensure community well-being.

Fluoride in Drinking and Utility Water

This section discusses the fluoride content in drinking and utility water, a crucial factor for both environmental and public health perspectives in Tursunze, highlighting regional comparisons, methodological approaches, and statistical analyses.

Contrary to some reports which mistakenly classify Tajikistan alongside areas with elevated fluoride levels like Estonia, Moldova, and certain regions of the Russian Federation, our studies confirm that many regions in Tajikistan actually fall into the category of endemic areas with fluoride deficiency. This is except for areas near the aluminum plant, which experiences anthropogenic pollution from fluoride compounds such as hydrogen fluoride and solid fluorides.

The chemical makeup of surface waters in Tajikistan, reflective of Central Asia at large, is defined by natural factors and exhibits regional specifics. It is characterized by either an excess or a deficit of macro- and micro-elements, including notably low levels of iodine and fluoride. This has been linked to prevalent iodine deficiency disorders and dental caries among the population.

Water for drinking and utility purposes in many regions of Tajikistan, particularly in the Khatlon region and other areas, is marked by insufficient fluoride content. For instance, average annual fluoride concentrations in the Bohtar region's water supply network ranged around 0.13±0.09 mg/L, indicating a widespread fluoride deficiency across different water sources, including centralized and non-centralized water supply systems.

The study reveals significant seasonal and regional variations in fluoride content. For example, the highest fluoride concentration observed in the Bohtar region during the autumn was 0.14 mg/L, which did not exceed the Maximum Allowable Concentration (MAC). Similarly, fluoride concentrations in various water samples, whether from centralized or non-

centralized sources, generally stayed below the MAC, showcasing a consistent deficiency across the board.

The statistical treatment of collected data employed the Kolmogorov-Smirnov and Shapiro-Wilk tests to assess the normality of fluoride distribution across different water sources. It was found that fluoride distribution did not follow a normal distribution, indicating the need for non-parametric statistical methods for further analysis. The study also highlighted statistically significant correlations between fluoride content and water sources, underscoring the heterogeneous distribution of fluoride across the region.

The study underscores a critical public health issue – the widespread fluoride deficiency in drinking and utility water across Tajikistan. This condition is particularly acute in regions away from industrial pollution sources like aluminum plants. Considering the climatic variability and regional dietary habits, this deficiency poses a considerable risk for dental health, necessitating interventions to ensure adequate fluoride intake for the population.

Study on the Impact of Fluoride on Children's Health

The analysis of the population's exposure to different fluoride levels was conducted by correlating data obtained from fieldwork, which determined fluoride content in drinking water, with information about each water source and the corresponding population using water from that specific source.

Our study covers a significant part of the population of Khatlon region and Tursunzade city, where 30% and 59.9%, respectively, have access to centralized water supply systems. The rest of the sample consisted of sources from a distributed system. Half of Tursunzade residents receive drinking water from surface water with low fluoride content (0.47 mg/l), while the other half consume groundwater with optimal fluoride content. The second largest settlement, Seshanbe, in the city of Tursunzade, received water with an optimal fluoride content, mainly from underground sources. Residents of the control zone received groundwater with a low fluoride content.

A significant portion (76.1%) of Tursunzade's residents (44,124 individuals) was exposed to optimal fluoride levels (0.5–1.5 mg/L) in their water supply. A smaller population segment (21.9%, 12,690 individuals) consumed water with low fluoride levels (<0.5 mg/L), and water with high fluoride content (>1.5 mg/L) was consumed by 1,177 individuals, representing 2.0% of the population.

The study on the prevalence of dental caries and dental fluorosis was conducted among 12-year-old schoolchildren born and living in Tursunzade and Bohtar, where the fluoride concentration in drinking water varied significantly from one locality to another.

The oral examination and sociological study results showed that out of 224 surveyed 12-year-olds in Tursunzade (161) and Bohtar (63), 19 children in Tursunzade were found to have mild degrees of dental fluorosis. It is essential to note that no cases of moderate or severe fluorosis were identified in the target cities. Notably, fluorosis was not detected in Bohtar during the fieldwork.

The research highlighted a significant dependency between the level of fluoride in drinking water and the number of children with dental fluorosis. The prevalence of fluorosis tended to increase with the concentration of fluoride in the drinking water ($r = 0.87$). The Navobod community, with the highest average water fluoride concentration, saw a more than fivefold increase in fluorosis prevalence among children compared to the Pakhtaobod community, where the water fluoride concentration was the lowest.

The risk assessment utilized baseline data from the study, specifically the correlation between dental fluorosis and caries and the fluoride content in drinking water. Among all surveyed children in Bohtar (63), 48 had light dental caries, accounting for a 76.2% prevalence rate.

In Tursunzade (161), 19 children had light dental fluorosis, accounting for an 11.8% prevalence rate, and 21 children had light dental caries, marking a 13% prevalence of this pathology.

No fluorosis was observed in areas with low fluoride (<0.5 mg/L). Fluorosis prevalence in Tursunzade was noted with its increase in drinking water containing optimal fluoride levels (1.0–1.5 mg/L), suggesting a direct correlation: as fluoride levels in drinking water rise, so does the prevalence of dental fluorosis.

A strong positive correlation ($r=0.87$) was found between the fluoride content in drinking water and the prevalence of dental fluorosis.

High fluoride content in drinking water represents excessive exposure that can be avoided. This study stage focused on the population risk. Risk indicators for acquiring the disease were compared with the exposure group's risk, exposed to drinking water fluoride levels of 0.50–1.5 mg/L. The risk (expressed as odds ratio) of dental fluorosis was calculated according to 3 exposure categories based on the World Health Organization's recommendation. The

probability of developing dental fluorosis in the exposure category of 0.51 to 1.50 mg/L was 2.1 times higher than when the exposure was below the limit of 0.50 mg/L.

Discussion

In the context of technological progress and increased stress for humans, the impact of unfavorable socio-economic factors, observed in almost all countries, including the Republic of Tajikistan, plays an important role in maintaining the health of the population. Children are especially sensitive to the negative impact of environmental factors. It has been established that eliminating or minimizing environmental pollution factors, considering a number of tasks to optimize the water supply and sanitation system, organizing optimal and nutritious nutrition help to increase the body's resistance to the harmful effects of the environment.

Fluoride, one of the chemical elements most often found in contaminated areas, poses a serious threat to human health. Fluorine is an important trace element necessary for maintaining the structure and functioning of dental bones, and its physiologically required amount is very close to the dose that has a toxic effect. The main source of fluoride in the human body is drinking water and food. Many studies conducted in the 20th century have shown that insufficient consumption of fluoride leads to the development of caries, and an overdose leads to fluorosis. Currently, the problem of the impact of excess amounts of fluoride on human health is not underestimated and remains relevant. The problem of complex consumption of fluoride, along with other chemicals, is of scientific interest.

According to numerous studies conducted in the second half of the 20th century, insufficient levels of fluoride in drinking water were found in many areas of Tajikistan, with the exception of the area of the city of Tursunzade, where the Tajik aluminum plant is located, whose residents had a high incidence of fluorosis. In this context, the study of sanitary The hygienic condition of water and gas supply systems plays an important role, since this area has not yet been studied and makes it difficult to carry out sanitary assessments of water chemistry. This has increased the need for broader research to study the condition of water supply and sewerage systems, the lack or excess of fluoride in the environment, and the cause-and-effect relationship between caries and the frequency of flu orosis, and a number of preventive measures have been developed.

Currently, 67.3% of the republic's population is provided with centralized drinking water, and 95.3% of the urban population is provided with centralized drinking water. At the same time, only 42.1% of the remote rural population has access to a centralized and safe water supply, and 51.9% uses water from unprotected sources. The population of the Bokhtar district is 2,126,494 people, of which only 30% are provided with tap drinking water, and the rest (70%) use water from open sources (rivers, canals, irrigation ditches, etc.). Previous similar studies assessing water supply in GBAO show that 18.7% of the population of GBAO is provided with drinking water, which is compared with the results of our research. According to our research, in the municipal water tap of the centralized drinking water supply system there are poor sanitary conditions and there is no water meter. However, many rural water supply systems do not purify or disinfect the water, and there is no laboratory control of water quality. This is shown in the picture. But in some rural areas, such as Vakhsh, Qubadieni Vakhdat, the population independently maintains and even expands existing water use systems. Of the 125 operating water systems in the Bokhtar district, 63% do not meet sanitary and hygienic requirements, and 69 water supply systems do not work due to wear and tear of the distribution network. The lack of high-quality drinking water in most rural settlements of the Bokhtar district is due to both a lack of water and the unsatisfactory condition of the infrastructure. A relatively good situation with the functioning of the water supply system was revealed during a similar study, in which 16 out of 10 water supply systems of the GBA were in working order.

In the most remote areas of the Bokhtar region, such as Jami, Panj, fresh groundwater is absent or partially absent. Almost 97% of the population in the Jaikhun and Vakhsh regions use surface water (rivers, canals, ditches) as a source of water supply. Fountain N. It is used as a source of water supply for 30.0% and 11.4% of the population of the Khusravi-Nurek districts. In the Dustian region, where About half of the population (48.0%) uses imported water for food, and stricter conditions regarding water supply will be observed in the near future. 3 out of 1(27.2%) population of Khorasan region use well water as a source of fresh water and 25.9% use rainwater. The population of Qubadiensky (66.9%), Shakritsa (42.6%), Kushoninsky (35.5%) and Panjsky (31.6%) districts use groundwater using hand pumps (tube wells). It should be noted that about 40% of the population of the Bokhtar district uses water from irrigation canals flowing in its territories as the main source of drinking water. The results of our research

are consistent with the results of similar studies conducted by Tajik scientists in the Republic of Tajikistan.

Currently, in the Republic of Tajikistan there are no production enterprises that pollute the atmosphere of populated areas with various fluoride compounds, with the exception of the giant non-ferrous metallurgy – an aluminum plant located in the densely populated region of the Gissar Valley in the city of Tursunzade.

Some authors mistakenly classify the Republic of Tajikistan, along with some countries, as zones with high fluoride content in drinking water. However, it has been proven that many areas of Tajikistan belong to endemic areas with limited fluorine content, with the exception of areas with aluminum smelters, where anthropogenic pollution of the environment with fluorine compounds is observed. The maximum amount of fluoride in the UK in the spring experimental zone (jamoatnavobod) exceeded the maximum permissible concentration in the western direction. The direction ranged from 0.01 to 1.0 mg/m3 and did not exceed the MPC value. In the control zone (jamoat Jura Rakhmonov) there were no necessary external substances, with the exception of hydrogen fluoride, which in the fall did not exceed the MPC.

When the wind direction from the side of the aluminum smelter changed from west to north and northeast, as well as the average content of hydrogen fluoride and hydrofluoric acids, both in spring and autumn, was from 0.001 to 0.06 mg/m3 and from 0.01 to 1.2 mg /m3. 0001 to 0. It was decided from 08 mg/m3 to 0.01-0.2 mg/m3. In atmospheric studies from the selected control zone in the city of Tursunzaden, no fluorine compounds were detected. The results of atmospheric studies in 15 cities and districts of the Bokhtar region showed a complete absence of hydrofluoric acid in all visible atmospheric samples. Minor traces of fluorine compounds, amounts from 0.0001 to 0.002 mg/m3, were found in Kubodien K, ushonien, Yavane, N. They were found in the areas of Khusrawa and the city of Levakant.

The overall negative effects of fluoride can vary significantly by region. In turn, this depends on the fluoride content in drinking water, food products and other environmental objects. The results of research by scientists such as Buzalaf M.A.R. and Levy S.M. The fact is that the leading producer of fluoride is drinking water. In our studies, the fluoride content in water concentration, the fluoride concentration in all studied water samples of Bokhtarsky was below the MPC and fluctuated over a wide range: 0.01–0.45 mg/l with an average value of 0.13 mg/l. In 1148 (92.2%) samples the fluoride content was below 0.3 mg/l. A relatively deeper situation with fluoride content in water was found in the Khorasan region, where its maximum content in water was 0.09 mg/l. Correlation analysis on a scale with seasons revealed a difference in the fluorine content in water in autumn with statistical significance ($p<0.001$). The population of the Yavan and Pyanj regions, consuming water from centralized municipal and departmental water supply systems, respectively consume water close to the normal fluoride content in drinking water of 0.41 mg/l – 0.43 mg/l, respectively. The most significant situation with low fluoride content in the water of centralized systems with departmental water supply was noted in the Dusti and Khorasan regions, where the maximum fluoride content in the water was 0.02 mg/l, respectively. The concentration of fluoride in water samples detected from open water sources does not exceed 0.19 mg/l at an average temperature throughout the Bokhtar region of 0.11 mg/l. The population of the Pyanj and Kushoniyon regions consume water from closed water sources with a high concentration of 0.44 and 0.45 mg/l, respectively, which is a relatively low figure for the entire region. The results of the analysis confirmed that fluoride levels were lowest in NCSOI compared with CSCW ($p<0.001$), CSCWW ($p<0.001$) and NCSZI ($p<0.001$). The highest level of fluoride content was observed in NCSZI (0.18 [0.10, 0.27]), however, when analyzing the CSCW and CSCWW indicators, no statistically significant signs were found ($p>0.05$).

The average annual fluorine content in water samples from the village of Tursunzade ranged from 0.43 to 1.50 mg/l, with an average value of 1.04 mg/l, and the highest concentration of fluorine (1.52 mg/l) was found in the fall in jamoat Navobod (village Shodien). However, the concentration of fluoride in water samples taken from closed springs (wells) on the territory of the aluminum smelter was slightly higher than in other sources. This indicates that fluorine compounds deposited on the soil surface move along its profile, polluting groundwater. The population of Navobod jamoat (experimental zone) consumes water with a maximum concentration of 1.50 mg/l, while the minimum concentration of fluoride in water was found in Pakhtaobod jamoat (experimental zone). In the control zone located east of the plant (jamoat J.In, water samples were taken from the Rakhmonov spring), at different times of the year fluorine was detected in amounts ranging from 0.39 to 0.60 mg/l, not exceeding the maximum permissible concentration.

Our study showed that in growing aquatic products selected as a sample for research in the village of Tursunzade, the fluorine content ranged from 0.39

to 1.99 mg/kg. 0.19 mg/kg. Jamoat Nasvoboda was recognized as the most relatively polluted zonal settlement in Tursunzoda, with a low content of fluorine in food products. It was found that fluorine-containing samples collected in the control direction of the eastern wind were the poorest. Considering that fluorine was found in the external environment of several settlements in the experimental city of Tour at Sunset Yes, we can say with confidence that the actual level of environmental pollution with fluorine represents the current risk to the health of the population of these places. Region. When studying the target cities and districts of the Bokhtar region, the fluorine content in products of plant and chicken origin remained practically unchanged and remained below the MPC.

A statistically significant difference in the level of fluoride content in food products between zones was established. It should be noted that dynamic observation in the zone of harmful effects of aluminum smelters on fluorine content over a certain period of time in various environmental objects (selected experimental zone of the city of Tursunzade) revealed a slight dynamic accumulation of this element in them, but its content was higher than in other regions. However, in this regard, it is necessary to establish a quantitative relationship between the degree of environmental pollution and the health status of the population living in these areas by conducting targeted studies to establish daily fluoride intake by studying actual nutrition.

A study conducted in Iran showed that the influence of drinking water on total fluoride exposure can vary from 70 to 90% depending on the level of fluoride in drinking water. Analysis of the impact of different levels of fluoride in water in the population showed that the total fluoride exposure of residents of Tursunzaden was at the optimal level (0.5-1.5 mg/l) fluoride content was 76 .1% (44,124 people). Residents have a low fluoride content in water (<0.5 mg/l) was consumed by a minority of the population (21.9%, 12,690 inhabitants), and water with a high fluoride content (>1.5 mg/l) -1177 people, which is 2.0%. The vast majority of the population of Bokhtar consumes water with a very low fluorine content (less than 0.50 mg/l) in the input. Consequently, as research results show, poisoning of the human body with fluorine compounds in the artificially exposed area of the aluminum smelter in the city of Tursunzade occurs due to water and food. Our data are relatively consistent with the results of research by many Tajik scientists.

The results of studies of the prevalence of dental diseases among various segments of the population conducted in Tajikistan in the 1980s revealed that the prevalence of caries in temporary and permanent teeth among children aged 7-17 years in the city of Dushanbe ranged from 76 to 90%. The highest rates were recorded in children aged 7-9 years: from 87 to 90%, and in children aged 15-17 years: from 81 to 85%. In the process of work, an analysis of the incidence of fluorosis and caries among schoolchildren in the cities of Bokhtar and Tursunzade was carried out, which revealed a strong correlation between the level of fluoride in drinking water and the incidence of disease. The prevalence of mild fluorosis among schoolchildren in the city of Tursunzade was 11.8%, of which 6.2% were boys, 5.6% were girls, with a significant portion (43%) living in areas with optimal fluoride content. The prevalence of various stages of dental caries among children was 13% in the city of Tursunzade and 76.3% of children in the city of Bokhtar. The results of our research are consistent with other studies, however, Tajik scientists state a very high prevalence of caries among 7-year-old schoolchildren in the city of Tursunzade. The intensity of caries according to DMFT data among children aged 7-15 years in the city of Tursunzade was 1.12. A high prevalence among children was also revealed by Mirzoev M.Kh., where the prevalence of caries among children aged 15 years reached absolutely high levels (96.3%) due to the lack of preventive measures at the proper level. In Navobod jamoat, where the average fluoride concentration in water was the highest, the prevalence of fluorosis among children was more than five times higher than in Pakhtaobod jamoat, where fluoride concentration in water was lowest.

Factor analysis revealed an insignificant correlation between the level of fluoride in drinking water and the number of children with caries and fluorosis. It should be noted that the prevalence of fluorosis tended to increase with increasing fluoride concentrations in drinking water, and the prevalence of dental caries tended to increase with decreasing fluoride concentrations in drinking water. There was a strong positive correlation (r=0.87) between fluoride levels in drinking water and the prevalence of fluorosis. The results of our study are consistent with the results of similar studies conducted by Tajik scientists in the Republic of Tajikistan among children aged 7 years, which revealed a cause-and-effect relationship between dental caries and fluoride content in drinking water depending on the climatic and geographical zone. Thus, in the city of Tursunzade, which was supplied with drinking water with a fluorine content of up to 2 mg/l, the prevalence of varying degrees of fluorosis among

children aged 6 years was up to 25%, and among children aged 15 years up to 30%. It should be noted that the DMFT index in older children did not differ from children living in the Rudaki region and the city of Dushanbe, where there was a lack of fluoride. In the cities of Tursunzade and Dushanbe, an increase in the DMFT index among children aged 6-15 years was noted: in Tursunzade up to 2, in the capital – 3, respectively. Among schoolchildren in the city of Bokhtar, with insufficient fluoride content, dental caries is mainly diagnosed, and in the city of Tursunzade, with a relatively high fluoride content, fluorosis is diagnosed. The likelihood of developing fluorosis in the 0.51 to 1.50 mg/L exposure category is 2.1 times higher than for exposures below the 0.50 mg/L limit. Similar studies conducted by Tajik scientists in the city of Bokhtar revealed an increase in the prevalence of caries among the population aged 40-49 years from 74 to 80%, and the DMPT index from 4 to 8. Issues of reducing the prevalence and prevention of caries dental caries is recorded in national programs, in In connection with this, Tajik scientists have conducted a number of studies, in particular, they have considered the implementation of treatment and preventive programs involving the use of fluoride-containing drugs before and after the eruption of both temporary and permanent teeth, differentiated sanitation of the oral cavity and active sanitary educational work, which were carried out at the end of the twentieth century. century in the city of Khujand, led to a decrease in the prevalence of caries among children from 97 to 95%.

Conclusion

The health of the population, particularly children, in the Republic of Tajikistan is significantly impacted by unfavorable socio-economic factors and environmental pollution, especially concerning fluoride contamination. Fluoride, while essential in small amounts for dental health, poses a significant health risk when present in excessive amounts. In Tajikistan, various studies have revealed both insufficient and excessive levels of fluoride in drinking water across different regions, leading to dental caries and fluorosis, respectively.

Centralized water supply is inadequate, especially in rural areas, resulting in a reliance on unprotected and potentially contaminated water sources. In regions like Bokhtar and Tursunzade, studies show a prevalence of dental diseases correlating with fluoride levels in water. Tursunzade, impacted by emissions from an aluminum plant, exhibits higher fluoride levels and corresponding higher rates of fluorosis among children. Conversely, areas with low fluoride levels, such as Bokhtar, have high rates of dental caries.

Addressing these issues requires improved water purification systems, consistent monitoring of fluoride levels, and preventive healthcare measures. This includes public health initiatives focused on optimizing water supply and sanitation, providing nutritious diets, and implementing fluoride management programs to mitigate the dual burdens of dental caries and fluorosis. Through these efforts, the overall health and resistance of the population to environmental hazards can be significantly enhanced.

Competing interests

The authors declare that they have no competing interests.

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