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Fluoride Awareness, Safety Concerns, and Sociodemographic Patterns: Evidence from a Cross-Sectional Study in Preventive Dentistry

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Abstract

Background/Objectives: Systemic fluoridation represents one of the most effective public health interventions for preventing dental caries, being endorsed by international organizations such as the WHO and CDC. **Methods**: A cross-sectional observational study was conducted between May and June 2023 on a sample of 200 adults from Iasi, Romania. A self-administered questionnaire composed of 15 items was used to assess knowledge, perceptions, and attitudes regarding systemic fluoridation. **Results**: Most respondents (94%) declared familiarity with the term “fluoride,” and 91% were aware of its protective role in dental health. However, only 34% reported awareness of the types of fluoridation, and 53% recognized the term “dental fluorosis.” Familiarity with “water fluoridation” was significantly associated with education level (χ^2 = 32.219, p < 0.001, r = 0.401), while gender significantly influenced perceptions regarding fluoride safety (χ^2 = 6.031, p = 0.049, r = 0.174). The perception of toxicity was strongly correlated with belief in the safety of general fluoridation (χ^2 = 29.116, p < 0.001, r = 0.382), highlighting cognitive dissonance. Awareness of “dental fluorosis” was significantly correlated with knowledge of preventive strategies for children (χ^2 = 67.31, p = 0.000, r = 0.580). **Conclusions**: Although general awareness of fluoride is high, deeper understanding of systemic fluoridation remains limited. Targeted educational interventions tailored to the population's educational and demographic profile are required.

Keywords: systemic fluoridation; fluoride; knowledge; perceptions; oral health; preventive dentistry

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1. Introduction

Systemic fluoridation can be implemented through several methods, the most common being the fluoridation of drinking water, salt, and milk, along with the administration of fluoride supplements in the form of tablets or drops. Among these, water fluoridation is considered the most efficient and sustainable public health measure, as it requires no behavioral change and ensures consistent fluoride exposure at the population level [1,2]. Salt fluoridation has been effectively applied in several Latin American and European countries, while milk fluoridation is used especially in school-based programs. The World Health Organization (WHO) recommends selecting the most appropriate method based on local infrastructure and population needs, as all have demonstrated effectiveness in reducing dental caries [2].

Fluorides have played a crucial role in reducing the global prevalence of dental caries, mainly due to their topical action, which interferes with the enamel demineralization and remineralization processes [3,4]. The main sources of systemic fluoride in-take are fluoridated water, infant formula, fluoridated salt, and oral fluoride supplements. To a lesser extent, beverages such as black tea and wine, and foods like seafood, also contribute [3,5].

Water fluoridation remains one of the most extensively researched and validated public health strategies for caries prevention. It involves the controlled addition of fluoride to public water supplies, aiming to reduce the population-level incidence of caries. International organizations including the WHO and the Centers for Disease Control and Prevention (CDC) support this practice as safe, effective, and equitable [2].

However, emerging studies have raised concerns about potential neurodevelopmental effects of early-life fluoride exposure. A systematic review and meta-analysis reported a small but statistically significant association between fluoride exposure and reduced IQ scores in children [6]. These concerns are reinforced by the 2024 National Toxicology Program monograph, which reviewed existing evidence and emphasized the need for continued evaluation of fluoride's neurodevelopmental impact [7]. Furthermore, Till et al. (2025) discussed the health risks and benefits of fluoride exposure during pregnancy and infancy, highlighting the importance of careful dosage management in these sensitive periods [8]. A more recent systematic review by Gopu et al. (2023) consolidated evidence across the life course and found suggestive links between fluoride exposure and cognitive outcomes, especially when exposure occurs prenatally or during early childhood [9].

Technological advances have broadened research perspectives. The use of F-18 Fluoride PET/CT imaging offers new insights into fluoride distribution and bone metabolism, supporting potential systemic health applications [10].

The systemic action of fluoride begins with its absorption in the gastrointestinal tract, followed by transport via the circulatory system and deposition in mineralized tissues, particularly developing dental enamel. Fluoride facilitates the conversion of hydroxyapatite to fluorapatite—a more stable crystal structure, highly resistant to acid attacks from oral bacteria. In addition, systemic fluoride is secreted in trace amounts into saliva, producing a topical effect that enhances enamel remineralization and inhibits demineralization [5,11].

Multiple studies confirm the effectiveness of systemic fluoridation in lowering caries prevalence. Communities with fluoridated water consistently report fewer cavities, especially among children and adolescents [2]. This strategy is effective across socioeconomic backgrounds and oral hygiene behaviors, contributing to equity in oral health. Fluoridation is also recognized for its cost-efficiency, lowering dental treatment expenditures, particularly for underserved populations [2].

The most notable adverse effect associated with systemic fluoride intake is dental fluorosis, which develops during enamel formation in early childhood due to excessive fluoride exposure. It manifests white opacities or, in more severe cases, brown dis-coloration and structural defects. Preventive strategies include maintaining optimal fluoride levels (0.5–1.0 mg/L depending on climate) and monitoring total fluoride in-take from all sources—water, supplements, food, and dental products [2,5,11]. Educating caregivers about the correct use of fluoridated toothpaste and preventing ingestion in young children are essential preventive measures.

In regions where water fluoridation is not feasible, alternatives such as salt and milk fluoridation, as well as the controlled use of supplements, remain viable and effective, according to WHO guidelines [2].

Ethical and social concerns accompany systemic fluoridation due to its universal application. These include debates over individual consent and autonomy. Thus, transparent communication, community consultation, and evidence-based public education are essential. From a public health perspective, systemic fluoridation is regarded as one of the most equitable preventive strategies, protecting those with limited access to dental care and oral health education [2].

Reliable, up-to-date information on systemic fluoridation can be found in scientific repositories such as PubMed, Scopus, and Web of Science, as well as through re-sources provided by institutions like the WHO and CDC [1,2].

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Study Aim

This study aims to assess the level of knowledge and perceptions regarding systemic fluoridation among a representative adult population sample in Iași, Romania. The objective is to identify informational gaps and determine possible associations with socio-demographic variables. Null Hypothesis (H_0): There is no significant association between the level of knowledge about systemic fluoridation and the respondents' sociodemographic variables. Testable Hypothesis (H_1): There is a significant association between the level of knowledge about systemic fluoridation and at least one sociodemographic variable (age, gender, educational level, residential background).

2. Materials and Methods

2.1. Study Design and Setting

The level of knowledge assessment was conducted using a questionnaire method. A cross-sectional study was conducted from May to June 2023. For this study, a pre-liminary semi-structured questionnaire with multiple-choice questions was used. The questions focused on the level of knowledge among medically trained subjects regarding the general fluoridation. To further enhance the accuracy and reliability of the data, the survey was pilot tested on a subset of 10 subjects who provided valuable feedback on question clarity, phrasing, and survey length. Revisions were made accordingly. A total of 760 774 individuals were registered in population of Iasy [12]. According to the calculation formula [13], a minimum number of 196 subjects was representative. This means 196 or more measurements/surveys are needed to have a confidence level of 95% that the real value is within ±7% of the measured/surveyed value. A total number of 200 subjects were included in the study sample. A Cronbach's alpha value of 0.759, derived from reliability testing, confirmed strong internal consistency across survey items.

2.2. Study Sample

The estimation of the sample size was based on a probability of alpha error pow-er=0.95. This means 196 or more measurements/surveys are needed to have a confidence level of 95% that the real value is within ±7% of the measured/surveyed value. We included a total of 200 subjects in the study, making the chosen sample representative for Romania. The selection of the study group followed specific criteria. Inclusion criteria were for any person who agreed to participate, including students from the Faculty of Dentistry. The exclusion criteria were subjects who did not consent to participate. The final sample was demographically diverse, encompassing a balanced mix of genders, academic years, and age groups. This diversity allowed for the exploration of trends and patterns across different student profiles, enriching the analysis and supporting the generalization of findings within the wider dental student community. All participants were assured that their responses would remain completely anonymous and would have no bearing on their academic assessments. This approach helped mitigate any potential bias and encouraged candid responses. Participants were also informed about the broader significance of the study, particularly its potential to shape improvements in dental education.

2.3. Study Instrument Development

The main instrument used for data collection was a rigorously developed 18-question questionnaire, carefully constructed to balance comprehensiveness with clarity. The data collection phase was executed using a digital distribution strategy. A digital version of the questionnaire was hosted on a secure Google Docs platform, accessible through unique access links. All responses were anonymized, with each participant assigned a unique code for data tracking purposes. Confidentiality of all data collected was strictly maintained throughout the research process. The entire procedure was carried out in full compliance with ethical research standards, including the principles of voluntary participation and participant anonymity. All participants were informed

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about the study and were provided with a verbal summary of the purpose of the study and potential implications. Among the selected eligible subjects were students of the Faculty of Dentistry of the University of Medicine and Pharmacy "Grigore T. Popa" of Iasi (UMFI), students from other faculties and subjects without a medical background. Inclusion criteria were for any person who agreed to participate, including students from the Faculty of Dentistry. Subjects who did not agree to participate were excluded from the study.

2.4. Questionnaire Contents

The questionnaire was divided into two main sections, each addressing a different dimension of the study. The first section, "Demographics," collected basic information about the participants, including age, gender, the highest level of education completed and background. This section provided the fundamental context for interpreting the results and conducting subgroup analyses. The second section, "Knowledge about General Fluoridation," included 12 multiple-choice questions designed to assess participants' theoretical understanding of fluoridation. A multiple-choice question was also included to assess participants' interest in assessing their oral health status, including their last dental visit. The questions were formulated to be accessible, ensuring that they adequately tested concepts about general fluoridation. The questions asked were: Q5 = When was your last check-up at the dentist? Q 6 = Did you know that fluoride protects your teeth? Q7= Do you know how many types of fluoridation there can be? Q8 = Are you familiar with the term water fluoridation? Q9 = Are you aware of the benefits of fluoridated water? Q10= Are you aware of the need for drinking water fluoridation? Q11 = Are you familiar with the term "fluoride"? Q12 = Are you familiar with the term 'dental enamel fluorosis'? Q13 = Do you know how you can benefit from fluoride intake and minimize the risk of fluorosis for your child? Q14 = Are you aware of the benefits of fluoride supplements? Q15 = Do you know where you can find more reliable information about fluoride?

2.5. Statistical Analysis

The data were collected, processed and analyzed using IBM SPSS (IBM, Armonk, NY, USA, version 26), a powerful statistical tool, capable of handling complex data sets and generating a wide range of descriptive and inferential statistics. The first phase of the analysis involved descriptive statistics to summarize the demographic characteristics of the participants and their knowledge level. These included frequencies, means, standard deviations and cross-tabulations to provide a clear overview of the sample population. Confidence intervals were calculated for all key variables to provide additional interpretative clarity. Pearson's Chi-square test was used to compare the data, together with nominal symmetric measures (Phi, Cramer's V, contingency coefficient) along with Spearman's rank correlation coefficient, and Pearson's correlation coefficient. All tests were performed with a statistical significance cut-off point of $p \leq 0.05$.

2.6. Ethical Considerations

The study was conducted in strict compliance with ethical standards, as stipulated by institutional and international guidelines for research involving human subjects. Informed consent was obtained from each participant prior to their inclusion in the study. Consent forms provided a clear explanation of the objectives, procedures, risks and benefits of the study, ensuring that participation was fully voluntary and based on an understanding of the research. (Please see the appendix for a copy of the consent forms). Confidentiality and anonymity were rigorously maintained throughout the re-search process. All responses were coded with unique identifiers rather than personal information, and the data was stored on encrypted servers with limited access to the main research team. After submitting the questionnaire, participants received an in-formation document summarizing the objectives of the study and explaining how their contributions would be used to improve educational policies. The ethical framework of the study ensured that the rights, dignity and well-being of all participants were prioritized. Compliance with ethical norms was continuously monitored and steps were taken to address any unforeseen ethical issues that might arise during the research process. Ethical review and approval were obtained for this study, with reference number 307/16.05.2023.

3. Results

3.1. Demographic Data

As shown in Table 1, the majority of respondents fell within the 20–30 years age range, accounting for 91% (N=182) of the total sample. This was followed by the 30–40 age group, which represented 4% (N=8) of participants. At the lower end of the distribution, 6 respondents 3% (N=6) were aged between 40 and 50 years, while the 50–60 age group included only 2% (N=4). Regarding gender distribution, the sample was predominantly female, with 82.5% (N=165), compared to males 16.5%(N=33). A majority of the participants 61.5% (N=123), reported residing in urban areas whereas 38.5%(N=77) lived in rural settings. Concerning educational attainment, 67.5%(N=135) of respondents had completed high school, 27.5%(N=55) held a bachelor's degree, and 4.5% (N=9) had obtained a master's degree. Only one participant reported middle school as their highest level of completed education (Table 1).

Table 1. Demographic data.

Demographic data	Demographic bracket	Percentage of respondents	N
Q1=Age	20-30	91	182
	30-40	4	8
	40-50	3	6
	50-60	2	4
Q2 = Gender	Female	82.5	165
	Male	16.5	33
	Others	1	2
Q3 = Highest form of education completed	Middle school	0.5	1
	Highschool	67.5	135
	Bachelor's degree	27.5	55
	Master's degree	4.5	9
Q4 = Background	Urban	61.5	123
	Rural	38.5	77

N = Count

3.2. Assessment of Knowledge and Perceptions Regarding Systemic Fluoridation

As presented in Table 2, most participants reported that fluoride protects teeth (91%). However, Chi-square analyses revealed no statistically significant differences based on age ($\chi^2 = 1.838$, $p = 0.607$), gender ($\chi^2 = 4.455$, $p = 0.108$), education level ($\chi^2 = 0.15$, $p = 0.985$), or background ($\chi^2 = 0.295$, $p = 0.587$). Regarding knowledge about the number of fluoridation types, 66% admitted not knowing, with no significant associations observed with age ($\chi^2 = 4.576$, $p = 0.206$), gender ($\chi^2 = 1.491$, $p = 0.475$), education ($\chi^2 = 6.538$, $p = 0.088$), or background ($\chi^2 = 0.447$, $p = 0.504$). In terms of familiarity with the term "water fluoridation," 66% responded affirmatively. Here, a statistically significant association was found with the level of education ($\chi^2 = 32.219$, $p < 0.001$), but not with age ($\chi^2 = 1.186$, $p = 0.978$), gender ($\chi^2 = 0.198$, $p = 0.995$), or background ($\chi^2 = 1.075$, $p = 0.584$). Awareness of the benefits of fluoridated water was significantly associated with gender ($\chi^2 = 6.031$, $p = 0.049$), while age ($\chi^2 = 0.648$,

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$p = 0.885$), education ($\chi^2 = 3.109$, $p = 0.375$), and background ($\chi^2 = 1.783$, $p = 0.182$) showed no significant differences. Perceptions regarding the necessity of fluoridated drinking water showed no significant associations with age ($\chi^2 = 1.052$, $p = 0.789$), gender ($\chi^2 = 2.294$, $p = 0.318$), education ($\chi^2 = 3.484$, $p = 0.323$), or background ($\chi^2 = 0.669$, $p = 0.413$). Although 94% of participants reported being familiar with the term "fluoride," the only near-significant relationship was with education level ($\chi^2 = 4.299$, $p = 0.231$); age ($\chi^2 = 0.034$, $p = 0.998$), gender ($\chi^2 = 1.167$, $p = 0.558$), and background ($\chi^2 = 2.861$, $p = 0.091$) were not statistically significant. Only half of the respondents reported familiarity with "dental fluorosis," without statistically significant variation across age ($\chi^2 = 10.358$, $p = 0.110$), gender ($\chi^2 = 2.547$, $p = 0.636$), education ($\chi^2 = 5.255$, $p = 0.512$), or background ($\chi^2 = 1.231$, $p = 0.540$). Furthermore, 40% stated they knew how to benefit from fluoride while minimizing fluorosis risk for children. Nonetheless, no significant differences were found based on age ($\chi^2 = 6.338$, $p = 0.386$), gender ($\chi^2 = 5.372$, $p = 0.251$), education ($\chi^2 = 5.297$, $p = 0.506$), or background ($\chi^2 = 0.308$, $p = 0.857$). Awareness of the benefits of fluoride supplements was reported by 41% of participants, with no statistically significant differences by age ($\chi^2 = 6.742$, $p = 0.345$), gender ($\chi^2 = 5.456$, $p = 0.244$), education ($\chi^2 = 10.504$, $p = 0.105$), or background ($\chi^2 = 1.943$, $p = 0.378$). Finally, 49% of participants indicated knowing reliable sources of information about fluoride, but Chi-square analysis showed no significant relationships with age ($\chi^2 = 5.386$, $p = 0.495$), gender ($\chi^2 = 7.028$, $p = 0.134$), education ($\chi^2 = 6.854$, $p = 0.335$), or background ($\chi^2 = 2.299$, $p = 0.317$).

Table 2. Distribution of responses for assessment of perceived knowledge of general fluoridation.

Question	**No. of answers**		Age		Gen		Studies		Background	
	N	**%**	χ^2	p	χ^2	p	χ^2	p	χ^2	p
Q5 = Did you know that fluoride protects your teeth?										
Yes	182	91	1.838	.607[a,b]	4.455	.108[a,b]	0.15	.985[a,b]	0.295	0.587
No	18	9								
Q6 = Do you know how many types of fluoridation there can be?										
Yes	68	34	4.576	.206[a]	1.491	.475[a,b]	6.538	.088[a,b]	0.447	0.504
No	132	66								
Q7 = Are you familiar with the term "water fluoridation"?										
Yes	131	66	1.186	.978[a,b]	0.198	.995[a,b]	32.219	.000[a,b,*]	1.075	.584[a]
No	69	35								
Q8 = Are you aware of the benefits of fluoridated water?										
Yes	108	54	0.648	.885[a]	6.031	.049[a,b,*]	3.109	.375[a,b]	1.783	0.182
No	92	46								
Q9= Are you aware of the need for drinking water fluoridation?										
Yes	106	53	1.052	.789[a]	2.294	.318[a,b]	3.484	.323[a,b]	0.669	0.413
No	94	47								
Q10 = Are you familiar with the term "fluoride"?										
Yes	188	94	0.034	.998[a]	1.167	.558[a,b]	4.299	.231[a,b]	2.861	0.091
No	7	4								
No, but I would like to know	5	3								
Q11 = Are you familiar with the term 'dental enamel fluorosis'?										

Yes	106	53								
No	47	24								
No, but I would like to know	47	24	10.358	.110^{a,b}	2.547	.636^{a,b}	5.255	.512^{a,b}	1.231	0.54
Q12 = Do you know how you can benefit from fluoride intake and minimize the risk of fluorosis for your child?										
Yes	80	40								
No	64	32								
No, but I would like to know	56	28	6.338	.386^{a,b}	5.372	.251^{a,b}	5.297	.506^{a,b}	0.308	0.857
Q13 = Are you aware of the benefits of fluoride in supplements?										
Yes	81	41								
No	65	33								
No, but I would like to know	54	27	6.742	.345^{a,b}	5.456	.244^{a,b}	10.504	.105^{a,b}	1.943	0.378
Q14 = Do you know where you can find more reliable information about fluoride?										
Yes	98	49								
No	45	23								
No, but I would like to know	57	29	5.386	.495^{a,b}	7.028	.134^{a,b}	6.854	.335^{a,b}	2.299	0.317

3.3. Demographic Variations in Attitudes Toward Water Fluoridation Safety and Toxicity

As shown in Table 3, the majority of participants reported having visited a dentist within the last six months, reflecting a generally proactive approach toward oral health. However, these findings did not show statistically significant associations with any sociodemographic variables: age (χ^2 = 13.208, p = 0.586), gender (χ^2 = 7.491, p = 0.678), education level (χ^2 = 22.152, p = 0.104), or background (χ^2 = 5.005, p = 0.415).

Regarding perceptions of the safety of general fluoridation (Q6), most respondents either totally or partially agreed that systemic fluoride use is safe. This perception was not significantly influenced by age (χ^2 = 12.204, p = 0.429), gender (χ^2 = 13.041, p = 0.110), education (χ^2 = 8.815, p = 0.719), or background (χ^2 = 3.753, p = 0.440).

In contrast, when evaluating whether fluoride added to community water might be considered toxic (Q7), a significant proportion of respondents disagreed with this statement. Notably, there were statistically significant differences by age (χ^2 = 23.736, p = 0.022) and gender (χ^2 = 20.275, p = 0.009), while differences by education level (χ^2 = 13.084, p = 0.363) and background (χ^2 = 2.594, p = 0.628) were not statistically significant. These results suggest that both age and gender may influence risk perception regarding water fluoridation and toxicity concerns.

Overall, the responses summarized in Table III indicate that while general attitudes toward fluoridation are positive, there are still perceptual differences among subgroups of the population, particularly related to concerns over toxicity. These findings highlight the importance of tailored public health communication strategies.

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Table 3. Distribution of responses with multiple answer data about assessment of knowledge of general fluoridation.

Question	No. of answers		Age		Gen		Studies		Background	
	%	N	χ^2	*p*	χ^2	*p*	χ^2	*p*	χ^2	*p*
Q5 = Time of last dental check-up										
One week ago	11	21	13.208	0.586	7.491	.678	22.152	.104	5.005	0.415
One month ago	23	45								
Six months ago	32	64								
One year ago	20	40								
Two years ago	6	12								
Three years ago	9	18								
Q6 = Given the dental health benefits, do you think general fluoridation is safe?										
Total agreement	22	43	12.204	.429	13.041	.110[a,b]	8.815	.719	3.753	.440
Partial agreement	48	95								
Neutral	23	46								
Partial disagreement	7	14								
Total disagreement	1	1								
Q7 = Could the fluoride supply to the community through water fluoridation be considered a toxic substance?										
Total agreement	2	4	23.736	.022*	20.275	.009,*	13.084	.363	2.594	.628
Partial agreement	13	26								
Neutral	35	70								
Partial disagreement	36	72								
Total disagreement	14	28								

r= Pearson's R;p = significance level.

3.4. Perceptions of Fluoride Toxicity and Public Awareness of Systemic Fluoridation

A detailed comparative analysis (Table 4) was conducted to examine the association between the perception that fluoride supplied to the community through water fluoridation is a toxic substance and three related knowledge-based questions.

Among the 36% of respondents (N = 72) who expressed partial disagreement with the statement about fluoride toxicity, 69 individuals reported being familiar with the term "fluoride," while 2 were unfamiliar but interested in learning more, and only one participant was completely unfamiliar. The association between these two items did not reach statistical significance (χ^2 = 2.212, p = 0.645), suggesting a consistent level of familiarity with fluoride regardless of perceived toxicity.

Regarding the question “Did you know that fluoride protects your teeth?”, 91% of respondents answered affirmatively. Within the subgroup that partially disagreed with the toxicity claim, 66 participants answered “yes,” while only 6 responded “no.” Again, this relationship did not yield statistically significant differences ($\chi^2 = 4.989$, $p = 0.287$), indicating that positive knowledge of fluoride’s benefits is relatively independent of toxicity perceptions.

In contrast, when asked whether they believe general fluoridation is safe, significant variations were observed in response distribution within the same subgroup. Of the 72 participants, 47 considered general fluoridation to be safe, 12 had a neutral stance, while 13 expressed some level of disagreement. Statistical analysis revealed a highly significant difference in responses ($\chi^2 = 29.116$, $p < 0.001$), underscoring a potential cognitive dissonance between acknowledging fluoride safety and maintaining concerns about toxicity.

These findings (Table 4) highlight that while familiarity with fluoride and its dental benefits remains high, perceptions of safety are more polarized and merit targeted educational strategies. Addressing these discrepancies is essential to reinforce public confidence in systemic fluoridation policies.

Table 4. Comparative crosstabulation analysis for the questions Could the fluoride supplied to the community through water fluoridation be considered a toxic substance? Are you familiar with the term “fluoride”?

		Could the fluoride supply to the community through water fluoridation be considered a toxic substance?													
		Total agreement		Partial agreement		Neutral		Partial disagreement		Total disagreement		Total			
		%	N	%	N	%	N	%	N	%	N	%		*r*	*p*
Are you familiar with the term “fluoride”?	Yes	2	4	12	24	32	63	35	69	14	28	94	188	-0.088	0.645
	No	0	0	0.5	1	2.5	5	0.5	1	0	0	3.5	7		
	No, but I would like to know	0	0	0.5	1	1	2	1	2	0	0	2.5	5		
	Total	2	4	13	26	35	70	36	72	14	28	100	200		
Did you know that fluoride protects your teeth?	Yes	2	4	11	22	31	62	33	66	14	28	91	182	-0.118	0.095
	No	0	0	2	4	4	8	3	6	0	0	9	18		
	Total	2	4	13	26	35	70	36	72	14	28	100	200		
Given the dental health benefits, do you think general fluoridation is safe?	Total agreement	1.5	3	1.5	3	5.5	11	4.5	9	9	18	22	44	-0.343	0.00
	Partial agreement	0.5	1	5	10	14	28	24	47	4.5	9	47.5	95		
	Neutral	0	0	2	4	15	29	6	12	0.5	1	23	46		
	Partial disagreement	0	0	4	8	1	2	2	4	0	0	7	14		
	Total disagreement	0.5	1	0	0	0	0	0	0	0	0	0.5	1		
	Total	2	4	12.5	25	35	70	36	72	14	28	100	200		

r= Pearson's R;p = significance level.

3.5. Sociodemographic Determinants of Dental Check-Up Frequency

As shown in Table V, among the participants who reported having a dental check-up in the past six months 32%, (N=64), a majority resided in urban areas 23%, (N=46), while the remaining respondents were from rural settings 9%, (N=18). The association between place of residence and time since the last dental visit was not statistically significant (χ^2 = 4.295, p = 0.415), indicating that location did not significantly influence recent dental attendance.

Regarding education level, of the same subgroup 32%, (N=64), 21% (N=42) had completed high school, 10% (N=20) held a bachelor's degree, and 1% (N=2) had completed postgraduate studies. The comparison between education level and dental check-up timing also yielded no statistically significant association (χ^2 = 8.568, p = 0.104).

These results suggest that, within the study sample, neither educational attainment nor place of residence had a significant influence on the likelihood of attending a dental check-up in the last six months (Table 5).

Table 5. Comparative crosstabulation analysis for the questions Place of residence and highest degree of education completed - Time of last dental check-up.

		Time of last dental check-up															
		1W		1M		6M		1Y		2Y		3Y		Total			
		%	N	%	N	%	N	%	N	%	N	%	N	%	N	*r*	*p*
Place of residence	Urban	5.5	11	12	24	23	46	12	24	3.5	7	5.5	11	61.5	123	-0.045	0.582
	Rural	5	10	10.5	21	9	18	8	16	2.5	5	3.5	7	38.5	77		
	Total	10.5	21	22.5	45	32	64	20	40	6	12	9	18	100	200		
Highest degree of education completed	Middle school	0	0	0	0	0	0	0	0	0.5	1	0	0	0.5	1	-0.039	0.582
	Highschool	6.5	13	16.5	33	21	42	14	28	2.5	5	7	14	67.5	135		
	Bachelor's degree	3.5	7	4.5	9	10	20	5	10	2.5	5	2	4	27.5	55		
	Master's degree	0.5	1	1.5	3	1	2	1	2	0.5	1	0	0	4.5	9		
	Total	10.5	21	22.5	45	32	64	20	40	6	12	9	18	100	200		

r= Pearson's R;p = significance level.

3.6. Correlations between Public Knowledge of Fluoride Terminology and Perceived Benefits of Water Fluoridation

As presented in Table 6, among the 132 participants who responded "No" to the question about knowing the types of fluoridation, 90.9% (N=120) indicated familiarity with the term "fluoride." A small portion, 5.3% (N=7), stated they were not familiar with the term, and 3.8% (N=5) reported not being familiar but willing to learn more. The association between knowledge of fluoridation types and familiarity with the term "fluoride" was statistically significant (χ^2 = 10.305, p = 0.016), indicating a weak but relevant correlation (r=0.171).

Regarding the benefits of fluoridated water, 106 respondents (53%) reported awareness of the need for drinking water fluoridation. Of these, 89.6% (N=95) also affirmed awareness of the benefits of fluoridated water, while 10.4% (N=11) were not aware of its benefits. In contrast, among the 94 participants (47%) who were not aware of the need for water fluoridation, only 5.5% (N=11) stated

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knowledge of its benefits, whereas 86.2% (N=81) did not. This difference was highly statistically significant (χ^2 = 113.46, p < 0.001), suggesting a strong association between awareness of water fluoridation needs and knowledge of its benefits (r=0.759)(Table 6).

Table 6. Comparative crosstabulation analysis for the questions Are you familiar with the term "fluoride"? Do you know how many types fluoridation there can be?

Q		Yes		No		Total		*r*	*p*
		%	N	%	No	%	N		
Q	**Do you know how many types of fluoridation there can be?**								
Are you familiar with the term "fluoride"?	Yes	34	68	60	120	94	188	0.171	0.016
	No	0	0	3.5	7	3.5	7		
	No, but I would like to know	0	0	2.5	5	2.5	5		
	Total	34	68	66	132	100	200		
Q	**Are you aware of the need for drinking water fluoridation?**								
Are you aware of the benefits of fluoridated water?	Yes	47.5	95	6.5	13	54	108	0.759	0.000
	No	5.5	11	40.5	81	46	92		
	Total	53	106	47	94	100	200		

r= Pearson's R; p = significance level; c. Based on normal approximation.

3.7. Correlations Between Public Knowledge of Dental Fluorosis and Attitudes Toward Systemic Fluoride Use

As shown in Table 7, a statistically significant association was found between participants' familiarity with the term "dental enamel fluorosis" and their knowledge about how to benefit from fluoride intake while minimizing the risk of fluorosis in children (χ^2 = 67.31, p = 0.000). Among those who responded "Yes" to being aware of these benefits (N=80; 40%), the majority (N=67; 33.5%) also reported familiarity with the term fluorosis. Similarly, a significant correlation was observed between the ability to identify reliable fluoride information sources and awareness of the benefits of fluoride intake (χ^2 = 55.61, p = 0.000). Specifically, 72 respondents affirmed knowledge of reliable sources, of whom 67 (33.5%) also acknowledged understanding the benefits and risk minimization strategies.

In contrast, when analyzing the relationship between awareness of the term "dental enamel fluorosis" and agreement with the statement "General fluoridation is safe," the differences among responses did not reach statistical significance (χ^2 = 8.72, p = 0.117). Although 46 respondents (23%) who reported familiarity with fluorosis expressed partial agreement with the safety of fluoridation, and 30 (15%) indicated total agreement, the variability in responses across agreement categories was not sufficient to establish a statistically meaningful correlation.

These findings highlight that participants who are informed about fluorosis tend to also understand preventive strategies and recognize trustworthy sources of information. However, knowledge of the condition alone does not necessarily translate into strong support for systemic fluoridation measures.

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Table 7. Comparative crosstabulation analysis for the questions Are you familiar with the term 'dental enamel fluorosis'? * Do you know how you can benefit from fluoride intake and minimize the risk of fluorosis for your child?

Q		Yes		No		No, but I would like to know		Total		*r*	*p*
		%	N	%	N	%	N	%	N		
Q	**Do you know where you can find more reliable information about fluoride?**										
Do you know how you can benefit from fluoride intake and minimize the risk of fluorosis for your child?	Yes	33.5	67	5.5	11	40	2	40	80	0.66	.000c
	No	10	20	16	32	32	12	32	64		
	No, but I would like to know	5.5	11	1	2	28	43	28	56		
	Total	49	98	22.5	45	100	57	100	200		
Q	**Are you familiar with the term 'dental enamel fluorosis'?**										
Given the dental health benefits, do you think general fluoridation is safe?	Total agreement	15	30	3	6	21.5	7	21.5	43	0.12	.101c
	Partial agreement	23	46	12.5	25	47.5	24	47.5	95		
	Neutral	9	18	6.5	13	23	15	23	46		
	Partial disagreement	5	10	1.5	3	7	1	7	14		
	Total agreement	0.5	1	0	0	0.5	0	0.5	1		
	Total	52.5	105	23.5	47	99.5	47	99.5	199		
Q	**Do you know how you can benefit from fluoride intake and minimize the risk of fluorosis for your child?**										
Are you familiar with the term 'dental enamel fluorosis'?	Yes	38.5	77	8	16	53	13	53	106	0.69	.000c
	No	1.5	3	18.5	37	23.5	7	23.5	47		
	No, but I would like to know	0	0	5.5	11	23.5	36	23.5	47		
	Total	40	80	32	64	100	56	100	200		

r= Pearson's R; p = significance level; c. Based on normal approximation;

4. Discussion

4.1. Scientific Consensus and Controversies Surrounding Systemic Fluoridation

The fluoridation of public water supplies remains a subject of extensive scientific discussion and public policy evaluation. Despite ongoing debates, the prevailing consensus among major global and national health organizations is in favor of its safety and effectiveness as a preventive public health strategy.

The American Dental Association (ADA) considers community water fluoridation one of the most successful public health interventions of the 20th century, citing significant reductions in dental caries across both children and adults and across all socioeconomic groups [14]. Likewise, the Centers for Disease Control and Prevention (CDC) underscores its cost-effectiveness and particular utility in underserved areas, identifying it as one of the ten greatest public health achievements of the past century [1]. The World Health Organization (WHO) similarly supports fluoridation, referencing its capacity to reduce dental caries prevalence globally as part of its broader oral health strategy [15].

However, despite widespread institutional support, concerns have been raised by re-searchers and advocacy groups regarding potential adverse effects.

The National Institute of Dental and Craniofacial Research (NIDCR) acknowledges the overall benefits of fluoride but calls for ongoing research to further evaluate potential risks, especially in children [16,17]. Particularly, concern has been directed toward dental fluorosis—an aesthetic condition caused by excessive fluoride ingestion during enamel formation—and more recently toward potential neurodevelopmental impacts suggested by emerging epidemiological studies [17].

Opposition from organizations such as the Fluoride Action Network (FAN) has intensified, citing studies linking excessive fluoride exposure to reduced IQ, thyroid dysfunction, and concerns about individual autonomy in mass fluoridation policies [18]. Nevertheless, health authorities like the ADA and CDC maintain that fluoride levels in drinking water are carefully regulated to remain within recommended thresholds and continue to advocate for the oral health benefits that fluoridation provides across the population [14].

These ongoing debates underscore the need for continuous public education and transparent policy development, ensuring that population-level interventions are both evidence-based and ethically justified.

4.2. Assessment of Knowledge and Perceptions Regarding Systemic Fluoridation

The analysis conducted within the assessment of knowledge and perceptions regarding systemic fluoridation highlights the current level of understanding among the participants. Although a substantial majority (91%, N = 182) reported being aware that fluoride protects teeth, no statistically significant differences were identified in this knowledge based on age, gender, educational attainment, or place of residence. These findings are consistent with those reported by AlShahrani et al. [19] and Petersen and Ogawa [20], who documented high levels of general awareness regarding the benefits of fluoride.

However, only 34% of respondents (N = 68) indicated awareness of the various types of fluoridation, with no significant differences observed across sociodemographic variables. This pattern of limited understanding concerning the diversity of systemic fluoride delivery methods echoes the findings of Aoun et al., 2018 [3], and Gopu et al. [9].

A statistically significant association was observed between educational level and familiarity with the term "water fluoridation" ($\chi^2 = 32.219$, p < 0.001), confirming previous research by Aoun et al., 2017 [21], which emphasized the influence of formal education on public health literacy. Notably, gender was the only variable significantly associated with awareness of the benefits of fluoridated water ($\chi^2 = 6.031$, $p = 0.049$), possibly reflecting gender-based differences in information-seeking behavior or expo-sure to oral health education.

Despite widespread familiarity with the term "fluoride" (94%, N = 188), only 53% (N = 106) recognized the term "dental fluorosis," and merely 40% (N = 80) understood how to appropriately manage fluoride intake to mitigate the risk in children. These findings support the conclusions of Gallego-Reyes et al., who highlighted persistent public confusion regarding fluoride toxicity thresholds, particularly in relation to pediatric exposure [5].

Overall, these findings suggest that although superficial knowledge about fluoride is widespread, deeper understanding is lacking and unevenly distributed across educational groups.

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This underscores the need for targeted, evidence-based public education campaigns aimed at improving literacy concerning the sources, benefits, and safety considerations of systemic fluoridation.

4.3. Demographic Variations in Attitudes Toward Water Fluoridation Safety and Toxicity

Most respondents reported recent dental visits, indicating a generally favorable orientation toward oral health care practices. However, no statistically significant associations were observed between the frequency of dental check-ups and demographic variables such as age, gender, educational attainment, or place of residence. These findings suggest that proactive dental health behaviors may be relatively evenly distributed across the population, irrespective of sociodemographic characteristics. In contrast, when perceptions regarding the safety of systemic fluoridation were evaluated (Question Q6), many participants either fully or partially agreed that fluoridation is safe. These responses did not exhibit statistically significant variation across demographic groups, which aligns with findings from similar studies reporting broad acceptance of fluoridation among educated populations [22]. However, when respondents were asked whether fluoride in drinking water could be considered a toxic substance (Question Q7), statistically significant differences emerged based on age ($\chi^2 = 23.736$, $p = 0.022$) and gender ($\chi^2 = 20.275$, $p = 0.009$), indicating a divergence in perceived risk according to these sociodemographic variables. This pattern is consistent with previous research suggesting that younger individuals and women may exhibit greater concern regarding health-related and environmental risks [9,24].

These findings emphasize the need for differentiated public health messaging that ad-dresses specific misconceptions and concerns about fluoride safety. Furthermore, they suggest that certain demographic subgroups may benefit from targeted educational interventions designed to reinforce the scientific consensus on the effectiveness and safety of community water fluoridation [1,2].

4.4. Perceptions of Fluoride Toxicity and Public Awareness of Systemic Fluoridation

The comparative analysis explores public perceptions of fluoride toxicity and their alignment with basic knowledge about fluoride's role in oral health. A key observation is that while a substantial majority (91%, N = 182) of participants reported knowing that fluoride protects teeth, and 94% (N = 188) declared familiarity with the term "fluoride", these indicators of knowledge did not significantly vary across levels of perceived toxicity ($\chi^2 = 2.212$, $p = 0.645$; $\chi^2 = 4.989$, $p = 0.287$, respectively). This suggests a relatively consistent level of fluoride-related knowledge, independent of whether individuals considered fluoridated water toxic.

However, a strong and statistically significant association was observed between perceptions of fluoride toxicity and beliefs about the safety of general fluoridation ($\chi^2 = 29.116$, $p < 0.001$). Although 47 participants in the subgroup that partially disagreed with fluoride toxicity considered fluoridation safe, a notable number remained neutral or skeptical. This cognitive dissonance mirrors findings from studies in other contexts. For example, Aoun et al. (2018) emphasized the dichotomy between general fluoride awareness and skepticism regarding its systemic use [3]. Similarly, Gopu et al. (2023) reported that although awareness of fluoride's dental benefits is high, concerns persist regarding potential systemic risks, especially in relation to neurodevelopmental effects [9].

These insights are essential in designing educational interventions. Simply disseminating basic knowledge about fluoride is not sufficient. Instead, communication strategies must address the nuanced beliefs about fluoride's safety and toxicity, incorporating up-to-date scientific evidence while also being sensitive to public concerns.

In this regard, reinforcing messages from authoritative sources such as the WHO (2020) and the CDC remains a cornerstone of public health promotion [1,2]. Their guidance affirms the safety and efficacy of systemic fluoridation when applied within recommended concentrations.

4.5. Sociodemographic Determinants of Dental Check-Up Frequency

The findings presented in Table V reveal a detailed exploration of the relationships between recent dental attendance and two key sociodemographic factors: place of residence and educational attainment. Within the surveyed population, 32% (N=64) of respondents reported having had a dental check-up in the past six months, with a larger share residing in urban areas (23%, N=46) compared to rural areas (9%, N=18). However, this association was not statistically significant (χ^2 = 4.295, p = 0.415), suggesting that location did not have a substantial influence on dental attendance.

A similar pattern was observed when examining the association between education level and the timing of the last dental visit. Among those with recent check-ups, 21% (N=42) were high school graduates, 10% (N=20) held bachelor's degrees, and only 1% (N=2) had completed postgraduate studies. Again, the statistical test revealed no significant correlation between educational status and recent dental attendance (χ^2 = 8.568, p = 0.104).

These findings align with literature from similar population-based studies. For instance, AlShahrani et al. (2020) reported that, while urban residency often correlated with better access to dental care, behavioral and attitudinal barriers often attenuated this effect [19]. Likewise, a systematic review by Sabbah et al. (2018) found that although education is generally a predictor of preventive dental visits, the relationship can be obscured by cultural norms, dental anxiety, or economic factors [24]. In contrast, some studies like those of Baskaradoss (2014) highlight a more direct connection between higher education levels and regular dental attendance [25], reinforcing the complexity of this relationship across settings.

The lack of significant associations in the current study might reflect relatively uniform access to dental services across the sampled urban and rural areas or may indicate that other variables—such as perceived oral health need, awareness of dental ser-vices, or cost—could play a more decisive role.

4.6. Correlations Between Public Knowledge of Fluoride Terminology and Perceived Benefits of Water Fluoridation

Table VI provides a relevant perspective on the relationship between respondents' familiarity with the term "fluoride" and their knowledge of fluoridation types, as well as the perceived benefits of water fluoridation. The results indicate that 90.9% (N=120) of those who were unfamiliar with the different types of fluoridation still claimed to be familiar with the term "fluoride." This discrepancy highlights a partial understanding of fluoridation concepts, further supported by the statistically significant, albeit weak, association between the variables (χ^2 = 10.305, p = 0.016).

Regarding awareness of the need for water fluoridation and the recognition of its benefits, the data is even more telling. Among those who acknowledged the necessity of water fluoridation (53%, N=106), 89.6% (N=95) were also aware of its benefits. Conversely, among those who were unaware of its necessity, only 5.5% (N=11) recognized the benefits of fluoridation—a statistically significant difference (χ^2 = 113.46, $p < 0.001$). This strong correlation underscores that the level of information significantly influences perceptions of the effectiveness of public health measures.

Previous studies support these findings. For example, Aoun et al. (2018) identified significant public knowledge gaps regarding fluoridation types, despite a general acknowledgment of fluoride's benefits for oral health [3]. Gopu et al. (2023) emphasized that perceptions of fluoride are often fragmented and influenced by educational factors and the nature of information sources [9]. Gallego-Reyes et al. (2024) further noted frequent parental confusion concerning fluoride safety, especially regarding pediatric exposure [5]. Consequently, these results support the need for educational campaigns that address both terminology and the real impact of fluoridation on oral health.

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4.7. Correlations Between Public Knowledge of Dental Fluorosis and Attitudes Toward Systemic Fluoride Use

The analysis presented in Table VII reveals a strong association between respondents' awareness of dental enamel fluorosis and their understanding of preventive fluoride strategies for children. Among participants who indicated familiarity with the benefits of fluoride intake and ways to minimize fluorosis risk (N=80), a significant majority 33.5% (N=67) also reported being familiar with the term "dental enamel fluorosis." The chi-square value confirms this association as statistically significant ($\chi^2 = 67.31$, $p = 0.000$).

This finding is consistent with previous studies that highlight the link between specific fluoride-related knowledge and the ability to implement safe and effective preventive practices. For example, Gallego-Reyes et al. (2024) emphasized that awareness of fluorosis is critical for making informed decisions, particularly in relation to pediatric health and infant formula use [5]. Likewise, Buzalaf and Levy (2011) underlined the importance of parental education regarding fluoride exposure during early tooth development, as excessive intake during this stage is the primary risk factor for fluorosis [26].

Furthermore, knowledge of reliable fluoride information sources was also significantly correlated with an understanding of fluoride benefits ($\chi^2 = 55.61$, $p = 0.000$). This sug-gests that access to trustworthy educational resources may be instrumental in strengthening fluoride literacy. However, no statistically significant relationship was found between awareness of fluorosis and the belief that general fluoridation is safe ($\chi^2 = 8.72$, $p = 0.117$), indicating that technical familiarity with the condition does not necessarily translate into public trust or acceptance of systemic fluoridation policies.

These results mirror findings from broader literature. For instance, a systematic review by Gopu et al. (2023) illustrated that while general awareness about fluoride is relatively high, nuanced understanding — particularly concerning safety thresholds and long-term implications — remains limited and unevenly distributed across populations [9].

In conclusion, this dataset reinforces the need for targeted public health education that not only disseminates information about fluoride benefits but also addresses public concerns and misconceptions about safety. Fostering such balanced knowledge could enhance support for fluoridation programs and ensure more effective individual-level implementation of preventive measures.

Only 34% of participants (N=68) demonstrated awareness of the different methods of systemic fluoridation, reflecting earlier findings by Aoun et al. [3] and Gopu et al. [9], who emphasized the public's limited recognition of alternative fluoride delivery strategies despite their established relevance in oral health promotion. Additionally, familiarity with the term "water fluoridation" was significantly associated with education level ($\chi^2 = 32.219$, $p < 0.001$), corroborating evidence from a study, which underlined the role of formal education in shaping public health literacy [21].

Gender was the only socio-demographic factor significantly correlated with awareness of the benefits of fluoridated water ($\chi^2 = 6.031$, $p = 0.049$), which may reflect differing patterns in health information acquisition between male and female respondents. While 94% (N=188) recognized the term "fluoride," familiarity with the condition "dental fluorosis" was notably lower at 53% (N=106), and only 40% (N=80) understood how to manage fluoride intake to balance its preventive benefits and mitigate associated risks for children. These observations align with findings from Gallego-Reyes et al. [5], who reported significant gaps in public understanding of fluoride safety thresholds and risks, particularly in relation to early childhood exposure. The results of another study show that two-thirds of respondents, 66.8% (N=117), reported having heard of fluoride to a significant extent [27].

The results of another study highlighted that 27%(N=42) of physicians do not apply fluoride methods [28]. The findings reported by Dakó et al. [29] emphasize the urgent need for targeted public health interventions addressing socio-behavioral factors and promoting effective preventive strategies among Romanian preschool children to reduce the high prevalence of S-ECC [30].

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In sum, while awareness of fluoride's dental benefits is prevalent, more sophisticated knowledge of systemic fluoridation methods and associated health considerations remains limited. These insights reinforce the need for targeted educational interventions tailored to population subgroups to support informed public engagement with systemic fluoridation policies.

Study Limitations

This study presents several important limitations that must be considered when interpreting the results. First, the sample consisted of a relatively well-educated population, with a significant proportion of participants from urban areas and individuals with medical backgrounds, including dental students. This may have influenced the overall high level of reported knowledge. Such a sample structure limits the generalizability of the findings to the broader adult population in Romania or to groups with lower levels of education.

Second, the research tool employed was a self-administered questionnaire, which carries the risk of response bias—either due to the tendency to provide socially desirable answers or due to subjective interpretation of the questions. Additionally, the cross-sectional nature of the study does not allow for causal relationships to be established, but only for statistical associations between variables to be observed.

Finally, the distribution of participants was not proportional to the general population in terms of age, gender, and place of residence, which may affect the external validity of the results. Future studies should include larger and more heterogeneous samples to obtain a more comprehensive and representative picture of systemic fluoridation literacy among the adult population in Romania.

5. Conclusions

The findings of this study highlight a generally high level of awareness regarding the benefits of fluoride for dental health, while also revealing significant gaps in the public's in-depth understanding of systemic fluoridation, its mechanisms, and safety considerations. Although most respondents reported familiarity with fluoride and its protective effects, perceptions related to toxicity and the safety of fluoridation remain fragmented and, at times, contradictory—indicating a disconnect between declarative knowledge and applied understanding.

The statistically significant association between education level and knowledge of terms such as "water fluoridation" underscores the influence of formal education on public health literacy. Additionally, the observed differences in risk perception by gender and age emphasize the importance of tailoring public health messaging to specific demographic groups.

These findings support the need for the development of targeted, differentiated educational strategies that go beyond basic information dissemination and directly address safety concerns. Effective communication should be grounded in up-to-date scientific evidence and leverage the credibility of institutional sources such as the World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC).

Promoting a balanced and nuanced understanding of systemic fluoridation is essential for strengthening public support for oral health policies. Educational programs that integrate technical content with culturally and demographically adapted approaches can enhance the effectiveness of preventive interventions and contribute to reducing inequalities in oral health.

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Abbreviations

The following abbreviations are used in this manuscript:

MDPI	Multidisciplinary Digital Publishing Institute
DOAJ	Directory of open access journals
TLA	Three letter acronym
LD	Linear dichroism
Q	Questions
N	Count
A	Age
G	Gender
B	Background
p	Significance
$\chi 2$	Pearson Chi-Square
WHO	World Health Organization
CDC	Centers for Disease Control and Prevention
IQ	Intelligence Coefficient
ADA	American Dental Association
NIDCR	National Institute of Dental and Craniofacial Research
FAN	Fluoride Action Network

References

1. Centers for Disease Control and Prevention (CDC). Community Water Fluoridation. Available online: https://www.cdc.gov/fluoridation/index.html (accessed on 10 June 2024).
2. World Health Organization (WHO). Fluoride and Oral Health. WHO Technical Report Series No. 846. Geneva: WHO; **2020**. Available online: https://iris.who.int/bitstream/handle/10665/39746/WHO_TRS_846.pdf (accessed on 10 June 2024).
3. Aoun, A.; Darwiche, F.; Hayek, S.A.; Doumit, J. The fluoride debate: the pros and cons of fluoridation. Prev. Nutr. Food Sci. **2018**, 23, 171–180. https://doi.org/10.3746/pnf.2018.23.3.171
4. Pollick, H. The role of fluoride in the prevention of tooth decay. Pediatr. Clin. North Am. **2018**, 65, 923–940.
5. Gallego-Reyes, S.M.; Cury, J.A.; Pérez-Silva, A.; Serna-Muñoz, C.; Fernández-Pizarro, I.; Martínez-Beneyto, Y.; Ortiz-Ruiz, A.J. Potential risk of dental fluorosis associated with different baby formulas and water brands marketed in Spain. J. Clin. Pediatr. Dent. **2024**, 48(1), 111–119. https://doi.org/10.22514/jocpd.2024.013
6. Taylor, K.W.; Eftim, S.E.; Sibrizzi, C.A.; Blain, R.B.; Magnuson, K.; Hartman, P.A.; Rooney, A.A.; Bucher, J.R. Fluoride Exposure and Children's IQ Scores: A Systematic Review and Meta-Analysis. JAMA Pediatr. **2025**, 179(3), 282–292. https://doi.org/10.1001/jamapediatrics.2024.5542
7. National Toxicology Program. NTP Monograph on the State of the Science Concerning Fluoride Exposure and Neurodevelopment and Cognition: A Systematic Review. NTP Monogr. **2024**, 8, NTP-MGRAPH-8. https://doi.org/10.22427/NTP-MGRAPH-8

8. Till, C.; Grandjean, P.; Martinez-Mier, E.A.; Hu, H.; Lanphear, B. Health Risks and Benefits of Fluoride Exposure During Pregnancy and Infancy. Annu. Rev. Public Health **2025**, 46(1), 253–274. https://doi.org/10.1146/annurev-publhealth-060722-023526
9. Gopu, B.P.; Azevedo, L.B.; Duckworth, R.M.; Subramanian, M.K.P.; John, S.; Zohoori, F.V. The Relationship between Fluoride Exposure and Cognitive Outcomes from Gestation to Adulthood—A Systematic Review. Int. J. Environ. Res. Public Health **2023**, 20, 22. https://doi.org/10.3390/ijerph20010022
10. Nogueira-Lima, E.; Alves, T.; Etchebehere, E. F-Fluoride PET/CT—Updates. Semin. Nucl. Med. **2024**, 54(6), 951–965. https://doi.org/10.1053/j.semnuclmed.2024.09.005
11. Buzalaf, M.A.R.; Levy, S.M. Fluoride intake of children: considerations for dental caries and dental fluorosis. Monogr. Oral Sci. **2011**, 22, 1–19. https://doi.org/10.1159/000325101
12. Available online: https://populatia.ro/populatie-judetul-iasi/ (accessed on 23 May 2023). According to the calculation formula
13. Xia, F.; Hughes, J.P.; Voldal, E.C.; Heagerty, P.J. Power and sample size calculation for stepped-wedge designs with discrete outcomes. Trials **2021**, 22, 598. https://doi.org/10.1186/s13063-021-05542-9
14. ADA, "All About Fluoride," [Online]. Available: https://www.ada.org/-/media/project/ada-organization/ada/ada-org/files/community-initiatives/**2022**_ada_adh_all_about_fluoride.pdf?rev=d24af5b913ae44658e3941f6c44c65e6&hash=6C3EF965D2C0255DDE51EBA51DCC87BA. [Accessed 26 June 2024].
15. WHO, "Fluoride in Drinking-water," **2006**. [Online]. Available: https://iris.who.int/bitstream/handle/10665/43514/9241563192_eng.pdf?sequence=1. [Accessed 26 June 2024].
16. NIDCR, "The Story of Fluoridation," **2018**. [Online]. Available: https://www.nidcr.nih.gov/health-info/fluoride/the-story-of-fluoridation. [Accessed 26 June 2024].
17. NIDCR, "Fluoride & Dental Health," **2019**. [Online]. Available: https://www.nidcr.nih.gov/health-info/fluoride. [Accessed 26 June 2024].
18. FAN, "Health Effects of Fluoride," [Online]. Available: https://fluoridealert.org/key-topics/health-effects-of-fluoride/. [Accessed 26 June 2024].
19. AlShahrani, I.; Tikare, S.; Togoo, R.A.; Al-Asmari, A.; Al-Qahtani, M.H.; Al-Ghamdi, N. Knowledge, attitude and practices regarding fluorides among dental professionals in Southern Saudi Arabia. J. Int. Soc. Prev. Community Dent. **2020**, 10(6), 747–753. https://doi.org/10.4103/jispcd.JISPCD_178_20
20. Petersen, P.E.; Ogawa, H. Prevention of dental caries through the use of fluoride: the WHO approach. Community Dent. Health **2016**, 33, 66–68.
21. Aoun, A.; Hayek, S.; Doumit, J. The impact of educational level on knowledge and attitude toward fluoridated water in a Lebanese population. J. Int. Oral Health **2017**, 9(5), 234–240. https://doi.org/10.4103/jioh.jioh_102_17
22. Mariño, R.; Khan, A.R.; Morgan, M. Systematic Review of Economic Evaluations on Community Water Fluoridation. Int. J. Environ. Res. Public Health **2021**, 18, 11786. https://doi.org/10.3390/ijerph182211786
23. Taylor, K.W.; Eftim, S.E.; Sibrizzi, C.A.; Blain, R.B.; Magnuson, K.; Hartman, P.A.; Rooney, A.A.; Bucher, J.R. Fluoride Exposure and Children's IQ Scores: A Systematic Review and Meta-Analysis. JAMA Pediatr. **2025**, 179, 282–292. https://doi.org/10.1001/jamapediatrics.2024.5542
24. Sabbah, W.; Tsakos, G.; Chandola, T.; Sheiham, A.; Watt, R.G. Social gradients in oral and general health. J. Dent. Res. **2018**, 96(4), 364–370. https://doi.org/10.1177/0022034516688882
25. Baskaradoss, J.K. Relationship between oral health literacy and oral health status. BMC Oral Health **2014**, 14, 171. https://doi.org/10.1186/1472-6831-14-171
26. Buzalaf, M.A.R.; Levy, S.M. Fluoride Intake of Children: Considerations for Dental Caries and Dental Fluorosis. Monogr. Oral Sci. **2011**, 22, 1–19. https://doi.org/10.1159/000325101
27. Saveanu, C.I.; Danila, O.; Iovan, A.; Anistoroaei, D.; Boronia, O.; Saveanu, A.E. Cross-Sectional, Questionnaire-Based Survey on Primary Prevention Attitudes among Romanian Teenagers. Rom. J. Oral Rehabil. **2023**, 15(2), 280.

 doi:10.20944/preprints202507.0685.v1

28. Saveanu, C. I.; Danila, I.; Barlean, L.; Balcos, C. Dentists' Attitudes towards Prevention in North-East of Romania. Rom. J. Oral Rehabil. **2012**, 4(3), July–September. Available online: https://rjor.ro/revista/2012/numarul-3-2012/ (accessed on 6 July 2025).
29. Dakó, T., Lazăr, A.-P., Vlasiu, A., Lazăr, L., Monea, M., & Bica, C.-I. Socio-Behavioral Determinants for Severe Early Childhood Caries (S-ECC). Rom. J. Oral Rehabil. **2024**, 16(3), 460–469. https://doi.org/10.6261/RJOR.2024.3.16.48
30. Popa, Ș.; Dimitriu, B.A.; Giurgiu, M.-C.; Dumitriu, A.S.; Păunică, S.; Mocanu, B.F.; Colbu, Ș.-C.; Didilescu, A.C. Romanian Children's Perception of Dental Cavities and Gingival Bleeding in Correlation with Personal Oral Behaviours—A Cross-Sectional Study. Rom. J. Oral Rehabil. **2024**, 16(2), 592. https://doi.org/10.6261/RJOR.2024.2.16.54.