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ORIGINAL ARTICLE

Silver Diamine Fluoride Use among Dental Students and Pediatric Dentists: An Observational Study

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ABSTRACT

Objective: To evaluate the use of silver diamine fluoride (SDF) among undergraduate dental students and graduate students/specialists in pediatric dentistry in Brazil. **Material and Methods:** The data were collected with online questionnaires sent to the participants (n=404) by e-mail and were analyzed by logistic regression models (α=0.05). **Results:** A total of 26.2% were unfamiliar with SDF. The product effectiveness (84.8%) was the main reason reported by respondents who used SDF in pediatric dental care. Professionals who had graduated for 1-15 years (OR=4.83), those with more than 15 years since graduation (OR=21.58), postgraduate students, graduates and professors (OR=10.01), or professionals who work in a dental office (OR=7.73) were more likely to have used the SDF. Most participants (67.8%) reported that they would use SDF even considering the unfavorable aesthetic result, especially those who would consider its use in a pandemic situation (OR=26.90), who know the SDF (OR=3.39), professionals who had graduated for 1-15 years (OR=2.40) or those with more than 15 years of graduation (OR=2.93). **Conclusion:** Most participants who know and use SDF are professionals who have graduated for longer and have more contact with the academic environment. Its use has become more considered by participants within a pandemic context.

Keywords: Cariostatic Agents; Knowledge; Pediatric Dentistry.

Introduction

Dental caries is a multifactorial disease and a public health problem highly common worldwide [1,2]; it is one of childhood's most frequent chronic conditions [3]. However, in Brazil, according to preliminary results from the last SB Brazil 2020, we see that the DMFT index in children fell in the previous decade, being 2.2 for 5-year-old children [4]. It can also be prevented and controlled [1]. At the early stages, such as white spots, micro cavitation, and small enamel cavitations, caries progression can be reversed and stopped by changing habits and improving preventive measures [5].

Dentistry currently focuses on the maximum preservation of dental structures, involving prevention techniques and minimally invasive treatments. According to the American Academy of Pediatric Dentistry (AAPD) [6], alternative measures should be used for conventional restorative treatment, especially in non-cooperative children with financial restrictions and difficult dental care access.

Among the numerous therapies indicated for preventing and treating dental caries, silver diamine fluoride (SDF), also known as a cariostatic agent, is used in several countries [7]. It is a low-cost topical product that stops caries lesions and reduces dental hypersensitivity [6]. Despite the esthetic disadvantage of tooth surface darkening, it has several advantages, such as being safe, effective, inexpensive, and easy and fast to apply [8,9]. Most patients can use SDF, especially those at high risk for caries activity, non-cooperative with treatment, or without oral health care access [7].

Another excellent advantage of SDF is non-invasiveness [8,9], which does not require high rotation, preventing aerosols from spreading in the environment [10,11] and facilitating child conditioning. According to the Latin American Association of Pediatric Dentistry, during the COVID-19 pandemic, dental practice changes were necessary to reduce the risk of contamination for patients and professionals, and SDF represents a suitable treatment [11]. The constant emergence of several new therapies for preventing and treating caries lesions has caused a considerable reduction in SDF use [12] over the years. Recent studies, such as systematic literature reviews and *in vivo* clinical trials, demonstrate the scientific evidence of SDF efficacy [7,9,13-17]. However, undergraduate dental schools and dentists working in some locations in Brazil still do not know or even use SDF, as confirmed in specific studies [10,11].

Considering the scientific evidence on SDF efficacy and the lack of national population studies on its use, this study aimed to evaluate SDF use among undergraduate dental students and graduate students/specialists in pediatric dentistry and the associated variables.

Material and Methods

Study Design and Ethical Clearance

It is a quantitative, observational, analytical, cross-sectional, population-based (census) study with data collection through online questionnaires.

The Research Ethics Committee of the São Paulo State University (UNESP), School of Dentistry, Araraquara, Brazil (Opinion No. 4.727.973) approved this study according to the ethical recommendations of Resolutions No. 466, December 12, 2012, and No. 510, April 7, 2016, of the Brazilian Health Council.

Pilot Study and Sample Size

A pilot study (n=34) was previously conducted to verify the understanding and potential challenges of the questions and answers in the questionnaire. This questionnaire was created based on a previous literature

review with questions that collected sociodemographic information, academic training, professional performance information, and information related to SDF. The final sample size was determined by the total of senior dental students and graduate students/specialists in pediatric dentistry who agreed to participate in the survey by filling out the online form.

Study Sample and Data Collection

Considering it is a population-based study with a convenience sample, all senior dental students and graduate students/specialists in pediatric dentistry registered in their respective states' Regional Council of Dentistry (RCD) were invited to participate.

The data was collected online with Google Forms, based on a previous study [18], in active Higher Education Institutions (HEI) offering undergraduate dental degrees and graduate programs in pediatric dentistry and RCD across Brazil, from April to December 2021, along with the COVID-19 pandemic.

Data were surveyed for each HEI (name of the institution, e-mail, telephone, period, terms, and city) and the RCD of each state (president, telephone, e-mail, and city) through the Brazilian Course Registry, Higher Education Institutions of the Ministry of Education (e-MEC Registry), and the website of the Federal Council of Dentistry [19,20]. Subsequently, all HEIs and RCDs were contacted via e-mail to present the project and invite undergraduate dental students and graduate students/specialists in pediatric dentistry to participate in the research.

e-MEC does not provide exact data on how many students are enrolled in Dentistry courses in Brazil, only that there were 78,230 vacancies, and the Federal Council of Dentistry website reports that there were 9,013 specialists distributed across all Regional Council of Dentistry during the survey period for the execution of the present study [19,20].

The Informed Consent Form (ICF) was available for participants to download online. After reading it, they should select the option available in the form "*I have read the Informed Consent Form and agree to participate in the research*" to access the full questionnaire content. Only participants who agreed to participate in the survey through the ICF were included in the sample.

Study Variables and Research Question

The study considered the following variables:

(a) Outcome variables: "*Do you use or have used silver diamine fluoride (cariostatic agent) in any pediatric dental care?*" and "*Considering the esthetic result after using silver diamine fluoride (cariostatic agent) and the scientific evidence demonstrating its efficacy, do you or would you use this product in your pediatric dental practice?*".

(b) Independent variables: Sex, time since graduation, type of institution, primary practice location, SDF knowledge, and potential SDF use in a pandemic.

The following research question was also considered: "*Is silver diamine fluoride use in pediatric dental care associated with the profile of the practitioner?*".

Statistical Analysis

All data were descriptively analyzed using absolute and relative frequencies. Next, logistic regression models were estimated between each independent variable and the outcomes. Crude odds ratios were calculated

from these models with their respective 95% confidence intervals. Variables with p<0.20 in the individual analyses were tested in multiple logistic regression models and remained in the final model when p≤0.05 after adjusting for the other variables. Adjusted odds ratios were estimated from the multiple models with their respective 95% confidence intervals. The fit of the models was evaluated using the AIC (AKAIKE information criterion). All analyses were performed in R software at a 5% significance level.

Results

The answers of 404 participants were evaluated, including 83.7% of women and 16.3% of men, with an average age of 27 years (standard deviation = 11.8) according to the level of training, 49.3% of participants were undergraduate students, 21.8% were specialists in Pediatric Dentistry while 11.1% and 49.3% were students/master's and students/doctors in Pediatric Dentistry respectively. As for the time since graduation, 16.6% had not graduated yet, 31.9% had graduated for less than a year, 26.0% for one to 15 years, and 25.5% for more than 15 years.

Of all participants, 26.2% claimed unfamiliarity with SDF, 37.9% are familiar with but never used it, and 35.9% are familiar with and have used it (Table 1).

Table 1. Frequency distribution of the participants' answers according to knowledge and use of silver diamine fluoride (cariostatic agent).

Participant Groups	N (%)
Unfamiliar with silver diamine fluoride (cariostatic agent)	106 (26.2)
Familiar with silver diamine fluoride (cariostatic agent) but never used it	153 (37.9)
Familiar with silver diamine fluoride (cariostatic agent) and have used it	145 (35.9)

Table 2 shows the analyses of association with the outcome "*uses or has used SDF in any pediatric dental care.*" The time since graduation, type of institution, and primary practice location variables showed p<0.20 in the crude analyses. When studied together in the multiple models, only the time since graduation and primary practice location variables remained significant (p≤0.05). SDF use was more likely among professionals who had graduated for one to 15 years (OR=5.32; 95%CI:1.49-18.98) and for more than 15 years (OR=18.06; 95%CI:4.85-67.24) than those with less than one year since graduation or not yet graduated (p<0.05). There was also a higher likelihood of SDF use among graduate students, graduated professionals, professors (OR=10.43; 95%CI:2.20-49.39), and dental office professionals (OR=9.37; 95%CI:1.91-45.92) than undergraduate students (p<0.05).

Table 3 shows that considering the esthetic result after using SDF (cariostatic agent) and the scientific evidence demonstrating its efficacy, 67.8% of participants use or would use this product in their pediatric dental practice. In the analyses of association with this outcome, the time since graduation, type of institution, primary practice location, and region of operation variables showed p<0.20 and were tested in the multiple models. Only the time since graduation variable remained significant in the final model (p<0.05). SDF use was more likely among participants who had graduated for one to 15 years (OR=2.40; 95%CI: 1.41-4.08) and for more than 15 years (OR=2.93; 95%CI: 1.68-5.11) than those with less than one year since graduation or not yet graduated (p<0.05). There is a greater chance of using SDF among participants who responded that they did not know the product (OR=5.16; 95% CI: 1.43-18.55) and between those who would consider using it in a pandemic situation (OR=26.90; 95% CI: 7.72-93.67) than among those who responded that they would not use it in a situation pandemic (p<0.05).

Table 2. Analyses (crude and adjusted) of the associations with the outcome "uses or has used silver diamine fluoride (cariostatic agent) in pediatric dental care."

Variables	N (%)	Uses or has Used?		Crude OR (95%CI)	p-value	Adjusted OR (95%CI)	p-value
		No N (%)	*Yes N (%)				
Overall	404 (100.0)	259 (64.1)	145 (35.9)				
Sex							
Female	338 (83.7)	213 (63.0)	125 (37.0)	1.35 (0.76-2.39)	0.3020	-	-
Male	66 (16.3)	46 (69.7)	20 (30.3)	Ref			
Time Since Graduation							
Not graduated yet or graduated for less than one year	196 (48.5)	189 (96.4)	7 (3.6)	Ref		Ref	
One to $15 years	105 (26.0)	49 (46.7)	56 (53.3)	30.86 (13.24-71.92)	<0.0001	4.83 (1.31-17.77)	0.0179
More than 15 years	103 (25.5)	21 (20.4)	82 (79.6)	105.43 (43.13-257.71)	<0.0001	21.58 (5.52-84.34)	<0.0001
Type of Institution							
Private	250 (61.9)	180 (72.0)	70 (28.0)	Ref		-	-
Public	154 (38.1)	79 (51.3)	75 (48.7)	2.44 (1.60-3.71)	<0.0001		
Primary Practice Location							
University - seniors	180 (44.6)	176 (97.8)	4 (2.2)	Ref		Ref	
University – Graduate students/specialists and faculty	92(22.8)	36 (39.1)	56 (60.9)	68.42 (23.34-200.61)	<0.0001	10.01 (2.06-48.76)	0.0043
Dental Office	132 (32.7)	47 (35.6)	85 (64.4)	79.55 (27.75-228.00)	<0.0001	7.73 (1.52-39.30)	0.0137
Region of Operation							
Southeast	280 (69.3)	199 (71.1)	81 (28.9)	Ref		Ref	
Other	124 (30.7)	60 (48.4)	64 (51.6)	2.62 (1.69-4.06)	<0.0001	2.52 (1.34-4.73)	0.0039

*Outcome event; $Median among specialists; Ref: Reference category for independent variables; OR: Odds ratio; CI: Confidence interval; AIC (empty model)=529.45; AIC (final model)= 305.29.

Table 3. Analyses (crude and adjusted) of the associations with the outcome "considering the esthetic result after using silver diamine fluoride (cariostatic agent) and the scientific evidence demonstrating its efficacy, do you or would you use this product in your pediatric dental practice?".

Variables	N (%)	Uses or has Used?		Crude OR (95%CI)	p-value	Adjusted OR (95%CI)	p-value
		No N (%)	Yes* N (%)				
Overall	404 (100.0)	130 (32.2)	274 (67.8)				
Sex							
Female	338 (83.7)	111 (32.8)	227 (67.2)	0.83 (0.46-1.48)	0.5196	-	-
Male	66 (16.3)	19 (28.8)	47 (71.2)	Ref			
Time Since Graduation							
Not graduated yet or graduated for less than one year	196 (48.5)	84 (42.9)	112 (57.1)	Ref		Ref	
One to $15 years	105 (26.0)	25 (23.8)	80 (76.2)	2.40 (1.41-4.08)	0.0012	2.40 (1.41-4.08)	0.0012
More than 15 years	103 (25.5)	21 (20.4)	82 (79.6)	2.93 (1.68-5.11)	0.0002	2.93 (1.68-5.11)	0.0002
Type of Institution							
Private	250 (61.9)	90 (36.0)	160 (64.0)	Ref		-	-

Public	154 (38.1)	40 (26.0)	114 (74.0)	1.60 (1.03-2.50)	0.0369		
Primary Practice Location							
University - seniors	180 (44.6)	76 (42.2)	104 (57.8)	Ref		-	-
University – Graduate students/specialists and faculty	92 (22.8)	13 (14.1)	79 (85.9)	4.44 (2.30-8.56)	<0.0001		
Dental Office	132 (32.7)	41 (31.1)	91 (68.9)	1.62 (1.01-2.60)	0.0449		
Region of Operation							
Southeast	280 (69.3)	97 (34.6)	183 (65.4)	Ref		-	-
Other	124 (30.7)	33 (26.6)	91 (73.4)	1.46 (0.92-2.33)	0.1121		
Know SDF							
No	106 (26.2)	56 (52.8)	50 (47.2)	Ref		-	-
Yes	298 (73.8)	74 (24.8)	224 (75.2)	3.39 (2.13-5.39)	<0.0001		
Would consider using in a situation of pandemic							
Don't know the product	94 (23.3)	53 (56.4)	41 (43.6)	5.16 (4.43-18.55)	0.0120	5.16 (1.43-18.55)	0.0120
I wouldn't use	23 (5.7)	20 (87.0)	3 (13.0)	Ref		Ref	
Would use	287 (71.0)	57 (19.9)	230 (80.1)	26.90 (7.72-93.97)	<0.0001	26.90 (7.72-93.67)	<0.0001

*Outcome event; $median among specialists; Ref: Reference category for independent variables; OR: Odds ratio; CI: Confidence interval; AIC (empty model)=509.59; AIC (final model)= 493.15.

Among the participants who have used SDF in pediatric dental care, the most prevalent reason was their perceived product effectiveness (84.8%) (Table 4). However, the lack of opportunity was the main reason for not using SDF (68.7%) (Table 5). Most professors (62.0%) reported teaching SDF use in theoretical and practical classes (Table 6).

Table 4. Descriptive analysis of the reasons for using silver diamine fluoride (cariostatic agent) in pediatric dental care.

Reason	N[1] (%)
Perceived product effectiveness	123 (84.8)
Good cost/benefit ratio	51 (35.2)
Easy to handle	51 (35.2)
Non-invasive, producing minimum aerosols during assistance	46 (31.7)
Helps child conditioning	41 (28.3)
Helps caries prevention and treatment	1 (0.7)
Helps reduce sensitivity	1 (0.7)
Excellent prognosis for nearby lesions in dentin	1 (0.7)
Helps condition special needs patients without motor coordination and hard to manage	1 (0.7)
Stops active caries lesions in enamel and dentin	1 (0.7)
Lack of other products in the public network	1 (0.7)
It fits the medium of patients with little or no cooperation, associated with a varnish	1 (0.7)
Total number of participants who use or have used it	145 (100.0)

[1]The participant could indicate more than one reason.

Table 5. Descriptive analysis of the reasons for not using silver diamine fluoride (cariostatic agent) in pediatric dental care.

Reason	N[1] (%)
Lack of opportunity	178 (68.7)
Unfamiliarity with the product	99 (38.2)
Lack of scientific knowledge	57 (22.0)
Parents do not like the esthetic result	27 (10.4)
Patients do not like the esthetic result	15 (5.8)
The participant does not like the esthetic result	20 (7.7)
The participant had negative results	1 (0.4)
Unsatisfactory cost/benefit ratio	1 (0.4)
Not sufficiently promoted to parents looking for more esthetic results and pain relief	1 (0.4)
Not available for use in the current clinical setting	1 (0.4)
Not available at the university	1 (0.4)
The university does not use the product	1 (0.4)
Profile of esthetically demanding patients with a low prevalence of caries lesions	1 (0.4)
The participant does not like the esthetic result, preferring fluoride varnish	1 (0.4)
Total of participants who never used it	259 (100.0)

[1]The participant could indicate more than one reason.

Table 6. Descriptive analysis of teaching silver diamine fluoride (cariostatic agent) use by professors.

Teaches Students Silver Diamine Fluoride (Cariostatic Agent) Use	N[1] (%)
No	11 (12.0)
Yes, only in theoretical classes	20 (21.7)
Yes, only in clinical classes	4 (4.3)
Yes, in theoretical and clinical classes	57 (62.0)
Total professors	92 (100.0)

Discussion

In this study, participants were unfamiliar with SDF, corroborating the study by Vollú et al. [21], which showed that only 19.7% of participants did not know the product. Moreover, data from this study showed that 37.9% of the sample was familiar with SDF but had never used it, and 35.9% knew and had used it, showing a higher use percentage compared to 13.2% of participants in the study by Vollú et al. [21]. This divergence may have occurred because this study was developed nationwide in Brazil, not restricted to routines and practices regionally developed.

The time since graduation and primary practice location variables were associated with SDF use in pediatric dental care. Professionals who had graduated for longer and graduate students/specialists and faculty were more likely to use SDF. These data corroborate the permanence of SDF on the market since the 1960s [22] with proven efficacy and the academic community's interest in seeking clinical and scientific information [21].

When asked about the use of SDF after unfavorable aesthetic results caused by stains on dental elements, the majority reported that they would use the material in their pediatric dentistry office. Furthermore, SDF use was more likely among respondents who had graduated for longer. Thus, professionals established longer in the market know the benefits, indications, safety, and control of environmental contamination, avoiding more invasive interventions [21].

The participants who used SDF in pediatric dental care justified this decision based on product efficacy, significant cost/benefit, easy handling, non-invasiveness, and assistance in child conditioning. Findings by Ezzeldin et al. [10] corroborate this study, as they also verified that the vast majority of respondents who used SDF considered it easy to apply, good cost/benefit, and non-invasive, reducing the chances of general anesthesia and sedation to treat pediatric dental patients.

The participants who did not use SDF listed the following obstacles: the lack of opportunity, unfamiliarity with the product, lack of scientific knowledge, and the unsatisfactory esthetic result reported by parents and/or patients or the respondents. Vollú et al. [21] also showed that 58.3% of respondents had no scientific knowledge, and 27.6% considered the esthetic damage.

Although no evidence attributes tooth staining to the refusal of SDF use in deciduous teeth [23], this was among the main barriers to its non-use, with the rejection of 22.5% of parents, according to Vollú et al. [21]. In this study, only 16.2% refused the product due to tooth staining, as in the study by Crystal et al. [24], in which parents of children with dental treatment limitations were more likely to accept the product.

Considering the few situations that prevent SDF use, there should be further efforts to promote the product, especially during professional training. Among the professors, 62% claimed to teach about SDF in theoretical and clinical classes, and only 12% did not. Vollú et al. [21] observed that 59.5% of the interviewed professors taught SDF use in theoretical courses and only 28.4% in clinical practice. It is important to note that it is essential that more scientific evidence on SDF reaches dental professionals and students so that routine clinical practice aims at controlling caries disease and minimally invasive treatments.

These findings suggest the need for greater dissemination of scientific and practical knowledge about SDF in different areas, such as undergraduate and graduate courses, lectures, scientific conferences, and information leaflets. This would benefit professionals by providing relevant information to encourage them to use the product in their daily clinical practice, leading to the control of caries disease through minimally invasive treatments. Parents or guardians of children must also learn about the advantages of treatment with SDF, such as the easy application and use possibilities for all patients, including non-cooperative ones.

According to the American Academy of Pediatric Dentistry (AAPD) [6], the final decision about treatment with SDF must be made jointly by parents and professionals, considering the tendency of patients to develop caries disease. Parents should also be instructed through an informed consent form about the staining of the dental element and potentially of the skin and clothing and the need for product reapplication to prevent and control caries disease [25].

Regarding the esthetic result, the dental element darkens after applying SDF, but using saturated potassium iodide solution (SSKI) after SDF treatment (separately) decreases such darkening, maintaining the effectiveness in stopping caries lesions [7]. Moreover, glass ionomer cement or composite resin may promote esthetic recovery [7].

Brazil is characterized by intense social and regional inequalities [26], and caries affect 53.4% of five-year-old children [27]. In this context, SDF emerges as an essential public health ally because it is inexpensive, painless, safe, and easy and fast to apply. It is also an excellent treatment for non-cooperative children and special needs patients [28,29].

In an atypical context such as the COVID-19 pandemic, an infectious disease, the use of SDF is considered by most participants in the present study, even with its anti-aesthetic effects. Remembering that SDF can contain dental caries in a simple way, painless, and non-invasive way, not generating aerosols in addition to promoting remineralization and neutralizing demineralization [30], essential properties in a context that wants to reduce the production of aerosols and reduce the possibility of transmission of the disease/virus.

Considering the serious problems caused by the COVID-19 pandemic and potential large-scale contamination resulting from globalization and ease of movement around the globe, and the described advantages, further efforts should focus on scientific research and promotion of SDF so that the population and professionals in the field know and accept the product for stopping caries lesions and promoting oral health.

The limitations of the present study include the online application of questionnaires via Google Forms, the dependency on the engagement of people invited, the delivery of e-mails by the RCD, and study performance during the COVID-19 pandemic.

Conclusion

In this study, most participants who know and use silver diamine fluoride are professionals who have been trained for a long time and have more significant contact with academia. The silver diamine fluoride must be covered more in undergraduate courses and for more scientific information about its advantages and facilities to be more widespread and discussed among clinical professionals so that they can use yet another option effective for controlling the progression of caries lesions.

Authors' Contributions

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All authors declare that they contributed to a critical review of intellectual content and approval of the final version to be published.

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Conflict of Interest

The authors declare no conflicts of interest.

Data Availability

The data used to support the findings of this study can be made available upon request to the corresponding author.

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