

ORIGINAL RESEARCH

Acceptance and awareness of southeastern and western private practice pediatric dentists of fluoride-free toothpastes: a survey study

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Abstract

The American Academy of Pediatric Dentistry (AAPD) affirms that the use of fluoride, as an adjunct in the prevention of caries, is safe and effective. The AAPD encourages dentists, other healthcare providers, and parents to optimize fluoride exposures to reduce the risk of caries and to enhance the remineralization of affected teeth. However, there is resistance amongst patients towards fluoride overexposure and despite there being research on other effective remineralizing agents, most pediatric dentists primarily cater their practice to fluoride-based products. The objective of the study is to survey pediatric dentists' acceptance and awareness of fluoride-free remineralizing agents. A listserv of the southeastern and western private practice pediatric dentists was obtained from the AAPD consisting of 6490 email addresses. A questionnaire consisting of 15 questions was sent to each address using Qualtrics. Different trends in fluoride-free acceptance and awareness were seen based on region of practice, region of training and age of practitioner. Region of practice, residency training and age can be contributing factors toward fluoride-free remineralizing agent opinion. The data gathered trends towards western-trained pediatric dentists are more likely to recommend a fluoride-free toothpaste than a southeastern-trained dentist.

Keywords

Fluoride; Fluoride-free; Nano-hydroxyapatite; Theobromine; Phosphate; Casein; Phosphopeptide; Arginine; Xylitol; Remineralize

1. Introduction

The American Academy of Pediatric Dentistry recommends fluoride toothpastes to prevent tooth decay [1, 2]. Fluoride is beneficial in its ability to remineralize weakened tooth enamel, slow down the loss of minerals from enamel, reverse tooth decay and prevent the growth of harmful bacteria [3, 4]. According to the Centers for Disease Control and Prevention, the average number of missing or decayed teeth in 12-year-old children in the United States has dropped by 68% from the 1960s through the early 1990s [5]. However, there are potential side effects from accidental consumption of too much fluoride which include dental and skeletal fluorosis, cognitive disabilities and cancer [5–11]. Because of this, there is a growing concern by many parents to not over-fluoridate their children to avoid risks of impaired brain development and other ailments. Despite this, the body of research as a whole does not suggest that fluoride is neurotoxic at levels typically seen in developed countries [12]. Because of this growing trend among some parents to steer away from fluoride, newer research is being conducted for fluoride-free remineralizing alternatives. Research shows that many fluoride-free alternative toothpastes are just as effective at remineralizing enamel

as fluoride toothpastes. Some remineralizing agents which have shown strong evidence for their ability to remineralize enamel include nano-hydroxyapatite (n-HA), theobromine, tricalcium phosphate, casein phosphopeptide stabilized amorphous calcium phosphate, arginine and xylitol coated calcium and phosphate [13–20]. Some of these ingredients are starting to become incorporated in over-the-counter toothpastes, but questions remain about how aware pediatric dentists were of these ingredients, if dentists could recognize brands that contained these ingredients, and how accepting these fluoride-free remineralizing agents would be among pediatric dentists. The purpose of this study was to examine the awareness and acceptance of fluoride-free remineralizing agents and to assess trends based on region of practice, region of study and age, in relation to awareness and acceptance.

2. Methods

A listserv of the southeastern and western private practice pediatric dentists was obtained from the AAPD consisting of 6490 email addresses. A questionnaire comprising fifteen questions (Table 1) designed to gather information regarding acceptance and awareness of fluoride-free remineralizing agents was sent

to each address using Qualtrics: (Qualtrics, Provo, UT, USA). The data was analyzed to assess trends in acceptance based on region of education and age of practitioner. Questions included demographic information gathering. The survey was sent to each email address with Institutional Review Boards approval and was open to all participants for 35 days. A follow-up reminder to complete the questionnaire was sent 2 weeks after the initial email. In total, 205 responses were collected and analyzed.

3. Results

Survey responses were gathered and are summarized in Table 2. The survey's return rate was 3.1% with a total of 204 responses. 46.7% of those responding were female and 52.2% were male. 1.1% of respondents chose not to disclose their gender. When questioned about their age, 3.8% of respondents were under the age of 30, 30% responded being 31 to 40, 29.5% 41 to 50 and 35% were over 51 years old. When questioned for how many years each respondent had been practicing pediatric dentistry, 32.8% responded 0–9 years, 22.4% responded 10–19 years, 25.1% responded 20–29 years, 14.8% responded 30–39 years and 4.9% responded over 40 years. When questioned about what type of residency program each respondent attended, 71% reported being in a combination of hospital and university system, 19.7% were hospital trained and 9.3% were in an academic setting only. A majority of responding dentists reported that they work in a private practice in either a solo or group setting (86.4%). Other respondents said they worked in a hospital (4.4%) or a dental school (7%). There were 73 respondents who trained in the southeastern district for residency and 72 respondents were trained in the western region.

When questioned about how accommodating the practitioner was to fluoride-free patients, 2.2% of pediatric dentists said they were not accommodating at all, 6% said they offer very little accommodation, 39.9% said they are moderately accommodating, 27.9% said they are strongly accommodating and 24% said they were extremely accommodating. There was no statistical difference based on region of education and their personal accommodation towards fluoride-free parents. One hundred percent of pediatric dentists who responded 40 years and younger said they were either moderately, strongly or extremely accommodating towards fluoride-free parents/patients while 88% of pediatric dentists 41 years and older said they were either moderately, strongly or extremely accommodating towards fluoride-free parents/patients.

When surveyed how often pediatric dentists saw patients/parents who were opposed to receiving any form of fluoride, 19% reported “a few times a day”, 28.8% reported “a few times a week”, 25% reported “a few times a month”, and 21.7% reported “a few times a quarter”. Fifty-six percent of western-trained pediatric dentists and 44% of southeastern-trained pediatric dentists reported having fluoride-free parents/patients either a “few times a day or a few times a week”. Fifty-seven percent of dentists practicing in the western region reported seeing patients/parents opposed to fluoride either “a few times a day” to “a few times a week” while 45.2% of pediatric dentists practicing in the southeastern

region reported seeing patients/parents opposed to fluoride either “a few times a day” to “a few times a week.”

When questioned, “if research shows that n-HA toothpaste is just as efficacious at remineralizing enamel lesions, would you recommend it to all of your patients or fluoride-free patients only”, 35.5% of dentists 40 years of age and under said they would recommend it to all patients while 30.6% of dentists 41 years and older said they would recommend to all patients. When asked the same question above, 64.5% of dentists 40 years of age and under said they would recommend a n-HA toothpaste over a fluoride toothpaste to only their fluoride-free patients while 62% of dentists 41 years and older that they would only recommend n-HA toothpaste to fluoride-free patients. When comparing the same question based on the region of training, 30.1% of southeastern-trained dentists would recommend n-HA toothpaste to all patients and 65.8% would recommend it to only fluoride-free patients. 33.3% of western-trained dentists would recommend a n-HA to all patients and 59.7% would recommend n-HA to only fluoride-free patients.

When surveyed, 30.4% of dentists said they would recommend fluoride-free toothpaste over a fluoride-containing toothpaste to all of their patients regardless of their patients' fluoride beliefs. 40.3% of all western-trained dentists claimed they would recommend a fluoride-free toothpaste to “all patients” regardless of their patients' fluoride beliefs, while only 21.9% of southeastern-trained dentists said they would do the same.

Pediatric dentists surveyed were asked on a scale of 1–5, how likely are you to recommend a fluoride-free alternative if effective at arresting caries? Three percent of pediatric dentists said “never”, 12% said “not likely”, 54.9% said “sometimes”, 19% said “most of the time” and 10.9% said “all of the time”. When surveyed, “for which reason would you most likely not recommend a fluoride-free alternative”, 7.6% responded “personal preference”, 48.9% said “lack of research in the field”, 32.6% said “not enough personal research” and 10.9% responded for “other reasons”.

Twenty-four percent of all pediatric dentists surveyed 40 years of age and under said they would recommend a fluoride-free toothpaste over a fluoride-containing toothpaste, while 34% of pediatric dentists 41 years and older said they would recommend a fluoride-free toothpaste over a fluoride toothpaste. Fifty-four percent of southeastern-trained pediatric dentists and 57% of western-trained pediatric dentists replied they have either “moderate or strong awareness” of fluoride free-alternatives that remineralize enamel. Despite this, 63% of respondents who were western-trained dentists, and 57% of southeastern-trained pediatric dentists, did not recognize 7 common fluoride-free remineralizing toothpaste brands. When questioned about which brand of fluoride-free remineralizing toothpaste brands pediatric dentists had heard of (Risewell, Boka, Pearlie White, Kinder Karex, Grind, Dr. Raven's Enrich, PerioScience), 52% of pediatric dentists 40 years and under had heard of at least 1 brand. However, only 35% of pediatric dentists 41 years and older had heard of at least of the brands above. Ten percent of pediatric dentists who responded recognized Risewell (n-HA), 7.8% recognized Boka (n-HA), 8.7% recognized Pearlie White ART (n-HA), 5.9% recognized Kinder KAREX (n-HA), 2.3% recognized

TABLE 1. Statistics of the survey responses were gathered by calculating the percentage of response rates per question based on responses to age, region of training and gender.

Question	Response 1	Response 2	Response 3	Response 4	Response 5	Response 6	Response 7
How do you identify?	Male	Female	Prefers not to answer				
What is your age?	≤30	31–40	41–50	≥51			
How many years have you been practicing pediatric dentistry?	0–9	10–19	20–29	30–39	>40		
What type of residency program did you attend?	Hospital	Academic	Both Hospital and Academic				
What best fits your practice?	Solo	Group	Hospital	Dental School Faculty	Community Health Center		
In what region did you train for your residency?	Northeastern (CT, ME, MA, NH, NY, RI, VT) and Canadian provinces (NL, NS, PE, NB, QC)	South Eastern (AL, FL, GA, KY, MS, NC, SC, TN, VA, WV, PR)	Northcentral (MB, ON, NE, IA, MN, OH, IN, MI, ND, SD, IL, WI)	Southwestern (CO, KS, MO, NM, OK, AR, LA, TX and MX)	Western (AK, AZ, CA, HI, ID, MT, NV, OR, UT, WA, WY) and Canadian provinces (SK, AB, BC, NT, NU, YT)		
On a scale of 1 to 4, how often do you see pts/parents who are opposed to receiving fluoride varnish/fluoride trays?	A few times a day	A few times a week	A few times a month	A few times a quarter	Other (free space)		
On a scale of 1–5 how accommodating is your style of practice towards fluoride-free patients/parents?	Not accommodating	Very little accommodation	Moderately accommodating	Strongly accommodating	Extremely accommodating		
On a scale of 1–5 how aware are you of fluoride-free alternatives that remineralize enamel?	Not aware at all	Very little awareness	Neutral	Moderate awareness	Strong awareness		
Which of these fluoride-free remineralizing agents are you aware of? (Check all that apply)	Nano-hydroxyapatite toothpaste	Xylitol toothpaste	Arginine Toothpaste	Theobromine Toothpaste	Coral nano silver toothpaste		

TABLE 1. Continued.

Question	Response 1	Response 2	Response 3	Response 4	Response 5	Response 6	Response 7
If research shows that nano-hydroxyapatite is just as efficacious at remineralizing enamel lesions, would you recommend it to your patients/fluoride-free patients?	Yes-All patients	Yes-But only to fluoride-free patients	No				
Would you ever recommend a fluoride-free toothpaste over a fluoride containing toothpaste to your patients?	Yes	No					
On a scale of 1–5, how likely are you to recommend a fluoride-free alternative if effective at arresting caries?	Never	Not likely	Sometimes	Most of the time	All the time		
For which reason would you most likely not recommend a fluoride-free alternative?	Personal preference	Lack of research in the field	Not enough personal research	Other			
Which of these toothpaste brands have you heard of?	Risewell	Boka	Pearlie White ART	Kinder KAREX	Grind Coral	Dr. Raven's Enrich	PerioScience

Questionnaire sent for the study in table format.

Coral, 2.3% recognized Dr. Raven's Enrich (n-HA, Xylitol), 4.6% recognized PerioScience (n-HA), and 58.5% did not recognize a single brand.

4. Discussion

The AAPD states, when used appropriately, fluoride is both safe and effective in preventing and controlling dental caries. Although adverse health effects (*e.g.*, decreased cognitive ability, endocrine disruption and cancer) have been ascribed to the use of fluoride over the years, the preponderance of evidence from large cohort studies and systematic reviews does not support an association of such health issues and consumption

of fluoridated water [20]. Regarding cognitive ability, a study of mothers' urinary fluoride levels and their child's intelligence quotient (IQ) levels suggested an association with exposure levels greater than those recommended in the U.S. for water fluoridation [2]. However, a prospective study in New Zealand did not support an association between fluoridated water and IQ measurements [21], and a national sample in China stated that water at fluoride levels of 0.7 to 1.0 ppm, the study found no significant difference in IQ scores compared to water fluoride levels of less than 0.7 mg/L [22].

Despite the lack any significant evidence suggesting that fluoride exposure from the water system or daily dentifrice use causes cognitive effects, many parents have raised concerns

TABLE 2. Responses from survey titled, “A Survey Regarding the Acceptance and Awareness of Southeastern and Western Private Practice Pediatric Dentists of Fluoride-Free Toothpastes”.

	Answer (%) and frequency (#)	Southeastern Trained	Western Trained	Age 40 and Under	Age 41 and Over
a. Gender					
Male	52.20% (106)				
Female	46.70% (95)				
Prefer not to answer	1.10% (3)				
b. Age					
<30 yr	3.83% (6)				
31–40 yr	30.05% (61)				
41–50 yr	29.51% (60)				
>50 yr	36.07% (74)				
Other (free space)	0.00% (1)				
c. How many years have you been practicing pediatric dentistry?					
0–9 yr	32.79% (66)				
10–19 yr	22.40% (45)				
20–29	25.14% (51)				
30–39	14.75% (30)				
40+	4.92% (10)				
d. What type of residency program did you attend?					
Hospital	19.67% (40)				
Academic	9.29% (19)				
Hospital/ Academic combination	71.04% (145)				
e. On a scale of 1–5, how accommodating is your style of practice towards fluoride-free patients/parents?					
Not accommodating at all	2.19% (4)	1.37%	1.39%		
Very Little	6.01% (12)	9.59%	2.78%		
Moderately	39.89% (81)	46.58%	31.94%		
Strongly	27.87% (56)	15.07%	41.67%		
Extremely	24.04% (49)	27.40%	22.22%		
f. On a scale of 1 to 4, how often do you see patients/parents who are opposed to receiving fluoride varnish/fluoride trays?					
A few times a day	19.02% (38)	12.33%	26.39%		
A few times a week	28.80% (58)	32.88%	30.56%		
A few times a month	25.00% (51)	26.03%	25.00%		
A few times a quarter	21.74% (44)	20.55%	13.89%		
Other (free space)	5.43% (11)	8.22%	4.17%		
g. If research shows that nano-hydroxyapatite toothpaste is just as efficacious at remineralizing enamel lesions, would you recommend it to your patients/fluoride-free patients?					
Yes—all patients	32.07% (65)	30.14%	33.33%	35.48%	30.58%
Yes—only fluoride-free patients	62.50% (133)	65.75%	59.72%	64.52%	61.98%
No	5.43% (11)	4.11%	6.94%	0.00%	7.44%

TABLE 2. Continued.

	Answer (%) and frequency (#)	Southeastern Trained	Western Trained	Age 40 and Under	Age 41 and Over
h. Would you ever recommend a fluoride-free toothpaste over a fluoride containing toothpaste to your patients?					
Yes	30.43% (62)	21.90%	40.28%	24.19%	33.88%
No	69.57% (142)	78.08%	59.72%	75.81%	66.12%
i. On a scale of 1–5, how likely are you to recommend a fluoride-free alternative if effective at arresting caries?					
Never	3.26% (6)	2.74%	5.56%		
Not likely	11.96% (24)	10.96%	12.50%		
Sometimes	54.89% (111)	54.79%	50.00%		
Most of the times	19.02% (38)	21.92%	18.06%		
All of the time	10.87% (22)	9.59%	13.89%		
j. For which reason would you most likely not recommend a fluoride-free alternative?					
Personal preference	7.61% (15)	8.22%	8.33%		
Lack of research in the field	48.91% (99)	43.84%	48.61%		
Not enough personal research	32.61% (66)	34.25%	31.94%		
Other (free space)	10.87% (22)	13.70%	11.11%		
k. On a scale of 1–5, how aware are you of fluoride-free alternatives that remineralize enamel?					
Not aware at all	5.49% (11)	2.74%	7.04%		
Very little awareness	20.88% (42)	21.92%	19.72%		
Neutral	19.78% (40)	20.55%	15.49%		
Moderate awareness	41.21% (84)	45.21%	43.66%		
Strong awareness	12.64% (25)	9.59%	14.08%		
l. Which of these toothpaste brands have you heard of? (Check all that apply)					
Risewell	10.05%	1.19%	9.76%		
Boka	7.76%	5.95%	8.54%		
Pearlie White ART	8.68%	10.71%	7.32%		
Kinder, KAREX	5.94%	7.14%	4.88%		
Grind, Coral	2.28%	1.19%	1.22%		
Dr. Raven's	2.28%	2.38%	1.22%		
PerioSciences	4.57%	3.57%	3.66%		
None	58.45%	57.14%	63.41%	*At least 52% have heard of 1 brand	*At least 35% have heard of 1 brand

about the use of fluoride for their children. The AAPD recommends the best practice is to inform parents and practitioners regarding use of fluoride as an aid in preventing and controlling dental caries in pediatric dental patients. These recommendations address systemic fluoride (water fluoridation, dietary fluoride supplements, possibility of fluorosis), topical fluoride delivery *via* professional application (acidulated phosphate fluoride gel or foam, sodium fluoride varnish, silver diamine fluoride), and home use products (toothpastes, mouthrinses). The standard level for community water fluoridation (0.7 parts per million fluoride) helps balance the risk of caries and the possibility of fluorosis from excessive fluoride ingestion during the early years of tooth development [21]. When reading this policy statement above, parents who do not want their children to be exposed to fluoride have no recommendations from the AAPD on how to help remineralize their children's teeth and many practitioners do not know how to best serve patients who do not wish to use fluoride.

Despite there being evidence for the efficacy of fluoride-free remineralizing agents for patients who do not wish to use fluoride, there is no current policy from the AAPD to help patients and parents who wish to hold these views on fluoride. Despite fluoride being the gold standard, many children are left without support, as evidenced in the results, by the lack of recognition for brands of toothpastes that have remineralizing agents that are fluoride-free. 55.8% of all the pediatric dentists who responded said that they have either “moderate or strong recognition” of fluoride-free remineralizing agents but despite this, 58.4% of pediatric dentists had not heard of a single brand of toothpaste that was fluoride-free and had the capability of remineralizing teeth. As many people look to their oral healthcare providers for support, this lack of recognition poses a risk to the fluoride-free population who may not have the additional support needed to prevent caries. Furthermore, 15.2% of dentists who responded said they would “never” or “not-likely” recommend a fluoride-free alternative if effective at arresting caries, which may show a bias that we as clinicians may have to overcome in order to treat fluoride-free patients.

Limitations for this research included the low survey response rate. Despite sending 6490 emails, only 205 pediatric dentists responded giving a 3.1% response rate. The responses are not generalizable to the entire population of pediatric dentists since only the southeastern and western regions of the AAPD members were surveyed. There may be responder bias as many pediatric dentists have a great partiality in anti-fluoride topics. Responder bias could have also been seen when choosing toothpaste brands because many surveyors may not have wanted to select any wrong answers. Despite the limitations, this research offers insight into factors that may contribute to awareness and acceptance of fluoride-free remineralization products to better help a previously unaided population.

5. Conclusions

There is a growing resistance amongst certain populations towards fluoride-based products. This resistance can negatively impact the dentition of pediatric patients as a result. As oral healthcare providers, it is important to stay informed

of current research in order to offer the best care possible to patients/parents who do not want their children using fluoride toothpastes. According to the survey response, region of practice/residency training and age can be contributing factors towards opinion and exposure of fluoride-free remineralizing agents. The data gathered trends towards western-trained pediatric dentists to be more likely to recommend a fluoride-free toothpaste than a southeastern-trained dentist. The data gathered also trends towards pediatric dentists 41 years and older being more likely to recommend a fluoride-free toothpaste over a fluoride-containing toothpaste when compared to pediatric dentists 40 years and younger. Finally, the research conducted shows a need for increased exposure to pediatric dentists about fluoride-free remineralizing agents including brand names to help facilitate the best care to the fluoride-free populations.

AVAILABILITY OF DATA AND MATERIALS

The data are contained within this article.

AUTHOR CONTRIBUTIONS

MKP, MM and RLM—designed the research study. MKP—performed the research. MP and MM—analyzed the data. MKP—wrote the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

IRB approval was obtained from the Augusta University Institutional Review Board (#1803408-1). Since participation in this study was voluntary, each participant provided informed consent by returning the completed survey.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

- [1] Goff SL, Gahlon G, Geissler KH, Dick AW, Kranz AM. Variation in current guidelines for fluoride varnish application for young children in medical settings in the United States. *Frontiers in Public Health*. 2022; 4: 785296.
- [2] American Academy of Pediatric Dentistry. Fluoride therapy. The reference manual of pediatric dentistry (pp. 302–305). American Academy of Pediatric Dentistry: Chicago. 2021.

- [3] Hamba H, Nakamura K, Nikaido T, Tagami J, Muramatsu T. Remineralization of enamel subsurface lesions using toothpaste containing tricalcium phosphate and fluoride: an *in vitro* μ CT analysis. *BMC Oral Health*. 2020; 20: 292.
- [4] NIH Office of Dietary Supplements. Fluoride. 2022. Available at: <https://ods.od.nih.gov/factsheets/Fluoride-HealthProfessional/> (Accessed: 5 February 2022).
- [5] Centers for Disease Control and Prevention. Achievements in public health, 1900–1999: fluoridation of drinking water to prevent dental caries. Available at: <https://www.cdc.gov/mmwr/preview/mmwrhtml/mm4841a1.htm> (Accessed: 21 March 2022).
- [6] Iheozor-Ejiofor Z, Worthington HV, Walsh T, O'Malley L, Clarkson JE, Macey R, *et al.* Water fluoridation for the prevention of dental caries. *Cochrane Database of Systematic Reviews*. 2015; 2015: CD10856.
- [7] Simon MJK, Beil FT, R  ther W, Busse B, Koehne T, Steiner M, *et al.* High fluoride and low calcium levels in drinking water is associated with low bone mass, reduced bone quality and fragility fractures in sheep. *Osteoporosis International*. 2014; 25: 1891–1903.
- [8] U.S. Department of Health and Human Services Panel on Community Water Fluoridation. U.S. public health services recommendation for fluoride concentration in drinking water for the prevention of dental caries. *Public Health Reports*. 2015; 130: 318–331.
- [9] Goodman CV, Bashash M, Green R, Song P, Peterson KE, Schnaas L, *et al.* Domain-specific effects of prenatal fluoride exposure on child IQ at 4, 5 and 6–12 years in the ELEMENT cohort. *Environmental Research*. 2022; 211: 112993.
- [10] Grandjean P. Developmental fluoride neurotoxicity: an updated review. *Environmental Health*. 2019; 18: 110.
- [11] Ullah R, Zafar MS, Shahani N. Potential fluoride toxicity from oral medicaments: a review. *Iranian Journal of Basic Medical Sciences*. 2017; 20: 841–848.
- [12] Guth S, H  ser S, Roth A, Degen G, Diel P, Edlund K, *et al.* Toxicity of fluoride: critical evaluation of evidence for human developmental neurotoxicity in epidemiological studies, animal experiments and *in vitro* analyses. *Archives of Toxicology*. 2020; 94: 1375–1415.
- [13] Amaechi BT, AbdulAzees PA, Alshareif DO, Shehata MA, Lima PPCS, Abdollahi A, *et al.* Comparative efficacy of a hydroxyapatite and a fluoride toothpaste for prevention and remineralization of dental caries in children. *BDJ Open*. 2019; 5: 18.
- [14] Boss   M, Saccucci M, Salucci A, Di Giorgio G, Bruni E, Uccelletti D, *et al.* Enamel remineralization and repair results of Biomimetic Hydroxyapatite toothpaste on deciduous teeth: an effective option to fluoride toothpaste. *Journal of Nanobiotechnology*. 2019; 17: 17.
- [15] Amaechi BT, Porteous N, Ramalingam K, Mensinkai PK, Ceahuana Vasquez RA, Sadehghpour A, *et al.* Remineralization of artificial enamel lesions by theobromine. *Caries Research*. 2013; 47: 399–405.
- [16] Cardoso CAB, de Castilho ARF, Salom  o PMA, Costa EN, Magalh  es AC, Buzalaf MAR. Effect of xylitol varnishes on remineralization of artificial enamel caries lesions *in vitro*. *Journal of Dentistry*. 2014; 42: 1495–1501.
- [17] Daas I, Badr S, Osman E. Comparison between fluoride and nano-hydroxyapatite in remineralizing initial enamel lesion: an *in vitro* study. *The Journal of Contemporary Dental Practice*. 2018; 19: 306–312.
- [18] Memarpour M, Shafiei F, Rafiee A, Soltani M, Dashti MH. Effect of hydroxyapatite nanoparticles on enamel remineralization and estimation of fissure sealant bond strength to remineralized tooth surfaces: an *in vitro* study. *BMC Oral Health*. 2019; 19: 92.
- [19] Razeghian-Jahromi I, Babanouri N, Ebrahimi Z, Najafi HZ, Sarbaz M, Montazeri-Najafabady N. Effect of 8% arginine toothpaste on *Streptococcus mutans* in patients undergoing fixed orthodontic treatment: randomized controlled trial. *Dental Press Journal of Orthodontics*. 2022; 27: e2220322.
- [20] Thimmaiah C, Shetty P, Shetty S, Natarajan S, Thomas N. Comparative analysis of the remineralization potential of CPP-ACP with Fluoride, Tri-Calcium Phosphate and Nano Hydroxyapatite using SEM/EDX—an *in vitro* study. *Journal of Clinical and Experimental Dentistry*. 2019; 11: e1120–e1126.
- [21] Perrott K. Health effects of fluoridation on IQ are unproven. *The New Zealand Medical Journal*. 2020; 133: 177–179.
- [22] Community water fluoridation exposure: a review of neurological and cognitive effects—a 2020 update. *Canadian Agency for Drugs and Technologies in Health*: Ottawa. 2020.

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