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Assessment of Pediatric Dentists' Knowledge and Practice towards the Use of Fluoridated Toothpaste

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Aim: To assess knowledge and practice of pediatric dentists towards using fluoridated toothpastes.
Materials and Methods: A cross-sectional, electronic, self-administered, modified version of a validated English questionnaire was used. The modifications were primarily regarding practice in different age groups. It was created using Google Forms and posted on social media groups for convenience sampling. Responses were accepted until 207 were reached. Categorical data were presented as frequencies (n) and percentages (%). Statistical analysis was performed using R statistical analysis software version 4.0.3 for Windows.
Results: Regarding practice, only 70% of respondents recommend specific types of toothpaste for patients according to their age. Almost half of the respondents didn't recommend any toothpaste to be used for infants aged 0-18 months. For toddlers aged 18 months to 3 years, 53.1% recommended to use toothpaste with 600 ppm fluoride, while 70.3% recommended the use of a smear/rice-sized amount of toothpaste. For children aged 3 to 6 years, 47.6% recommended to use toothpaste with 600 ppm, while 76.6% recommended using a pea-sized amount.
Conclusion: Pediatric dentists in Egypt have good knowledge of toothpastes' active ingredient, and of acute fluoride toxicity. However, there is confusion between dentists regarding fluoride concentrations recommended for each age group. This is most probably due to lack of consensus between different currently available guidelines regarding this matter.

Keywords: Fluoride, toothpaste, guidelines, knowledge, practice, pediatric dentistry, preventive dentistry.

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Introduction

Caries has been and remains the most common oral disease worldwide.[1] According to the American Dental Association (ADA), dental caries is a "biofilm-mediated, sugar-driven, multifactorial, dynamic disease that results in the phasic demineralization and remineralization of dental hard tissues." [2] Dental caries, if left untreated, can negatively affect the Oral Health Related Quality of Life (OHRQoL).[3]

Fluoride is the most efficient method for preventing caries.[4,5] Several mechanisms have been suggested for the antimicrobial and remineralization role of fluoride.[6–12] It can be delivered in several ways; water fluoridation, professionally applied, or self-administered using toothpastes.[4] However, fluoride toxicity is possible, mainly due to the accidental ingestion of fluoride-containing oral hygiene products.[13]

Fluoride toxicity has multiple possible mechanisms.[14–16] When fluoride contacts moisture, hydrofluoric acid is formed which is corrosive and causes burning of tissues.[15] Fluoride also combines with calcium, leading to hypocalcemia, which inhibits nerve impulses and function. Hypocalcemia, together with hyperkalemia, cause electrolyte imbalance and cardiac arrhythmia. Fluoride toxicity is classified into acute and chronic, with evidence that the acute toxicity is rare but fatal.[13,16] As for acute fluoride toxicity, speedy management is essential for life saving purpose. It has been found that ingestion of 5 mg/kg body weight fluoride is sufficient for fluoride toxicity to occur.[14]

After fluoride intoxication, management should include minimizing its absorption. This is achieved using milk, calcium gluconate or calcium lactate, which combine with the soluble fluoride and form insoluble complexes, thus reducing its absorption.[17] Inducing vomiting after fluoride intoxication was once advocated, but currently not recommended due to the danger of esophagus damage by hydrofluoric acid and risk of vomitus aspiration. Instead, gastric lavage is recommended.[14] Hospitalization and monitoring of vital signs are advised.[16]

There are several currently available guidelines regarding the use of fluoridated toothpastes; European Academy of Pediatric Dentistry (EAPD)[18], American Dental Association (ADA)[19], New Zealand Guidelines Group (NZGG)[20], National Health Service, England (NHS)[21], Australian Research Centre for Population Oral Health (ARCPOH)[22], American Academy of Pediatric Dentistry (AAPD)[23].

A study was conducted in India[24] to assess knowledge and attitude of dentists towards fluoride toothpaste for children. It showed that dentists lack sufficient knowledge regarding this subject. Therefore, it is of utmost importance to assess the knowledge and practice towards the use of fluoridated toothpastes among pediatric dentists. The current study aims to assess the knowledge and practice of pediatric dentists towards using fluoridated toothpastes.

Materials and Methods

The present study is a cross-sectional study using an online-based questionnaire that aims to assess the knowledge and practice among pediatric dentists in Egypt regarding the use of fluoridated toothpaste in children.

Ethical considerations

Ethical approval was granted from the research ethical committee at the Faculty of Dentistry, Ain Shams University, Egypt (Approval number FDASU-RecIM122004), following the guidelines of the Helsinki declaration. Informed consent was taken from participants.

Sampling

A power analysis was designed to have adequate power to apply a statistical test of the research question regarding the assessment of knowledge and practice among pediatric dentists in relation to the use of fluoride toothpaste in children. By

adopting an alpha (α) level of 0.05 (5%), a beta (β) level of 0.20 (20%) i.e. power=80%, and an effect size (W) of (0.239) calculated based on the results of George, Sageena, et al.[24]; the predicted sample size (n) was found to be a total of (191) participants. Sample size calculation was performed using G*Power version 3.1.9.4[25]

Starting from April 2021, a sample of pediatric dentists, both males and females, residing in Egypt and willing to participate was invited to reply to the study questionnaire, until a size of 207 respondents was reached by the end of May 2021.

The sampling strategy utilized in this study was a convenience sampling method. It is a non-probability sampling method in which members of the target population that are easily accessible to the researcher are included.[26]

The questionnaire was created using Google Forms and was posted on dental social media groups. Participation was voluntary. A note was added at the beginning of the survey to gain consent and to avoid duplication. The note stated: "This survey targets pediatric dentists of Egypt. Kindly answer all questions to help in fulfilling this survey. Please don't fill out this questionnaire again if you have previously done so. Submitting this survey is an approved consent to participate."

The beginning of the questionnaire consisted of an introductory paragraph. It contained the title of the current study and the inclusion criteria of the intended participants (mentioned above). It also included the benefits gained after participating in the study; an e-mail was sent to participants after completion of the research study. It contained all the currently available guidelines regarding the use of fluoridated toothpastes and information about acute fluoride toxicity. Therefore, participants were asked for their e-mail addresses.

Research Instrument (Survey)

An online, self-administered, closed-ended, structured, questionnaire was conducted. The questionnaire was a modified version of that used by Raju B et al,2020.[24] The modified questionnaire consisted of 13 questions, divided into two sections. The first section aimed to assess knowledge of pediatric dentists regarding the use of fluoridated toothpastes, while the second aimed to assess their practice.

A pilot test was conducted on 15 pediatric dentists at the Department of Pediatric Dentistry, Faculty of Dentistry, Ain Shams University, Egypt. The questionnaire was modified according to their feedback to remove any confusion and make it clearer. Results from the pilot study were not included in the final results analysis.

In the first section, modifications performed by the investigators of the current work were related to the questions regarding fluoride toxicity, where more choices were added, and the participant was allowed to choose more than one answer.

In the second section, modifications to the questions regarding the brand preference were performed, where they were modified to include toothpaste brands in the Egyptian market. Modifications were also made on questions regarding toothpaste fluoride concentration and the amount prescribed to children. These questions were expanded in order to be age-specific.

The first section of the questionnaire asked about dentists' knowledge regarding fluoridated toothpastes. The first question asked about the active ingredient in toothpastes, while the following three questions assessed knowledge regarding acute fluoride toxicity; symptoms, management and prevention.

The second section of the questionnaire assessed the dentists' practice regarding fluoridated toothpastes. Participants were asked about their toothpaste brand preference and the reason of preference. Participants were then asked

whether they recommend a specific type of toothpaste to their pediatric patient according to their age. Answering "yes" moves the participating dentist to the next set of questions, while answering "no" ends the questionnaire.

The next set of questions in section 2 assesses the dentist's practice regarding the prescription of specific types of toothpaste according to the patient's age. For each age group (infants; 0-18 months, toddlers; 18 months-3 years, preschool children; 3-6 years), the participant was asked about the toothpaste they prescribe regarding its fluoride concentration and its amount.

The questionnaire is attached as a supplementary material.

Data Management

All data was entered electronically. This ensured confidentiality.

Statistical analysis

Categorical data were presented as frequencies (n) and percentages (%). Statistical analysis was performed using R statistical analysis software version 4.0.3 for Windows.[27]

Results

Regarding knowledge of the active ingredient in toothpaste, the majority of respondents (93.7%) chose sodium fluoride as the toothpaste ingredient that provides protection against dental caries.

As for knowledge regarding acute fluoride toxicity, frequency and percentage of acute fluoride toxicity answers are presented in Table 1. Majority of respondents chose "Vomiting" (80.2%) as the most common symptom for fluoride toxicity, giving milk (69.6%) as the best management for high amounts of fluoride toothpaste ingestion and "Parental supervision" (94.2%) as the best method to reduce accidental ingestion of toothpaste by children.

Table 1: Frequency and percentage of acute fluoride toxicity answers

Parameter (n=207)	Value	n	%
If a child had ingested high amounts of fluoridated toothpaste, does it cause any of the following symptoms?	Headache	41	19.8%
	Nausea	158	76.3%
	Vomiting	166	80.2%
	Abdominal pain	157	75.8%
	Constipation	12	5.8%
	Diarrhea	75	36.2%
	Hypertension	6	2.9%
	Hypotension	23	11.1%
	Seizures	35	16.9%
How do you manage a child who had ingested high amounts of fluoride toothpaste?	Give water	21	10.1%
	Give milk	144	69.6%
	Give juice	1	0.5%
	Induce vomiting	65	31.4%
	Gastric lavage	67	32.4%
	Refer to the nearby hospital	128	61.8%
Do you think any of the following methods can reduce accidental ingestion of toothpaste by children?	Keep toothpaste out of reach to children	163	78.7%
	Parental supervision	195	94.2%
	Use toothpaste with low fluoride	85	41.1%
	Use toothpaste with high fluoride	0	0.0%
	Use the right amount of toothpaste	160	77.3%

As for pediatric dentists' practice, frequency and percentage of toothpaste brand preference answers are presented in Table 2. Slightly less than half of the respondents had no brand preference. Only 48.4% of respondents follow guidelines regarding fluoride concentration of toothpaste prescribed for children.

Table 2: Frequency and percentage of toothpaste brand preference answers

Parameter (n=207)	Value	n	%
Which brand of toothpaste do you prefer for children below 6 years of age?	I do not prescribe toothpaste for children	3	1.4%
	No brand preference	98	47.3%
	Fluro Kids	40	19.3%
	Signal Kids	46	22.2%
	Adult toothpastes any brand	13	6.3%
	Other	7	3.4%
If you prescribe toothpaste for children, what is the reason of preference?	No brand preference	72	34.8%
	Price	32	15.5%
	Because it is commercially available	66	31.9%
	Following guidelines according to fluoride concentration	100	48.3%
	Other	3	1.4%

Frequency and percentage (%) for recommended toothpaste for infants aged 0-18 months answers are presented in Table 3. Slightly more than half of the respondents do not recommend toothpaste for this age group.

Table 3: Frequency and percentage (%) for recommended toothpaste for infants aged 0-18 months answers

Parameter (n=145)	Value	n	%	Following which guidelines
If yes, what do you prescribe for infants aged 0 to 18 months?	No toothpaste is recommended	80	55.2%	ARCPOH
	Toothpaste with no fluoride is recommended	31	21.4%	-
	Toothpaste with 600 ppm fluoride is recommended	28	19.3%	-
	Toothpaste with 1000 ppm fluoride is recommended	6	4.1%	EAPD ADA NHS NZGG
What amount of toothpaste do you recommend for infants aged 0-18 months?	No toothpaste is recommended	82	56.6%	ARCPOH
	Smear or rice size amount	60	41.4%	EAPD ADA NHS NZGG
	Pea size amount	2	1.4%	-
	Full toothbrush	1	0.7%	-

Frequency and percentage (%) for recommended toothpaste for toddlers aged 18 months to 3 years answers are presented in Table 4. Slightly more than half of the respondents prescribe toothpaste with 600 ppm for this age group.

Table 4: Frequency and percentage for recommended toothpaste for toddlers aged 18 months to 3 years

Parameter (n=145)	Value	n	%	Following which guidelines
What do you prescribe for toddlers aged 18 months to 3 years?	No toothpaste is recommended	4	2.8%	-
	Toothpaste with no fluoride is recommended	41	28.3%	-
	Toothpaste with 600 ppm fluoride is recommended	77	53.1%	ARCPOH
	Toothpaste with 1000 ppm fluoride is recommended	22	15.2%	EAPD ADA NZGG NHS
	Toothpaste with 1500 ppm fluoride is recommended	1	0.7%	-
What amount of toothpaste do you recommend for toddlers aged 18 months to 3 years?	No toothpaste is recommended	4	2.8%	-
	Smear or rice size amount	102	70.3%	EAPD ADA NZGG NHS AAPD
	Pea size amount	38	26.2%	ARCPOH
	Full toothbrush	1	0.7%	-

Frequency and percentage (%) for recommended toothpaste for children aged 3 to 6 years answers are presented in Table 5. Slightly less than half of the respondents prescribe toothpaste with 600 ppm for this age group.

Table 5: Frequency and percentage for recommended toothpaste for children aged 3 to 6 years

Parameter (n=145)	Value	n	%	Following which guidelines
What do you prescribe for children aged 3 to 6 years?	Toothpaste with no fluoride is recommended	8	5.5%	-
	Toothpaste with 600 ppm fluoride is recommended	69	47.6%	ARCPOH
	Toothpaste with 1000 ppm fluoride is recommended	55	37.9%	EAPD ADA NZGG NHS
	Toothpaste with 1500 ppm fluoride is recommended	13	9.0%	-
What amount of toothpaste do you recommend for children aged 3 to 6 years?	Smear or rice size amount	17	11.7%	-
	Pea size amount	111	76.6%	ARCPOH EAPD ADA NZGG NHS AAPD
	Half full toothbrush	16	11.0%	-
	Full toothbrush	1	0.7%	-

Discussion

Pediatric dentists residing in Egypt were targeted in this questionnaire. To our knowledge, this has not been performed in Egypt before. It has, however, been carried out internationally, but the questions were not as thorough as that used in the current study.

In order to overcome low response rate and non-response bias, the survey was created on Google Forms, and the link was shared on dentists' social media groups until a sample size of (207) was reached.

The findings of the current study showed satisfactory knowledge amongst pediatric dentists residing in Egypt

regarding toothpaste active ingredient and acute fluoride toxicity symptoms, management and prevention. The results are better than that in the study conducted by *Raju B et al.*[24]

The majority of respondents (93.7%) answered that sodium fluoride is the toothpaste ingredient that provides protection against caries. In the study conducted by Raju B et al.,[24] only 87% answered correctly. These results show that there is sufficient basic knowledge amongst the majority of dentists.

The next three questions of the survey assessed pediatric dentists' knowledge of acute fluoride toxicity. Participants were asked about the symptoms caused by ingestion of high amounts of fluoridated toothpastes. They were allowed to choose more than one answer. The majority of respondents chose vomiting (80.2%), nausea (76.3%) and abdominal pain (75.8%) as symptoms of ingesting high amounts of fluoride. Some respondents chose diarrhea as a symptom (36.2%), while fewer respondents chose headache (19.8%), seizures (16.9%) and hypotension (11.1%). These results show better knowledge in the Egyptian community than the study conducted by *Raju B et al*[24]. From these answers, it is apparent that pediatric dentists in Egypt are familiar with most signs of acute fluoride toxicity.

For managing a child who had ingested high amounts of fluoride toothpaste, 69.6% chose to give milk, 61.8% chose to refer the child to the nearest hospital and 32.4% chose gastric lavage. These results show better knowledge in the Egyptian community than the study conducted by Raju B et al.[24] However, 31.4% chose to induce vomiting, 10.1% chose to give water and 0.5% chose to give juice. These are all not indicated for acute fluoride toxicity management.

From the respondents' answers, it is apparent that dentists' knowledge of the proper management of acute fluoride toxicity is not up to standard. Although it is not a common situation, awareness programs on this matter is important, as it is a matter of life and death.

For reduction of accidental ingestion of fluoridated toothpaste, 94.2% chose parental supervision, 78.7% chose to keep toothpaste out of reach of children, 77.3% chose to use the right amount of toothpaste, and 41.1% chose to use toothpaste with low fluoride concentration. These results show better knowledge in the Egyptian community than the study conducted by *Raju B et al.*[24] Thankfully, no one chose to use toothpaste with high fluoride, which is obviously an incorrect answer. It is evident that dentists have good knowledge on how to reduce accidental ingestion of toothpastes by children.

The current study also shows that there is a lack of knowledge amongst the dental community regarding fluoride concentration guidelines, and the commercially available toothpastes. The results showed the importance of educating pediatric dentists of the available toothpastes in the market, their fluoride concentrations and their prices.

Almost half of the respondents (55.2%) do not recommend toothpaste for infants aged 0 to 18 months. This coincides with the recommendations of the ARCPOH. On the other hand, other institutions do not recommend the same. The EAPD recommends using a rice-sized amount of toothpastes with a fluoride concentration of 1000 ppm as soon as the first tooth erupts and up to 2 years; the ADA and NHS both recommend using a rice-sized amount toothpastes with a fluoride concentration of 1000 ppm for children younger than 3 years; the NZGG recommends using a smear amount of toothpastes with a fluoride concentration of at least 1000 ppm. The AAPD doesn't have any specific recommendations regarding fluoride concentration in toothpastes.

Regarding the amount of toothpaste to be used by infants aged 0-18 months, 56.6% answered that no toothpaste is recommended. This coincides with the

ARCPOH guidelines. However, 41.4% of respondents recommend a smear or rice-sized amount, which coincides with the guidelines of the EAPD, ADA, NZGG, NHS and AAPD.

For toddlers 18 months to 3 years, almost half of the respondents (53.1%) prescribe toothpaste with 600 ppm fluoride, which is coincident with the ARCPOH recommendations. However, the EAPD, ADA, NZGG and NHS recommend using toothpaste with fluoride content of 1000 ppm. Only 15.2% of the respondents prescribed toothpaste with 1000 ppm. The AAPD doesn't have any specific recommendations regarding fluoride concentration in toothpastes.

As for the amount of toothpaste recommended for toddlers aged 18 months to 3 years, 70.3% of respondents recommended smear or rice-sized amount, which is coincident with the recommendations of EAPD, ADA, NZGG, NHS and AAPD. Only 26.2% of the respondents recommended a pea-sized amount of toothpaste for this age group, which is coincident with the recommendations of the ARCPOH.

For children aged 3 to 6 years, less than half (47.6%) of the respondents recommend using toothpaste with 600 ppm fluoride. This coincides with the recommendations of the ARCPOH. Of the respondents, 37.9% recommended toothpaste with 1000 ppm fluoride, which is coincident with the recommendations of the EAPD, ADA, NZGG and NHS. The AAPD doesn't have any specific recommendations regarding fluoride concentration in toothpastes.

Regarding the amount of toothpaste to be used by children aged 3-6 years, 76.6% recommended using a pea-sized amount, which is coincident with the recommendations of the EAPD, ADA, NZGG, NHS, ARCPOH and AAPD. It is to be noted that regarding the use of fluoridated toothpaste, this is the only matter that all guidelines agree upon.

After carrying out this survey, a shocking truth has been revealed. There are indeed several guidelines regarding the concentration of fluoride recommended for different age groups and the amount of toothpaste to be used. However, these guidelines are different and can lead to the confusion of any dental specialist seeking knowledge regarding this matter. The answers of respondents show clearly this confusion, as different dental specialists follow different guidelines for different age groups. It is possible that each guideline is based upon the prevalence of caries and caries experience in the population from which the guideline originates.

Due to the lack of consensus on this matter, and to help clear up the resultant confusion, the Dental Public Health team at the Faculty of Dentistry, Ain Shams University, Egypt, has proposed a guideline (Table 6) that targets populations of high caries index, as the prevalence of dental caries in Egypt was estimated to be nearly 70%, according to the World Health Organization (WHO) in 2014.[28] This guideline is adopted from the already available guidelines and aims to provide maximum caries prevention for populations with high caries prevalence.

Limitations of the Study

The knowledge and practices of pediatric dentists in Egypt assessed in the survey were not linked to the years of experience of the participants. Similar surveys have not been previously conducted in abundance, so comparison of results is scarce. The only similar study found was that conducted in India. However, modifications were made to questions in the survey used by *Raju B et al*[24], so comparison couldn't be carried out accurately.

Table 6: Proposed Guidelines of the Dental Public Health team, Faculty of Dentistry, Ain Shams University, Egypt, for fluoride use in children

Age	Proposed Fluoride Concentration "Following which Guidelines"	Proposed Amount of toothpaste "Following which Guidelines"
Birth – eruption of 1st tooth	Cleaning teeth is to be done with wet gauze, soft toothbrush or finger-brush only without any toothpaste. "ARCPOH"	-
Eruption of 1st tooth – 3 years	1000 ppm F, twice daily. "EAPD, ADA, NZGG, NHS"	Smear or rice-sized "EAPD, ADA, NZGG, NHS, AAPD"
3 – 6 years	1000 ppm F, twice daily. "ADA, NZGG"	Pea-sized "EAPD, ADA, NZGG, NHS, ARCPOH, AAPD"
Above 6 years	1500 ppm F, twice daily. Individuals should spit excess and avoid rinsing. "EAPD, ADA, NZGG, ARCPOH"	Pea-sized "ADA, NZGG, ARCPOH"
Teenagers and adults with high caries risk	5000 ppm F. "ARCPOH"	Pea-sized "ARCPOH"

Conclusions

Within the limitations of the current study, it can be concluded that pediatric dentists in Egypt have good knowledge of toothpastes' active ingredient, and of acute fluoride toxicity. However, there is confusion between dentists regarding fluoride concentrations recommended for each age group. This is most probably due to the lack of consensus between different currently available guidelines regarding this matter. Thus, there is a need to develop a clear guideline regarding toothpaste fluoride concentration and amount for each age group that serves populations with high caries prevalence. There is also a need to raise awareness of the dental community respect guidelines regarding fluoridated toothpastes according to age.

Conflict of Interest

The authors that they have no affiliations with or involvement in any organization or entity with any financial or non-financial interest in the subject matter discussed in this manuscript.

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Authors' contributions

All authors contributed to the conceptualization of the study:

AE contributed to the formulation and conduction of the questionnaire and writing the manuscript.

RE contributed to the revision of the manuscript.

AB contributed to the final review and approval of publication.

Availability of data and materials

All data generated or analyzed during this study are included in this published article.

Ethics Approval

Ethical approval was granted from the research ethical committee at Faculty of Dentistry, Ain Shams University (Approval number FDASU-ReclM122004). Informed consent was taken from participants.

Competing interests

The authors declare that they have no competing interests.

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