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Parental knowledge on preventive and adverse events of fluoridated dentifrices

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ABSTRACT

Purpose: To assess the knowledge of parents/guardians of children considered within the risk range for the development of dental fluorosis on the preventive and adverse effects of fluoride, as well as the relationship with variables related to the use of fluoridated toothpaste by their children.

Methods: Interviews (*n*=398; convenience sample) were conducted at three vaccination centers in the city of Araçatuba (Brazil), using a structured questionnaire comprising items related to the interviewees' education, child's age and gender, data on brushing habits and use of fluoridated dentifrice, and questions on preventive and adverse effects of fluoride. The amount of toothpaste used was estimated by showing 7 identical toothbrushes with varying amounts of biscuit-simulating toothpaste (previously determined by dentifrice weighing using a precision scale). Data were submitted to Mann Whitney's, Kruskal Wallis' and Dunn's tests, and Spearman's correlation coefficient ($p<0.05$).

Results: The interviewees' schooling was directly related to their knowledge of preventive and adverse effects of fluoride ($p<0.05$), and inversely related to the amount of dentifrice used by the child ($p<0.001$). Also, the child's age was inversely related to dentifrice ingestion (during toothbrushing and from the tube) ($p<0.001$). The type of dentifrice was also influenced by the child's age and the interviewee's schooling ($p<0.05$).

Conclusions: It was concluded that educational strategies targeted at parents/guardians of children are needed to achieve the greatest preventive effect of fluoridated dentifrices with the lowest possible side effects.

Key-words: *Dentifrices; Fluorosis, Dental; Child; Health Education; Dental Caries.*

INTRODUCTION

The decline in dental caries prevalence and incidence over the last decades can be largely attributed to the widespread use of fluoridated products, especially dentifrices, as this modality combines the mechanical removal or disruption of the dental biofilm with the therapeutic effects of fluoride.[1-3] However, the early use of toothpaste has been associated with an increased prevalence of dental fluorosis,[4] since swallowing of toothpaste during toothbrushing is inversely related to the child's age.[5]

Despite the existing evidence pointing to the influence of parental knowledge on variables related to children's oral health, especially dental caries,[6,7] the literature is scarce on information about the influence of parental knowledge on the effects of fluoride and the use of fluoridated toothpaste by their children. In New Zealand, a survey found that the choice of fluoridated toothpaste for preschoolers was significantly affected by the order of birth, previous visits to the dentist, and marketing strategies adopted by manufacturers.[8] In Ireland, a study conducted with parents of 4-6-year-old children concluded that parents had limited knowledge of their children's oral health, pointing out the need for improved education towards parents, particularly regarding toothbrushing behavior and use of toothpaste.[9] Another study conducted with parents of 3-6-year-old Serbian children found that the awareness of fluoride and its role in caries prevention was low, and that little is translated into practice.[10]

Given that oral health-related knowledge of children and their parents seems to be associated with children's oral health-related behavior,[11] and considering that maternal oral hygiene practice and attitude towards dentists are related to children's toothbrushing habits,[12] it becomes evident that parental knowledge plays a key role on the success of preventive strategies targeted to children. In this sense, the assessment of the parental knowledge on the effects of fluoride and the relationship with variables related to the use of fluoridated toothpaste by their children could be valuable for guiding clinicians and policymakers in determining strategies to ensure maximum benefits with minimum side-effects related to the use of toothpaste.

Based on the above, the present study aimed to assess the knowledge of parents/guardians of children considered within the risk range for the development of dental fluorosis on the preventive and adverse effects of fluoride, as well as the relationship with variables related to use of fluoridated toothpaste by their children.

MATERIAL AND METHODS

This study was approved by the IRB of the School of Dentistry, Araçatuba, São Paulo State University, Brazil (CAAE: 69012817.0.0000.5420). The study was performed in a convenience sample 398 parents or legal guardians of 0-5 year-old children, attending public vaccination stations in the city of Araçatuba, State of São Paulo, Brazil, in 2017. Informed, written consent was obtained from each participant before the beginning of the study. Out of the 20 vaccination centers in Araçatuba, three were selected for the study in a convenience sample. The centers were located in three different areas of the city, including the downtown area and two suburban areas, to minimize location bias.

The approach of parents/guardians of the children was done by a single researcher (submitted to no training), through the use of a structured questionnaire, which involved questions about (1) the schooling of the interviewees; (2) the date of birth and gender of the child; (3) area of the city in where they lived and time of residence at the location; (4) child's brushing habits (frequency, type of toothpaste used and quantity placed on the toothbrush); (5) ingestion of dentifrice by the child (during brushing or directly from the tube); and (6) knowledge of the effects of fluoride (preventive and adverse).

To estimate the amount of toothpaste placed on the toothbrush, a toothbrush holder containing 7 toothbrushes was developed, which contained varying

amounts of biscuits mimicking seven different quantities of toothpaste applied on the toothbrushes. The shape of the biscuit was determined by weighing a commercial toothpaste on a precision scale in triplicate, varying amounts of dentifrice, corresponding to 0.02; 0.05; 0.10; 0.15; 0.30; 0.50, and 0.70 grams. All brushes were simultaneously shown to the interviewee, who was instructed to choose the one that most resembled the quantity of toothpaste used by the child.

To evaluate dentifrice intake, two different questions were asked: (1) whether the child had a habit of eating toothpaste directly from the tube (possible answers: yes/no), and (2) whether the child swallowed the toothpaste during brushing (possible answers: does not swallow/partially swallows/swallows all the toothpaste placed on the brush). In addition, the frequency of toothbrushing and the commercial brand of toothpaste used were also asked. In cases in which the interviewee did not remember the brand of toothpaste used, a box containing the most common toothpaste found in supermarkets in the city was shown, which included products for adult and child use. If the child used a dentifrice different from the ones presented, or the parent/guardian did not recall the name of the product used at home, the information was recorded as "other".[13]

As for the interviewee's knowledge about the preventive and adverse effects of fluoride, an open question was asked on the effect of fluoridated toothpaste. The interviewee was also asked whether he/she knew about any possible adverse effects of fluoride (possible answers: yes/no). For respondents answering "yes", he/she was inquired about the name or a description of such effect (open question). Finally, the question "What is fluorosis?" (open question) was asked to all interviewees. All open questions were subsequently dichotomized into “correct/incorrect”. The interviewer was responsible of transcribing the answers related to the open questions.[13]

At the end of the questionnaires, an explanatory leaflet was provided to the participants, containing information on the use of fluoridated toothpaste by children. The content of the leaflet was discussed with the interviewee, emphasizing the need to (1) supervise the child's brushing; (2) encourage the child to spit out the toothpaste after brushing; (3) place a small amount of dentifrice in the brush; (4) be vigilant towards the child ingesting toothpaste directly from the tube.[13]

Data were analyzed using descriptive statistics, using absolute and relative values. In addition, the data were analyzed using the Mann-Whitney’s and Kruskal Wallis’ tests, followed by the Dunn’s test for multiple comparisons. The relationship between variables was also analyzed by the Spearman correlation coefficient. The SigmaPlot program, version 12.0 was used, adopting a significance level of 5%.

RESULTS

A total of 398 parents/guardians were interviewed, with the majority of the interviewees (82.9%) being one of the parents. The survey encountered no refusal. The predominant level of schooling was high school (48.2%), followed by elementary school (24.6%, summing up complete elementary education and incomplete middle school education). The proportion of boys and girls was relatively balanced in the study population. Similarly, the age of the children whose parents were interviewed was relatively well distributed in the population (ranging from 1 to 71 months of age), with slightly higher participation of children between 1 and 12 months of age. In addition, the median age of children who brushed their teeth was significantly higher than those who did not brush ($p < 0.001$).

Considering the total number of interviewees, schooling was shown to significantly influence the answers to questions "Knowledge about the overall effects of fluoride" (Figure 1-A), "Do you know if fluoride has any harmful effect?" (Figure 1-B), "Which harmful effect may be associated with fluoride?" (Figure 1-C)" What is dental fluorosis?" (Figure 1-D). Overall, interviewees with higher levels of schooling presented a higher proportion of correct answers. The educational level of the interviewee, however, had no significant influence on whether the children brushed their teeth or not (Figure 1-E).

Considering only children who reportedly brushed their teeth (n = 297), the distribution of

children according to the amount of toothpaste placed on the toothbrush and the daily frequency of toothbrushing is shown in Figures 2-A and 2-B, respectively. The variable "Ingestion of fluoride during toothbrushing" was transformed into scores of 1 to 3, respectively, for the categories "does not ingest", "partially ingests " and "ingests all toothpaste" placed on the toothbrush, which allowed the observation of an inverse trend between the age of the child and ingestion habit (Figure 2-C) Likewise, the variable "amount of toothpaste placed on the brush", the scores from 1 to 7 represented the amounts of 0.02, 0.05, 0.10, 0.15, 0.30, 0.50 and 0.70 grams, respectively. The age of the child presented a moderate negative correlation with the variable "toothpaste intake during toothbrushing" ($r = -0.41$, $p < 0.001$), and was shown to significantly influence the habit of ingesting toothpaste directly from the tube (Figure 2-D).

Overall, older children did not ingest toothpaste directly from the tube (median 48.0 months) or during toothbrushing (median 53.5 months) compared to younger ones (median 32.0 and 34.5, months respectively). The "age of the child" presented a very weak correlation with the variable "brushing frequency" ($r = 0.15$, $p = 0.009$). As for "Schooling of the interviewee", this variable had a weak correlation with "brushing frequency" ($r = 0.19$, $p < 0.01$) and "amount of toothpaste placed on the toothbrush" ($r = -0.20$, $p < 0.001$). It was also observed that the parents' schooling did not present a significant relationship with the variable "ingestion of toothpaste directly from the tube" ($r = -0.03$, $p = 0.605$).

As for the type of dentifrice used, these were grouped into five categories: "fluoride-free"; "for infant use" (with packaging and flavor intended for children, but having conventional fluoride concentrations (*i.e.*, 1100 ppm F); "for adult use " (packaging and flavor intended for the general public, with a concentration of 1100 ppm F or above); "low-fluoride concentration" (in the range of 500-550 ppm F); and "other" (none of the above categories). This variable had a significant relationship with parental schooling, child's age, and toothpaste intake during toothbrushing, as shown in Figure 3. Dentifrice ingestion during toothbrushing was significantly higher in children using fluoride-free and low-fluoride toothpaste compared to products for adult use (Figure 3-A). In addition, products with child-appealing packaging (such as fluoride-free, low-fluoride, and for infant use products) were used by younger children (median 31 to 43 months of age) when compared with children brushing with dentifrices for adult use (median 57 months of age) (Figure 3-B). Finally, children whose parents/guardians had higher schooling used toothpaste with lower fluoride content (fluoride-free or low-fluoride) compared to children from parents with lower educational levels (Figure 3-C).

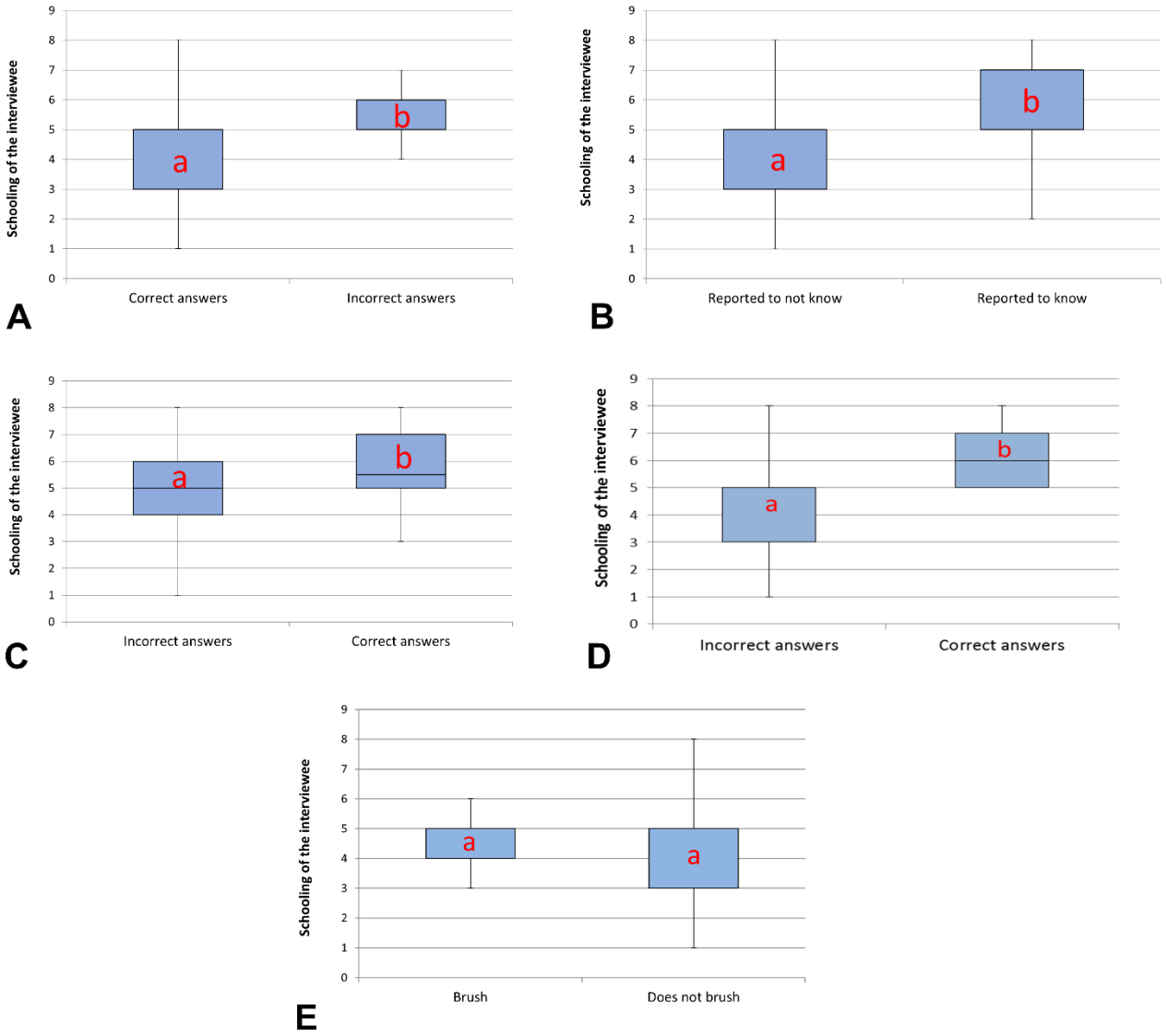

Figure 1. Interviewees' answers to the questions (A) "Do you know about the overall effects of fluoride"; (B) "Do you know if fluoride has any harmful effects?"; (C) "What is/are the bad effect(s) of fluoride?"; (D) "What is dental fluorosis?"; and (E) “Does the child has his/her teeth regularly brushed?”, according to their schooling. Different letters indicate significant differences between the medians (Mann Whitney’s test, p <0.05, n = 398). Schooling from 1 to 8, respectively for illiterate, complete elementary school, incomplete high school, complete high school, incomplete higher education, complete higher education, and postgraduate. A, C, and D were open questions whose answers were dichotomized into correct/incorrect answers, whereas B and E were yes/no questions.

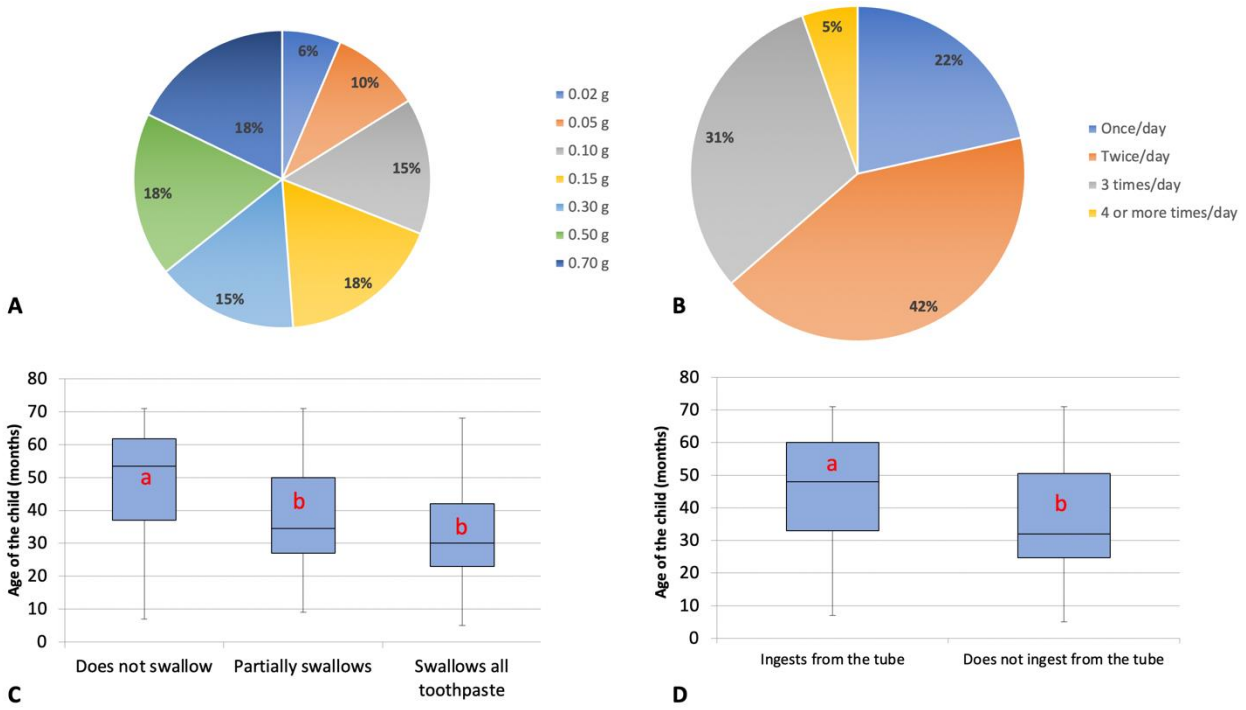

Figure 2. Distribution of children according to the amount of toothpaste placed on the toothbrush (A) and frequency of brushing per day (B), as well as toothpaste ingestion during toothbrushing (C) or directly from the tube (D), as reported by the interviewees. Lowercase letters indicate significant differences between the medians (Mann Whitney's test, $p < 0.05$, $n = 297$).

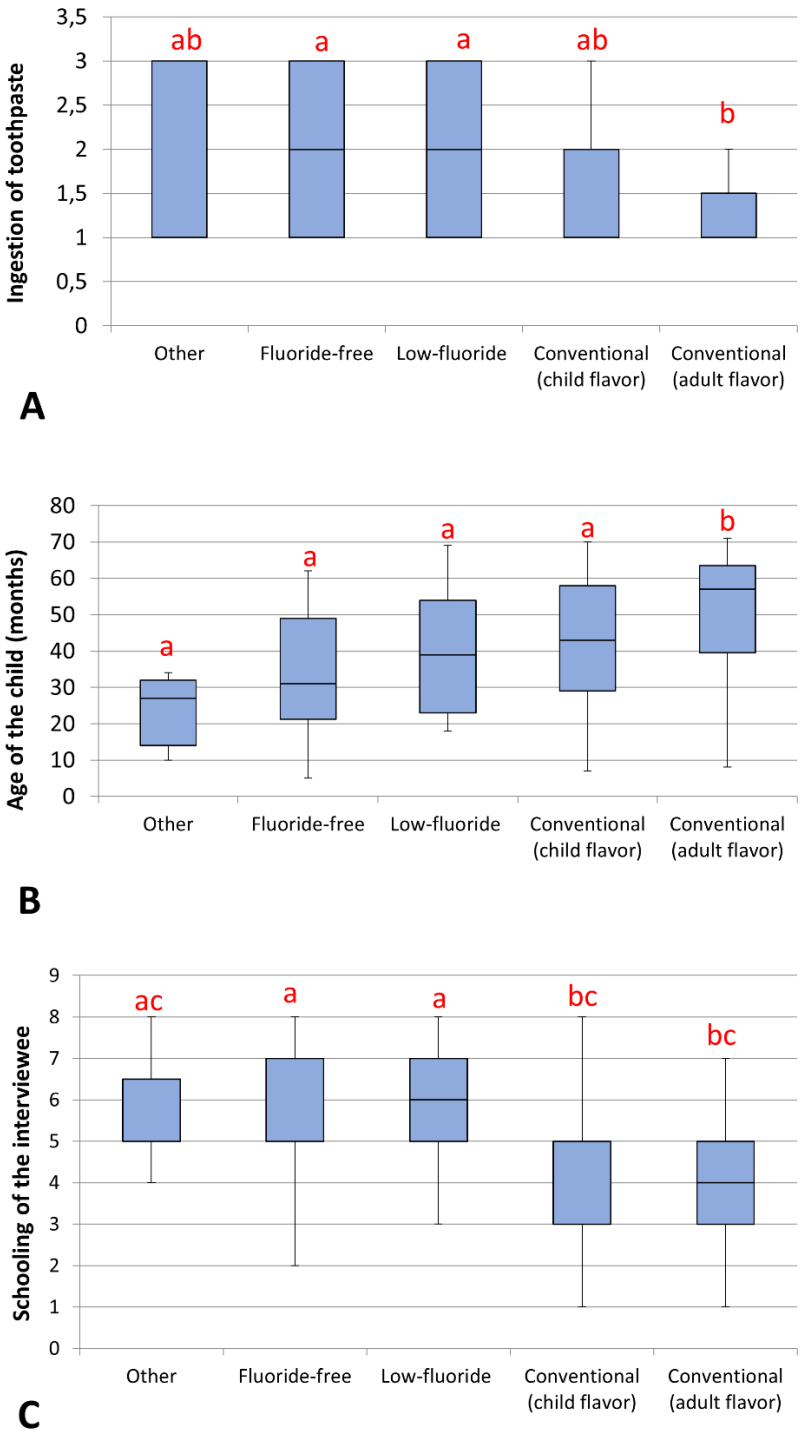

Figure 3. Intake of toothpaste during toothbrushing according to the type of toothpaste used (A); type of toothpaste used according to the children's age; and (C) type of toothpaste used by children according to the interviewee's schooling. Lowercase letters indicate significant differences between the medians (Dunn's test, p <0.05, n = 297). Schooling from 1 to 8, respectively, for incomplete and illiterate primary school, complete primary school, incomplete secondary school, complete secondary school, incomplete higher education, full tertiary education, and postgraduate education. Scores for dentifrice intake (Fig 4-A) from 1 to 3 correspond to "does not swallow", "partially swallows" and "swallows all" toothpaste placed on the toothbrush, respectively.

DISCUSSION

Recent data has shown that the age of the child plays a role in determining the amount of toothpaste applied on the toothbrush and the choice of toothpaste used. However, it has also been observed that there is significant variation in the parenteral interpretation of verbal instructions regarding the appropriate quantity of toothpaste to be used by children.[13] This suggests that further investigation is needed to address the issue of providing clear and consistent verbal instructions regarding toothpaste quantity. Consistent with these trends, the present study verified that various factors related to parents directly influenced their knowledge regarding the preventive and adverse effects of fluoride, as well as their usage patterns of fluoridated toothpaste for their children.

The increased prevalence of dental fluorosis observed over the last decades prompted to several studies assessing the reasons for such increases. In this sense, the use of fluoridated dentifrices by children under 6 years of age has long been pointed out as a risk factor for dental fluorosis.[14-22] Despite the variations between the studies, the intake of dentifrice by the child in the age group of 2 to 3 years is approximately 60%. Lima and Cury (2001)[23] and Paiva et al. (2003)[24], in Brazil, obtained approximate values for these studies. However, Almeida et al. (2007)[17] demonstrated that approximately 80% of toothpaste intake occurs in this age group and may reach 100% in some cases. Irrespective of this percentage, the difference found in these studies, the ingestion of fluoride by this source is considered high.

It is noteworthy that the interviewee's schooling did not influence the habit of brushing the child's teeth, which indicates that this aspect has been adequately taught and reinforced to the population. On the other hand, parents/guardians with higher schooling reported that children brushed their teeth more frequently, used less toothpaste on the toothbrush, and presented a greater proportion of correct answers on their knowledge about the preventive and adverse effects of the fluoridated dentifrice. These results are in line with those by Moura et al. (2013),[25] in which children whose parents/guardians with higher education presented lower prevalence and severity of dental fluorosis. In fact, this trend is in line with recent data on the caries burden in the Brazilian population in which it was shown that despite recent declines in caries prevalence among preschool children, caries levels increased with social inequalities, which includes the level of education, indicating a need of reviewing the policies to reduce the burden of this oral disease.[26] These findings emphasize the need for educational programs for the general public on oral health issues, especially for disadvantaged populations, whose educational level puts them at greater vulnerability to health problems

As for the methodology used for estimating the amount of toothpaste placed on the toothbrush, it was based on a previous study that assessed possible factors affecting brushing habits and the amount applied on the brush.[13] In that study, it was verified a wide discrepancy among participants regarding the understanding of usual descriptions of the amount of dentifrice to be placed on the toothbrush (*e.g.*, “smear”, “rice grain” and “pea-size”) and the actual amount placed by the participants. The study concluded that the use of three-dimensional models could be more useful in instructing parents and caregivers on the correct amount of toothpaste to be used by children, which motivated the development of the biscuit-simulating toothpaste.[13]

The age of the child presented a significant direct relationship with the frequency of toothbrushing and with the amount of toothpaste applied on the toothbrush, while it was inversely related to the habit of ingesting toothpaste directly from the tube and the habit of ingesting toothpaste while brushing teeth. Previous studies[5,17,27] demonstrated a direct relationship between the amount of toothpaste used and the amount of fluoride ingested during toothbrushing. Furthermore, it has been reported that 2-3-year-old children ingest up to 80% of the toothpaste placed on the toothbrush.[17,24] The abovementioned aspects reinforce once again the

need to educate parents/guardians about the correct supervision of children on the correct use of fluoridated dentifrices since younger children are prone to ingest toothpaste at the age of highest risk of development of enamel fluorosis.

The type of toothpaste used by the child was influenced by both the parents' schooling and the child's age (younger children consumed products with appealing packaging and flavor). The latter is a critical aspect, considering that: (1) the dentifrice flavor may influence the ingestion of the product by young children during toothbrushing;[5,28] (2) fluoride levels in these products may vary from placebo (fluoride-free) to conventional (1100 ppm F); (3) parents/guardians are not usually aware on the fluoride content in the formulation; and (4) the amount of dentifrice placed on the tooth.[13] All the above may have important implications both in caries prevention and in systemic fluoride intake from the product.

Notwithstanding the aforementioned findings, it is crucial to underscore certain limitations imposed by the study protocol. Firstly, it should be noted that the results presented in this study are confined to a specific location, and as such, different findings may potentially arise in other contexts. Additionally, it is important to acknowledge that the biscuit used to simulate the quantity of toothpaste may not be a perfect representation of actual toothpaste, thus introducing the possibility of variations.

CONCLUSIONS

Monitoring children during toothbrushing and keeping the toothpaste out of children's reach is paramount to ensure appropriate exposure to fluoride at therapeutic levels, aiming to reduce systemic exposure to this source. Educational strategies directed to children's guardians on both preventive and adverse effects of fluoride may also contribute to the rationale use of fluoride intended for caries control.

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CONFLICT OF INTERESTS

None.

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