

Effects of an Educational Comic Book on Knowledge Related to the Safe Use of Fluoride Toothpaste in Children

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ABSTRACT

Objective: To evaluate the effect of an educational comic book on indirectly supervised tooth brushing practices in early childhood education. **Material and Methods:** This is a quantitative action research aimed at evaluating the effect of a comic book on the necessary knowledge for indirectly supervised tooth brushing practices in early childhood education. Thirty-eight teachers from three daycare centers in the city of Porto Real, Brazil, participated in the year 2021, being carried out in three stages: 1: teachers answered a questionnaire for the identification of their sociodemographic and professional profile, in addition to prior knowledge about oral health. They also sent a photo of the toothbrush after applying the amount of toothpaste they used during the indirect supervised tooth brushing at the daycare center; 2: reception and 30 days to read the comic book; 3: answer to a new instrument on knowledge about oral health. Sending a new photo of the toothbrush with the toothpaste. **Results:** The amount of paste applied to toothbrushes decreased after reading the comic book from 58.1% to 27.8% of tufts, on average ($p < 0.05$). Reading the comic allowed an increase in the frequency of respondents who acquired knowledge about the term “dental fluorosis” ($p < 0.05$). **Conclusion:** Reading the comic book allowed a change in the knowledge required for the practice of indirect supervised tooth brushing.

Keywords: Fluorine; Dentifrices; Fluorosis, Dental; Graphic Novel; Health Education.

■ Introduction

In recent decades, a significant reduction in the severity of dental caries in various populations worldwide has been observed, and there is strong evidence that tooth brushing with fluoride toothpaste effectively prevents and controls dental caries in childhood [1,2]. However, there is a well-known association between the daily use of fluoridated products and an increase in the prevalence and severity of dental fluorosis [3]. In this context, it is essential to implement educational measures that provide the population with knowledge for this product's conscious use to prevent dental caries and fluorosis [3,4].

Considering oral health as an integral and inseparable part of general health, childhood is the period that can be regarded as the most important for the future of an individual's oral health, as it is at this stage that healthcare habits begin to be established, thus allowing educational actions implemented later to be based on the reinforcement of already established routines and health care habits [5,6]. For this reason, the school environment plays an essential role in promoting oral health due to the structural and curricular characteristics that can stimulate the development of skills and competencies favorable to oral health, promoting a positive relationship between the educational aspects of schools and the oral health outcomes of students [7].

In this space, indirect supervised tooth brushing aims to provide fluoride to the oral cavity and consolidate the tooth brushing habit. The agent of action is not necessarily a health professional but an educator [8]. Daily brushing with a fluoride toothpaste containing at least 1000 ppm of F is effective in preventing early childhood dental caries and should be initiated no later than 12 months of age [9], being evidenced that there is an increase in the prevalence of dental caries at 5 years of life in children whose tooth brushing frequency is less than twice a day during the preschool years and when there are difficulties in performing the procedure in early childhood [10].

Supervision during tooth brushing is essential because young children have motor difficulties in controlling swallowing, making them unable to expel all the saliva with the toothpaste [11], resulting in swallowing 30% - 63.2% of the product during tooth brushing [12]. The recommendation is that the guardian apply the amount of toothpaste on the brush to ensure the correct use of fluoride and stimulate expectoration, thus reducing the risk of dental fluorosis [13]. This practice becomes even more relevant in preschoolers, as it is the mineralization period of permanent teeth' dental crowns [14].

It is important to emphasize that dental fluorosis is a condition affecting the mineralization of developing teeth resulting from chronic ingestion of fluoride [3]. Its most significant relevance is in the aesthetic aspect when it occurs in permanent upper incisors, and its occurrence is associated with the intake of fluoride between 15 and 30 months of life when the permanent upper incisors are in the transition between the secretory phase and the enamel maturation phase [15]. In addition to the aesthetic concern, it is noteworthy that enamel affected by fluorosis is not necessarily richer in fluoride. It is hypomineralized in its subsurface, exhibiting high porosity in the region [16]. Therefore, teeth with fluorosis are not more resistant to the development of dental caries; instead, the opposite is true [16].

Adequate teacher and educator training is essential to increase the effectiveness and safety of educational oral health actions at school [17]. This ensures they become influential health advocates within the school environment, enhancing children's health. Given their potential for positive influence, teachers and educators can naturally play the role of multiplying agents [18].

In this scenario, it is imperative to make use of different health education strategies to reach children positively, considering that intersectoral action must be negotiated and included in the routine and practice of professionals, allowing the construction of more dialogic and contextualized knowledge for more effective health

policies, thus developing relevant methodologies aimed at meaningfully approaching users of health and teaching institutions to prevent health problems [19]. Another pertinent point is that traditional oral health education, through the transmission of knowledge, should be superimposed on alternative educational practices, with evidence that printed educational materials, including booklets and comic books, seem to be a practical way accessible to people [20].

Comic books are part of the youth universe, and their evolution as entertainment media has shown new possibilities of use and influence on this population [21]. A previous study validated an educational comic book that proved to be scientifically adequate for use in health education activities to guide adults on children's safe use of fluoridated toothpaste [22]. However, whether it would improve knowledge and change early childhood educators' behavior is still unknown. In this context, this study aimed to evaluate the effect of an educational comic book on indirectly supervised toothbrushing practices in early childhood education.

■ Material and Methods

Study Design and Ethical Clearance

This action research, a type of study that centers on generating solutions to practical issues, was conducted following the principles outlined in Resolution 466 of 2012, and the project was approved by the Research Ethics Committee of São Leopoldo Mandic Faculty (Opinion No. 3.974.726).

Scenario

The study was carried out in Porto Real, a small municipality in Rio de Janeiro, Brazil, that, in 2021, had an estimated population of 20,254 inhabitants. The public water supply of the municipality has been fluoridated since 2007. Its public education network is composed of seven municipal schools, an integrated public education center (CIEP 487), and three preschools, where the study was carried out: Creche Municipal Professora Cacilda Verri Marassi, *Creche Municipal* Waldir Roberto da Conceição, and *Creche Municipal* Enrico Secchi. All 40 educators linked to the three municipal daycare centers were, in May 2021, invited to participate in the study, which was organized in 3 stages (Figure 1).

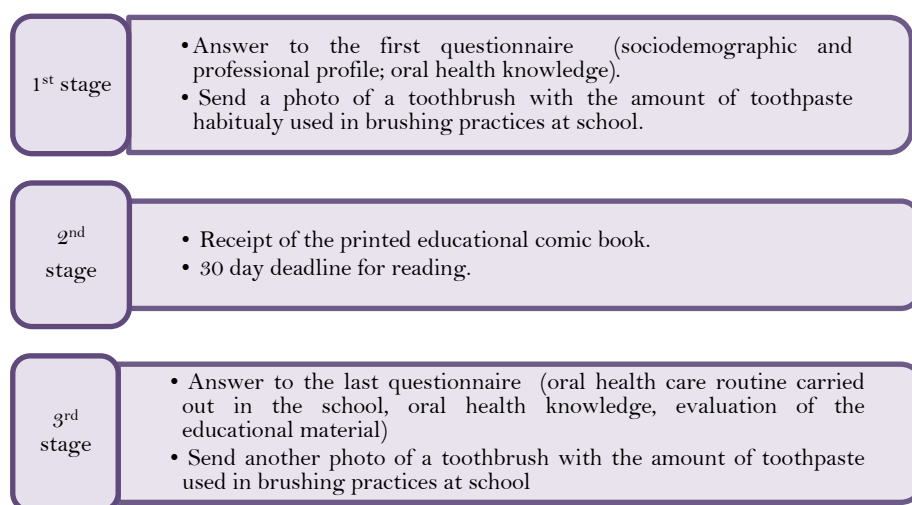


Figure 1. Diagram of the sequential stages of the study, considering the participation of the educators.

Data Collection

In the first stage, participating teachers answered a structured questionnaire to identify their sociodemographic and professional profile and previous knowledge about oral health, prepared based on previous studies [11,23]. In this stage, participants were also asked to send the researcher a photo of a toothbrush with the amount of toothpaste used in brushing practices at school, simulating the behavior adopted during the indirect supervised tooth brushing performed at the daycare center with children.

In the second stage, the printed educational comic book on using fluoride toothpaste for oral hygiene in children, produced and validated in a previous study, was individually distributed [22]. The material is entitled "*Dentitos: o flúor e a saúde bucal*" and is available for free download at <https://bit.ly/3v9cGdZ>.

In the third and last stage, 30 days after the comic book was delivered, a new questionnaire was applied to participants, seeking to identify the oral health care routine carried out in the school environment (questions 1 to 5), oral health knowledge (questions 6 to 11) in addition to the evaluation of the educational material according to the educators' conception (questions 12 to 20). Again, participants were asked to send a photo illustrating the amount of toothpaste used in brushing practices at school.

After completing the stages, a trained and calibrated evaluator ($p > 0.05$) counted the tufts of toothbrushes in each photo individually since there was no toothbrush standardization, and subsequently, of tufts not covered by paste to quantify, in relative frequency, the percentage of brush tufts occupied with paste used by the educator in the photos sent, and thus quantify the amount of toothpaste used. All 38 educators sent photos of both, which were used in the study.

The reproducibility of the counting of occupied tufts was analyzed using descriptive analysis, paired Wilcoxon test, and intraclass correlation analysis. The interpretation of the intraclass correlation coefficient was performed according to Szklo et al. [24], and there was no significant difference in the count of occupied tufts between the first and second evaluations ($p > 0.05$), and the reproducibility was excellent (ICC=0.990; 95%CI: 0.948-0.998).

Data Analysis

Descriptive analyses were carried out with variables such as educators' profiles, answers regarding the oral health care routine in daycare centers, and educators' perceptions about the comic book to assess the difference in knowledge on the topic before and after reading the comic book. For this, absolute and relative frequencies, means, standard deviations, medians, and minimum and maximum values were used. Subsequently, the non-parametric Wilcoxon test was used to compare the self-assessment scores of knowledge and amount of toothpaste on toothbrushes before and after the educational approach. Bowker non-parametric test was used to analyze answers to questions about knowledge of what fluoride is and the term dental fluorosis before and after the educational approach. All analyses were performed using the R software with a 5% significance level.

■ Results

At the end of the study, 38 of the 40 educators linked to participating daycare centers agreed to participate in the research and completed all stages of the research. Most are female (94.7%), with a mean age of 40.1 years, ranging from 21.1 to 57.2 years. It was also observed that 55.3% have children, and 68.4% have completed higher education.

Table 1 presents the descriptive analyses of the educators' answers regarding the oral health care routine in the school environment. It was observed that the majority answered that there is a time for brushing in schools

and that daycare centers understand the importance of this moment for children's oral health. Although the teacher/educator applies the paste on the toothbrush and supervises brushing, 18.4% reported not observing whether the child swallows the toothpaste, and 39.5% reported observing this behavior only a few times. In addition, 29.0% had never received guidance on the amount of toothpaste to be used by children.

Table 1. Descriptive analysis of daycare centers' oral health care routine.

Variables	N (%)
Daily Brushing Frequency	
Once	25 (65.8)
Twice	7 (18.4)
More than twice	4 (10.5)
Not reported	2 (5.3)
Does the daycare center understand the importance of brushing teeth for children's oral health?	
No	1 (2.6)
Yes	35 (92.1)
Not reported	2 (5.3)
Does it use toothpaste when brushing all children?	
No	0 (0.0)
Yes	38 (100.0)
Who applies toothpaste to the toothbrush?	
Child	1 (2.6)
Educator	37 (97.4)
Who brushes the child's teeth?	
The child (themselves)	5 (13.2)
The child and the educator supervise	31 (81.6)
The educator	2 (5.3)
During brushing, does the educator observe if the child swallows the toothpaste?	
No	7 (18.4)
Yes	16 (42.1)
Sometimes	15 (39.5)
The paste is rinsed	
With the child's cupped hand	25 (65.8)
With the educator's cupped hand	5 (13.2)
With a glass or mug	7 (18.4)
Not reported	1 (2.6)
Have you ever received guidance on the amount of toothpaste children should use?	
No	11 (29.0)
Yes	27 (71.0)

Table 2 shows that there was no significant difference between times before and after the educational intervention regarding the self-assessment score of knowledge by educators ($p > 0.05$); however, there was substantial reduction in the amount of paste applied on toothbrushes after the educational activity ($p < 0.05$): on average, educators applied paste on 58.1% of tufts and after the approach, the amount used on toothbrushes was on average of 27.8% of tufts ($p < 0.05$).

Table 2. Self-assessment of knowledge before and after the educational approach in indirect supervised tooth brushing practices in municipal daycare centers.

Variables	Time	Mean (SD)	Median (Minimum–Maximum)
Knowledge Self-Assessment	Pre	7.3 (2.0)	8.0 (2.0–10.0)
	Post	7.7 (1.2)	8.0 (4.0–10.0)
	p-value	0.2172	
Percentage of Tufts Filled With Paste	Pre	58.1 (21.3)	58.8 (17.1–100.00)
	Post	27.8 (14.4)	26.7 (8.6–70.0)
	p-value	<0.0001	

Regarding questions that allowed assessing knowledge before and after the educational intervention with the comic book, it could be observed in Table 3 that 60.5% of educators answered that they had no knowledge about the term “dental fluorosis” before and acquired the knowledge after the educational approach ($p < 0.05$). In addition, 36.8% knew the term before the educational approach and would acquire more knowledge after the approach. Thus, 97.3% of educators acquired some knowledge about the term dental fluorosis after reading the comic book.

Table 3. Knowledge about what fluoride is and self-assessment about knowledge of the term “dental fluorosis” before and after the educational approach in indirectly supervised tooth brushing practices.

Pre Approach	Post Approach		
	N (%) ¹	N (%) ¹	N (%)
	A product that prevents dental caries	Product that prevents and treats dental caries	Do not Know
Fluorine is a product that prevents dental caries	28 (73.7)	3 (7.9)	0 (0.0)
Fluorine is a product that prevents and treats dental caries	2 (5.3)	4 (10.5)	0 (0.0)
Do not know	1 (2.6)	0 (0.0)	0 (0.0)
p-value	0.7530		
	Did not acquire knowledge about the term “Dental Fluorosis”	Acquired some knowledge about the term “Dental Fluorosis”	Perhaps Acquired
No knowledge about the term “dental fluorosis.”	0 (0.0)	23 (60.5)	1 (2.6)
Knowledge about the term “dental fluorosis”	0 (0.0)	14 (36.8)	0 (0.0)
p-value	<0.0001		

¹Percentage of the total.

Regarding educators' perception of the comic book, it can be seen in Table 4 that 92.1% found that the information on the amount of toothpaste to be used by children is clear. In addition, 94.7% and 76.3%, respectively, thought that the information/content presented in the comic book is coherent and illustrated clearly and understandably. For 94.7%, the presentation of its content is inviting, and 92.1% believe that the comic book meets the objective of guiding children's safe use of fluoride toothpaste.

Table 4. Descriptive analysis of the educator's perception of the comic book.

Variables	N (%)
Information about the amount of toothpaste children use is clear	
Yes	35 (92.1)
Partially	3 (7.9)
Regarding "dental fluorosis," mark the option that best characterizes its cause	
Using too little toothpaste	2 (5.3)
Using too much toothpaste	20 (52.6)
Swallowing toothpaste	16 (42.1)
Is the information/content presented in the comic book coherent?	
Yes	36 (94.7)
Partially	2 (5.3)
The information/content of the comic book is presented in a clear and understandable way	
Yes	29 (76.3)
Partially	9 (23.7)
The presentation of the comic book content is inviting	
Yes	36 (94.7)
Partially	2 (5.3)
The comic book guides children in the safe use of fluoride toothpaste.	

Yes	35 (92.1)
Partially	3 (7.9)
The comic book is adequate and helps people understand the importance of using fluoride toothpaste	
Yes	36 (94.7)
Partially	2 (5.3)
The comic book is adequate and helps to understand the amount of toothpaste on the toothbrush	
Yes	35 (92.1)
Partially	3 (7.9)
The comic book is adequate and helps to understand the need to encourage the child to spit out the paste	
Yes	36 (94.7)
Partially	2 (5.3)

When questioned about the risk of dental fluorosis, educators attributed higher scores to the situation in which the child swallows the toothpaste during brushing (Table 5).

Table 5. Educators' perception of dental fluorosis risk associated with toothpaste ingestion by children.

Variables	Dental Fluorosis Prevention Care	
	Mean (SD)	Median (Min.–Max.)
Dental Fluorosis Prevention Care		
The adult is responsible for applying the paste to the child's toothbrush	4.1 (1.1)	4.0 (1.0–5.0)
Pay attention to the amount of paste according to the child's age	4.3 (1.0)	5.0 (2.0–5.0)
Observe whether the child spits out the paste while brushing	4.4 (0.9)	5.0 (2.0–5.0)
Encourage the child to spit out the paste during and after brushing	4.4 (0.9)	5.0 (2.0–5.0)
Risk of Occurrence of Dental Fluorosis		
Child holding the toothbrush with paste while waiting for their turn to brush	3.1 (1.4)	3.0 (1.0–5.0)
The child is responsible for applying the paste on the toothbrush	4.0 (1.0)	4.0 (1.0–5.0)
Adult supervising the child's brushing	1.6 (1.2)	1.0 (1.0–5.0)
The child swallowed the paste while brushing	4.2 (1.1)	5.0 (1.0–5.0)
The adult supervises the child to encourage them to spit out the paste	1.6 (1.2)	1.0 (1.0–5.0)
Is the comic adequate to be used in educational activities with children of the age group you work with?	7.8 (2.4)	8.0 (0.0–10.0)

Min.: Minimum; Max.: Maximum.

■ Discussion

The educational comic book used in the study was effective in improving knowledge about dental fluorosis and the risk related to swallowing toothpaste, in addition to having provided the opportunity for a significant decrease in the amount of paste applied on toothbrushes in a simulated situation of supervised brushing, since at the time when the study was carried out, schools remained closed due to the Covid-19 pandemic. Educational technology proved to be effective as a tool for health promotion, as desired by the WHO [25] and by the National Health Promotion Policy (NHPP) [26], as it involves empowering people to increase control over their health. One of the most effective health promotion mechanisms is the development of personal skills for care and self-care [27], which concept includes the importance of transmitting knowledge to educators for the health promotion of both students and educators.

The present study revealed that a significant portion of educators reported either not observing or observing only a few times if children swallow toothpaste while brushing at school. Additionally, almost one in three educators reported never having had access to information about the amount of toothpaste to be used by children. This leads to the following reflection: How can someone be made responsible for something without providing the necessary knowledge? What should adults know about the care and promotion of children's oral health? What consequences could this attitude have for children?

One of the main factors positively influencing oral health is access to water fluoridation, along with regular toothbrushing using fluoridated toothpaste throughout life [2]. To balance the preventive effect of fluoride without developing levels of fluorosis with aesthetic impairment, regulating the intake of fluoridated toothpaste during the enamel formation period is essential [28].

In permanent teeth, crown formation occurs after birth and continues until age six [29]. Fluoride intake occurs in different ways, including diet, fluoridated water consumption, and fluoridated toothpaste ingestion. Due to the challenge of controlling fluoride intake through water and food in children, ingesting fluoride toothpaste during brushing is the simplest way to control [28]. In the present study, reading the comic book reduced the amount of toothpaste used during indirect supervised brushing, potentially impacting the reduction of fluoride ingestion.

It is in early childhood, that is, from birth to six years of age, that a large part of fluoridated toothpaste is swallowed during tooth brushing, mainly due to the difficulty of expectorating it properly [15], making the toothpaste responsible for most of the daily exposure to fluoride, which may exceed the safety parameter suggested by Burt [30], that is 0.07 mg F/day/Kg of body weight, which is the limit dose of clinically acceptable fluorosis from the aesthetic point of view; however, this value has never been experimentally tested [28].

It is known that toothpastes with low concentrations of fluoride do not demonstrate evidence of effectiveness in controlling dental caries or reducing the risks of developing fluorosis [31]. Thus, at this stage of life, the consensus is for the use of toothpaste with conventional fluoride concentration (between 1000 and 1500 µg/g) and in small amounts (0.1 to 0.3g) [15]. Additionally, a guardian needs to apply the dentifrice on the brush and encourage the child to expectorate it at the end of brushing [32,33]. Increased knowledge about dental fluorosis can help educators understand the need for constant child supervision and stimulating expectoration.

This theoretical context served as the basis for the script of the educational comic book used in this study, which was previously validated [22]. In the present study, the comic book was delivered to educators without any complementary intervention on the researcher's part and showed positive results. These positive outcomes were observed regarding the knowledge acquired by educators and the amount of toothpaste applied to the toothbrush, which significantly reduced. This indicates that the comic book successfully raised awareness among the target population.

The use of comic books has demonstrated positive effects on public health in diverse areas, including HIV awareness [34], serving as an educational resource for teaching microbiology in the classroom [35], promoting vaccination against human papillomavirus (HPV)-related infections [36], providing information technology for performing eye self-examination [37], acting as an additional educational resource to disseminate information about dental trauma [20], and serving as an oral health education method in the waiting room of a family health unit [38]. Authors have previously demonstrated the effectiveness of a printed educational booklet's effectiveness in knowledge, attitude, and practice, highlighting the positive influence of utilizing this technological resource [39]. The present study adds evidence to the efficacy of this technology, expanding the range of options for materials that can be used in the school context.




As an advantage, this educational technology offers low cost and low technological requirements and the potential to transcend language barriers [34]. Using validated comic books enhances the reliability of the teaching-learning process, facilitates healthcare communication, ensures security in guidelines, and improves the coherence of information. It also mediates the relationship between the target population and healthcare professionals [40].

A limitation of this study was related to the analysis of photos to identify the amount of toothpaste used on brushes, an alternative necessitated by the pandemic, and the closure of schools in the evaluated municipality. However, the exhaustive training and prior calibration of the examiner resulted in error values that justify the consistency of measurements and the validity of findings. This approach provides primary data for further studies in the actual context of indirectly supervised education. After reading the comic book, educators found the information to be clear, coherent, understandable, inviting to read, and successful in guiding children's safe use of fluoride toothpaste. The present study underscores the relevance of health promotion and continuing education, emphasizing the need for education not only with the child but primarily with the educator, who serves as a health multiplying agent.

■ Conclusion

Reading the comic allowed for a change in the knowledge necessary for indirectly supervised tooth brushing, qualifying education professionals as multiplier agents of oral health promotion. It improved knowledge about dental fluorosis and provided opportunities to reduce the amount of fluoridated toothpaste used on toothbrushes.

■ Authors' Contributions

HCSP		https://orcid.org/0000-0001-5943-4856	Conceptualization, Investigation, Curation, Writing - Original Draft and Writing - Review and Editing.
LZS		https://orcid.org/0000-0003-0218-9313	Writing - Original Draft and Writing - Review and Editing.
FMF		https://orcid.org/0000-0001-7742-0255	Conceptualization, Methodology, Writing - Original Draft, Writing - Review and Editing, Supervision and Project Administration.

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

■ Financial Support

None.

■ 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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