Factors associated with the use of Dental Health Services by Mexican Schoolchildren to receive Professionally Applied Topical Fluoride

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Objective: To identify the prevalence of and factors associated with the use of dental health services to receive professionally applied topical fluoride (DHSU-PATF) in the 12 months prior to the study among Mexican schoolchildren aged 6 to 12 years.

Methods: A cross-sectional study was performed in 1,404 schoolchildren selected randomly from 15 public schools in the city of Pachuca, Mexico. Questionnaires were distributed to determine the demographic, socioeconomic, and behavioral variables. The dependent variable was the DHSU-PATF in the year before the study, which was dichotomized as 0 (no DHSU-PATF) or 1 (yes, DHSU-PATF). We calculated odds ratios (OR) and 95% confidence intervals. The analysis was performed in Stata 11.0.

Results: The prevalence of DHSU-PATF was 5.1%, but lower among younger children (OR = 0.86) and greater among children with health insurance (private insurance, OR = 3.64; insurance provided by the government-owned oil company, the Army, or the Navy, OR = 5.03). The level of knowledge about oral health among guardians/ parents was also a factor (medium, OR = 2.37; high, OR = 4.05). Additionally, among the children whose parents/guardians perceived them (the children) as having good or very good oral health, the OR was 3.33; among children whose parents brushed their teeth with greater relative frequency, the OR was 8.74. Finally, DHSU-PATF was greater among children with relatively higher socioeconomic status (2nd quartile, OR = 3.29; 3rd quartile, OR = 5.99; 4th quartile, OR = 4.64).

Conclusion: The receipt of PATF was low in this sample of Mexican schoolchildren and is associated with socioeconomic and behavioral factors. This gives us a guideline to create or improve topical fluoride application strategies in the public and private Mexican health systems. [*P R Health Sci J 2020;39:203-209*]

Key words: Oral health, Health services, Caries prevention, Topical fluoride, Epidemiology, Mexico

To ooth decay is a global public health problem and is a multifactorial disease caused by a physiological imbalance between the minerals of the tooth and dental biofilm. This imbalance causes a net loss of dental minerals (1). In 2010, only a third of the dentists in the United States accepted Medicaid; because dental care is often ignored or postponed when benefits are inadequate, it is not surprising that in that same year, US adults and children numbering over 132 million were without dental insurance. The fact is that for every person who remains insured, medically, there almost 3 who are not covered by dental insurance. These individuals—anyone without dental insurance face serious potential consequences for this lack of coverage, among which are progressive dental disease, expensive hospital stays, and school and work absences. Generally, children who develop good oral-health habits have

better oral health in their lifetimes, due, in large part, to the preventive care that attends those beneficial habits (2). Although tooth decay is reversible in its initial stages, it advances slowly once begun and destroys dental hard tissues. Tooth decay is

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one of the main causes of missing teeth (3, 4). Dental caries is a highly preventable disease. Fluoride treatment is widely used to prevent dental caries or treat it in its incipient stages, both in clinical practice and in the field of public health. There are several ways to supply fluoride, professionally; it is available as a fluoride solution and in varnish and gel forms (5).

Epidemiological studies in Mexico show a high prevalence and incidence of dental caries in pre-school and school-aged children. According to the National Caries Survey of Mexico, the decayed, missing, and filled teeth (dmft/DMFT for primary/ permanent teeth) index for 6-year-olds ranged from 0.73 to 5.35; that of 12-year-olds ranged from 0.52 to 3.67 (6). Significant resources are required for the treatment of this condition, and it is an important burden on both health care systems and the children's families (7). The World Health Organization has identified the overall lack of oral health services as being a critical issue that must be addressed. Dental treatment is costly, averaging 5% of total health expenditure and 20% of out-ofpocket health expenditure in most high-income countries. (8). The use of health services results from the interaction of biological, socioeconomic, and sociocultural factors as well as those factors related to the health system itself: availability, accessibility, and the quality of the resources used for health care, among others (9). The American Academy of Pediatrics and the American Academy of Pediatric Dentistry recommend periodic dental visits for the prevention of dental caries, beginning during the first year of life, with subsequent periodic examinations occurring twice a year. At these appointments, primary and secondary prevention activities are carried out for patients with a high risk of caries; these activities include the placement of sealants and fissures and topical applications of fluoride (10, 11). In Canada, the United States, and Mexico, professionally applied tropical fluoride (PATF) usually comes in the form of a gel, foam, or fluoride varnish. It can be effective for caries prevention in school-aged children (12, 13).

Recently, in Latin America, the estimated prevalence of school-age children who received PATF treatment ranged from 3.1 to 11.5% (14, 15). In developed countries, on the other hand, higher frequencies of dental health service utilization (DHSU) for the receipt of PATF have been observed. For example, in a study in the United States, Slayton et al. (16) found that at 3 years, at least 19% of children had received PATF. Levy et al. (17) reported that the prevalence of PATF was 27% among 4-yearold children, 44% among 5-year-old children, and 66% among 6-year-old children. In another study, the reported prevalence of DHSU-PATF ranged from 68% to 74% among children aged 7 and 9 years (18). Huebner et al. (19) recommend that the clinical decision to use fluoride should be based on a given child's caries risk status. While low socioeconomic status indicates a high risk, the actual use of in-office caries preventive agents varies considerably across dental practices. The following variables are associated with DHSU-PATF: sex (being female), age, race, health insurance, frequency (high) of toothbrushing, socioeconomic position (relatively better), access to schooling,

dental-caries experience in primary dentition, and health perception (14, 15, 19).

The Mexican dental health care system

In Mexico, dental health care is subsidized by a mix of public-service institutions and third-party payers (which latter include the Mexican Social Security Institute, the Institute of Social Security and Services of State Workers, and private insurance companies). Oral health services are delivered almost exclusively on a fee-for-item basis that requires out-of-pocket payments from the patient. The entire system, unregulated and under the control of the participating dental professionals, is designed so that costs are subject to the vagaries of the dental marketplace. Public health agencies provide a limited and fluid set of services that tend to be both unidentified and restricted to urban populations. The 2 social security institutions serve 2 groups: families of government workers, who have insurance that is funded by the government (Institute of Social Security and Services of State Workers [ISSSTE, by its initials in Spanish]), and those families having one or more members who work in private businesses (Mexican Institute of Social Security [IMSS, by its initials in Spanish]). Furthermore, the Army (Secretaría de la Defensa Nacional [SEDENA]), the Navy (Secretaría de Marina [SEMAR]), and the national oil company (Petróleos Mexicanos [PEMEX]) comprise a subsystem that is more complete and provides services with greater coverage. In 2003, the Mexican government implemented Seguro *Popular* (SP), a public health insurance plan that provides its members partial coverage and is funded by the federal and state governments as well as, to a lesser extent, by household contributions; for households in the lowest 3 income deciles, SP is free of charge. Finally, many public and private universities across the country have dental clinics that offer services to the general population at prices far below those of the health marketplace (20–22).

Pachuca (from which our study sample was drawn) is found, participated in a national salt fluoridation program that was implemented in 1991. Mexico does not currently (at the time of this writing) have a national program aimed at fluoridating water; However, water with high levels of naturally occurring fluoride can be found in many parts of Mexico; Pachuca, unfortunately, is not one them, thus, the salt fluoridation program. (23). The purpose of this study was to estimate the prevalence of PATF treatment in the 12 months prior to the study and to understand how the socioeconomic and behavioral factors of Mexican schoolchildren aged 6 to 12 years affect that prevalence.

Materials and Methods

Study design

A cross-sectional study was carried out in the city of Pachuca, Mexico, in schoolchildren from 6 to 12 years of age. This study was part of a larger project in which several indicators related to oral health were measured (21, 22, 24–26). In the first stage, 14 of the 93 public elementary schools were selected randomly (simple random sampling) from the official list available at the ministry of education for the city of Pachuca. We included 112 children per school who were distributed similarly with respect to age and sex. We subsequently used the school attendance list and simple random sampling to select the study subjects. The questionnaires (in Spanish) were distributed in person to the children's guardians/parents. Dental students were responsible for distributing and collecting the questionnaires, which were self-filled by the guardians/parents of the participants.

The questionnaire was first tested in a pilot study and had an initial return rate of 73.8% (n = 1158). A reminder increased the return rate to 87.8% (n = 1376), and a second reminder increased the return rate to 93.8% (n = 1470). No incentives were given to the participants. The sample size was calculated based on a smallest estimated proportion of 35%, a 95% confidence level, 3% accuracy, and a 10% no-answer rate. The estimated sample population was 1554 schoolchildren. The inclusion criteria were as follows: being enrolled in one of the selected schools and 6 to 12 years of age. The following exclusion criterion was used: having a disease that would compromise oral health. After the selection criteria were applied, 98 questionnaires were eliminated, leaving a final sample of 1,404 subjects.

Measures

The information was collected through a questionnaire addressed to the guardians/parents of the study subjects. The questionnaires were distributed through the schools and returned via the same route. The surveys collected details on socioeconomic, sociodemographic, dental, and behavioral variables as well as the patterns of use of oral health services.

The dependent variable in this analysis was the use of dental health services to receive PATF in the year prior to the study. This was dichotomized as 0 (no DHSU-PATF) or 1 (yes, DHSU-PATF). Likewise, the following independent variables were included in this study: the age and sex of the participant, the age of the participant's mother, parental knowledge about oral health, the parents' perception of the oral health status (using a Likert scale) of the child, and the frequency of brushing of the guardians/parents. In addition, we investigated a series of indicators of socioeconomic position, such as housing characteristics, household appliances, father's and mother's education, health insurance, and car ownership.

The presence or lack of health insurance and health insurance type was divided into categories as follows: 1) families without health insurance, 2) families with insurance funded by the government, private businesses, and workers (IMSS [Mexican Institute of Social Security] and ISSSTE [Institute of Social Security and Services of State Workers]), 3) families with health insurance from the Mexican oil company (PEMEX) and the Mexican Armed Forces (SEDENA and SEMAR), 4) families with private health insurance, and 5) families with social health protection. (A national health insurance program called Seguro Popular provides access to a package of comprehensive health services, the costs of which are controlled services with financial protection) Principal component analysis was used to determine the socioeconomic position (SEP) related to housing characteristics and household appliances—specifically the methodology known as polychoric correlation (27). In this analysis, a series of correlated variables were combined, through which combination 33.4% (housing) and 63.1% (appliances) of the variability was explained. The resulting variables were divided into quartiles, with the first quartile representing those with a low SEP and the fourth quartile representing those with the highest SEPs. Parental knowledge about oral health (22, 26) was analyzed similarly, with principal component analysis, and divided into tertiles. The internal consistency (evaluated with Cronbach's alpha) was adequate (>0.70). This tool evaluated knowledge based on responses to the following statements: fluoridated salt prevents cavities; eating lots of sweets can cause cavities; poor tooth cleaning causes oral diseases; bacteria in the mouth cause oral diseases, and so on.

Statistical analysis

Stata 11 was used to perform the data analysis. The summary measures were reported according to the measurement scales of the variables. A value of p lower than 0.05 was considered statistically significant. We calculated odds ratios (OR) and 95% confidence intervals (95% CI).

There were some missing data for the categories of oral health knowledge (n = 45), father's schooling (n = 21), and automobile ownership (n = 14). The missing data were imputed according to the method for analyzing missing data known as regression imputation (28).

Ethical considerations

This study met subject protection guidelines and relevant Helsinki ethical regulations. The Ethics and Research Committee of the Autonomous University of the State of Hidalgo (UAEH-DI-ICSA-ODO-CF-016) approved the study protocol. Written consent was obtained from all the guardians/ parents.

Results

This study sample included 703 boys and 701 girls with a mean age of 8.97 (\pm 1.99) years. The descriptive results are shown in Table 1. For most of the participating children, both parents had completed secondary school or greater (>65%). A high percentage of the schoolchildren in our sample had access to some form of health insurance (69.8%). One third of the participating households had no automobile. Very few guardians/parents reported that their children had very poor/ poor oral health. A high percentage of guardians/parents reported that their children their teeth at least once a day (89.4%). The prevalence of DHSU-PATF in our sample group was 5.1% (95% CI: 3.9 – 6.2).

Table 1.	Descriptive	results	of the sa	mple (n	= 1,404).
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Variable	Mean±sd
Child's age (years)	8.97±1.99
Mother's age (years)	34.89±6.1
	Frequency (%)
Sex	
Female	701 (49.9)
Male	703 (50.1)
Mother's Schooling	
Less than high school	452 (32.2)
High school or more	952 (67.8)
Father's Schooling	
Less than high school	428 (31.3)
High school or more	941 (68.7)
Health Insurance* Uninsured	422 (20.8)
Social security	433 (30.8) 727 (51.8)
Other governmental social security	68 (4.8)
Private insurance	49 (3.5)
Seguro Popular	127 (9.1)
Automobile at Home	127 (5.1)
Yes	871 (63.3)
No	504 (36.7)
SEP (household appliances)	, , , , , , , , , , , , , , , , , , ,
1st quartile	351 (25.0)
2nd quartile	352 (25.1)
3rd quartile	351 (25.0)
4th quartile	350 (24.9)
SEP (housing characteristics)	
1st quartile	356 (25.3)
2nd quartile	354 (25.2)
3rd quartile	345 (24.6)
4th quartile	349 (24.9)
Knowledge of Oral Health	
Low	468 (33.3)
Medium	468 (33.3)
High	468 (33.3)
Perception of Child's Oral Health	150 (11 25)
Very bad/bad	158 (11.25)
Regular Good (vory good	635 (45.23) 611 (43.52)
Good/very good	611 (43.52)
Brushing Frequency (guardian/parent) Less than once a day	1/19 (10 6)
At least once a day	149 (10.6) 1,255 (89.4)
At least office a udy	1,200 (09.4)

*The social security institutions in Mexico serve 2 groups: families of government workers with insurance funded by the government (Institute of Social Security and Services of State Workers [ISSSTE]) and workers in private businesses (Mexican Institute of Social Security [IMSS]). The Army (Secretaría de la Defensa Nacional [SEDENA]), the Navy (Secretaría de Marina [SEMAR]), and the national oil company (Petróleso Mexicanos [PEMEX]) comprise a subsystem that is more complete and provides services with greater coverage.Haberei privis, notastu strac re tea publiquam dem, C. Mo etia orarem

Table 2 shows the results of the bivariate analysis. Statistically significant differences (p<0.05) were observed for several variables. The age of those who were treated with topical applications of fluoride by an oral health professional in the year prior to the study was slightly higher than was the age of those who were not so treated. People with health insurance through PEMEX or the Mexican Armed Forces or who had private insurance received DHSU-PATF treatments more often than those without insurance did. Subjects with a better

socioeconomic positions had more topical applications of fluoride than the subjects with lower socioeconomic positions did. The children of guardians/parents with better knowledge of oral health had a higher frequency of DHSU-PATF treatments than their counterparts with less oral health knowledge did. When guardians/parents reported brushing their teeth at least once a day, their children were more likely to be treated with topical applications of fluoride by an oral health professional than were those children whose parents/guardians did not report this frequency of toothbrushing.

Discussion

The frequency of visits to the dentist to receive PATF in the last year was 5.1%. People in Latin America and Mexico generally suffer from poor oral health and these populations have high prevalences and incidences of dental caries, high treatment needs for caries, and little experience with curative and preventive treatments (29). In addition, DHSU-PATF treatment is low among children in developing nations, with values ranging from 3.1 to 11.5%, according to recent studies (14, 15). Other developing countries show a similar trend (30). In contrast, developed countries such as the United States have a high utilization of preventive dental services-reaching nearly 75% (16-18). Associations of health professionals widely recommend visits to the dentist at an early age because these visits can detect incipient caries lesions and perform early prevention and treatment (10, 11), including applications of fluoride, when appropriate. In this sense, several studies suggest that regular dental care is associated with better oral health outcomes and better quality of life (31). In addition, PATF treatment that is performed when visiting the dentist has been shown, in several studies, to reduce the incidence of dental caries. Therefore, PATF is a cost-effective measure that can prevent dental caries and is widely recommended (32, 33).

Numerous recent studies have analyzed the impact of socioeconomic position on various oral health indicators in the population. This impact results in what are called socioeconomic health inequalities (34, 35). One of the most important barriers that prevents people from using oral health services is their economic status (24, 36). The cost of oral health care services limits access in the developing world. In Mexico, publicly funded institutions offer a limited number of services. Although these services are intended mainly to provide preventive approaches, they are most frequently used for restorative and/or surgical services (22, 37). In addition, while dental health care personnel in the private sector offer a wide range of dental services, these services result in out-of-pocket expenses and are inaccessible to parts of the population-especially those who are the most socially unprotected. This fact is corroborated when we observe that the frequency of DHSU-PATF is lower in children whose services are financed by the government than it is in children with private insurance. These findings reveal the indirect costs associated with regular dental care in populations that are at a

greater social disadvantage; these costs can worsen oral health conditions and increase the risk of caries. Likewise, studies show that among low-income people, visits to the dentist tend to be delayed until the age of 3 years (19, 38), even though the ideal time to start dental visits is during the first year of life (10, 11). Socioeconomic inequalities for this oral health indicator have been demonstrated in other developing countries, such as Nicaragua (15), as well. In contrast, a study in the United Kingdom found no socioeconomic differences in preventive care (check-ups, pit and fissure seal, or treatment to prevent caries) (39).

Sociodemographic variables, such as age and sex, have also been found to be associated with this type of service. However, different outcomes may be seen depending on the age group-older children have greater frequencies of DHSU-PATF or have no significant differences between groups (15, 19). Knowledge, attitudes, and behaviors related to oral health have a positive impact for the different types of indicators: Greater knowledge, better attitudes, and positive behaviors are generally associated with better oral health results (14, 15, 40). Those results are consistent with those of our study. Children should be taught about oral health so they can create their own habits and learn the basic details about and rules for maintaining oral health. However, even after taking responsibility for their own oral health, children must still receive support from their parents and ongoing education from their teachers (29, 30).

As recommended by professional associations, PATF should not be applied routinely in dental practices. A patient's susceptibility to caries must first be determined, after which a plan of appropriate preventive care can be designed. Surfaces at risk of caries should also be considered

because PATF is more effective against caries of smooth surfaces than it is against caries of pits and fissures. The frequency of fluoride application depends on the individual risk but must be at least every 6 months, when indicated (13, 41). Hidalgo is one of the states of Mexico in which the water in certain regions contains fluoride (Zimapán: 0.01 to 1.10 ppm, and Tulancingo Valley: 0.10 to 1.20 ppm) (42). In our region of study, fluoridated salt is a widely available commercial product. Therefore, an evaluation of the caries risk in children (before their having had an available topical fluoride applied) is necessary because

Table 2. Bivariate analysis of the prevalence of DHSU-PATF with independent variables of the study (n = 1,404).

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Variable	No PATF	PATF	OR (95% CI)	p value					
Child's Age	8.99±1.98	8.44±2.16	0.86 (0.77 – 0.98)	0.023					
Mother's Age	34.88±6.08	35.10±5.77	1.01 (0.97 – 1.05)	0.764					
Sex									
Female	688 (95.0)	35 (5.0)	1*						
Male	665 (94.9)	36 (5.1)	1.03 (0.64 - 1.66)	0.893					
Mother's Schooling									
Less than high school	435 (96.2)	17 (3.8)	1*						
High school or more	898 (94.3)	54 (5.7)	1.54 (0.88 – 2.68)	0.129					
Father's Schooling									
Less than high school	411 (96.0)	17 (4.0)	1*						
High school or more	888 (94.4)	53 (5.6)	1.44 (0.82 – 2.52)	0.198					
Health Insurance ⁺									
Uninsured	417 (96.3)	16 (3.7)	1*						
Social security	692 (95.2)	35 (4.8)	1.32 (0.72 – 2.41)	0.370					
Other governmental									
social security	57 (83.8)	11 (16.2)	5.03 (2.22 – 11.37)	0.000					
Private insurance	43 (87.8)	6 (12.2)	3.64 (1.35 – 9.78)	0.011					
Seguro Popular	124 (97.6)	3 (2.4)	0.63 (0.18 – 2.19)	0.469					
Automobile at Home									
Yes	823 (94.5)	48 (5.5)	1*						
No	481 (95.4)	23 (4.6)	0.82 (0.49 – 1.36)	0.445					
SEP (household appliances)									
1st quartile	346 (98.6)	5 (1.4)	1*						
2nd quartile	336 (95.4)	16 (4.5)	3.29 (1.19 – 9.09)	0.021					
3rd quartile	323 (92.0)	28 (8.0)	5.99 (2.29 – 15.72)	0.000					
4th quartile	328 (93.7)	22 (6.3)	4.64 (1.74 – 12.40)	0.002					
SEP (housing characteristics)									
1st quartile	342 (96.1)	14 (3.9)	1+						
2nd quartile	342 (96.6)	12 (3.4)	0.86 (0.39 – 1.88)	0.701					
3rd quartile	319 (92.5)	26 (7.5)	1.99 (1.02 – 3.88)	0.043					
4th quartile	330 (94.6)	19 (5.4)	1.41 (0.69 – 2.85)	0.344					
Knowledge of Oral Health									
Low	458 (97.9)	10 (2.1)	1*						
Medium	445 (95.1)	23 (4.9)	2.37 (1.11 – 5.03)	0.025					
High	430 (91.9)	38 (8.1)	4.05 (1.99 – 8.22)	0.000					
Perception of Child's Oral Health									
Very bad/bad	155 (98.1)	3 (1.9)	1*						
Regular	604 (95.1)	31 (4.9)	2.65 (0.80 – 8.79)	0.111					
Good/very good	574 (93.9)	37 (6.1)	3.33 (1.01 – 10.94)	0.048					
Brushing Frequency (guardian/									
parent)									
Less than once a day	148 (99.3)	1 (0.7)	1*						
At least once a day	1,185 (94.4)	70 (5.6)	8.74 (1.20 – 63.40)	0.032					

*Category of reference. †The social security institutions in Mexico serve 2 groups: families of government workers with insurance funded by the government (Institute of Social Security and Services of State Workers [ISSSTE]) and workers in private businesses (Mexican Institute of Social Security [IMSS]). The Army (Secretaria de la Defensa Nacional [SEDENA]), the Navy (Secretaria de Marina [SEMAR]), and the national oil company (Petróleos Mexicanos [PEMEX]) comprise a subsystem that is more complete and provides services with greater coverage.

overexposure to fluoride is possible and would present negative consequences to the health of an individual so exposed.

This study has some limitations. The cross-sectional design of the study did not allow us to determine the temporality of the associations between the independent variables and outcomes. Another limitation was that the varying oral health statuses of the participants were not known, making it impossible to determine whether any given individual would have benefited from PATF treatment. Another limitation was that the oral health status was not known, and therefore PATF would not be appropriate for everyone. Finally, other factors that could have influenced the use of services were not included in the analysis. Among the strengths of our study was the limited availability of information related to preventive oral health services in Mexico. One of the first steps in planning oral health services is to collect baseline measures to establish goals and targets for programs and policies that are designed to improve the population's health.

Conclusions

In conclusion, the frequency of DHSU-PATF reported in this study was low. This frequency is associated with a number of socioeconomic and behavioral factors, which should guide treatment plans that include PATF for children at oral health service centers.

Resumen

Objetivo: Identificar los factores asociados a la utilización de servicios de salud bucal para la aplicación tópica de fluoruro (USSB-ATF) en escolares de 6 a 12 años de edad. Material y Métodos: Se realizó un estudio transversal en escolares de 15 escuelas públicas de Pachuca, México. La variable dependiente fue la visita al dentista para recibir aplicación profesional de fluoruro tópico en el último año, la cual estuvo dicotomizada como (0) No USSB-ATF y (1) Sí USSB-ATF. El análisis se realizó en Stata 11.0. Resultados: La prevalencia de USSB-ATF fue del 5.1%. La frecuencia de USSB-PATF fue menor entre los niños más pequeños (RM=0.86); pero mayor entre los niños cuyas familias tenían seguro de salud [seguro privado (RM=3.64), o compañía petrolera mexicana/Defensa/Marina (RM=5.03)]; entre los niños con tutores/padres con mejor conocimiento sobre la salud bucal [Medio (RM=2.37) y Alto (RM=4.05)]; entre los niños cuyos tutores/padres tenían una buena/muy buena percepción de la salud oral del niño (RM=3.33); y con mayor frecuencia de cepillado de dientes (RM=8.74). La USSB-ATF también fue mayor en los niños con la mejor posición socioeconómica [(2º cuartil (RM=3.29), 3º cuartil (RM=5.99) y 4º cuartil (RM=4.64)]. Conclusiones: La frecuencia de USSB-ATF reportada en este estudio fue baja, la cual se encuentra asociada con algunos factores socioeconómicos y conductuales. Esto nos da pauta a crear o mejorar los esquemas de aplicación tópica de fluoruro en el sistema de salud mexicano público y privado.

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