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Toothpaste use in children under 12 years of age in Peru during the years 2019-2021: a multivariate analysis

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ABSTRACT

Objective: To determine the use of toothpaste in Peruvian children under 12 years of age during the period 2019-2021. **Materials and methods:** Cross-sectional study where the records of the Demographic and Family Health Survey-ENDES (from 2019 to 2021) were used to collect information on oral health. The results were examined according to the study variables, and statistical analyses were performed. **Results:** A total of 98.89% (n = 81,668) of Peruvian children under 12 years of age used toothpaste in the period 2019-2021; however, its use decreased over the years, finding statistically significant differences. The use of fluoride toothpaste with a minimum of 1,000 ppm increased over the years, finding statistically significant differences. In the multivariate analysis there was a positive association between the year 2020 and the use of fluoride toothpaste with a minimum of 1,000 ppm (aPR = 1.04; 95% CI: 1.01-1.07; p = 0.004). A positive association was also found between the year 2021 and the use of fluoride toothpaste with a minimum of 1,000 ppm (aPR = 1.12; 95% CI: 1.10-1.15; p < 0.001). **Conclusions:** There is an association between the use of toothpaste and year, natural region, area of residence, place of residence, altitude and age; in addition to association between the use of fluoride toothpaste with a minimum of 1,000 ppm and year, natural region, area of residence, place of residence, wealth index and age.

Keywords: dentifrice; child; COVID-19.

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INTRODUCTION

Oral diseases constitute a considerable public health burden in many countries, and the most frequent is dental caries. It can occur throughout life. It is chronic, dynamic and multifactorial, affecting approximately 2 billion people with permanent dentition and 520 million children with deciduous dentition (1). Low- and middle-income nations mostly have a high prevalence of dental caries, mainly due to poor fluoride exposure, reduced access to oral health care services, and the affordability and availability of sugar-rich foods (2).

At the time of oral hygiene, one of the protective factors against dental caries is fluoride toothpaste or toothpaste (3), which is recommended to contain an optimal fluoride level of 1,000 to 1,500 ppm to promote remineralization and regression of the disease (4). Current evidence recommends toothbrushing with toothpaste twice a day to prevent dental caries, a result that is enhanced if supervised (5, 6). Early initiation of tooth brushing is important to reduce the development of childhood caries and should be performed as soon as the first deciduous teeth erupt (3).

In March 2020, the World Health Organization (WHO) announced the onset of the pandemic due to the emergence of SARS-CoV-2, a virus causing coronavirus 2019 (COVID-19). In the context of the health crisis, dental services were closed until May of the same year (7), probably triggering changes in access or timely treatment, in oral hygiene, and could even limit counseling on good eating habits, especially in a population as vulnerable as the pediatric one (3). During this period, proper oral health management and oral hygiene practices in this age group became crucially important (8), so we must consider possible changes before, during and after confinement.

Prior to the pandemic, the use of fluoride toothpastes was limited in low-income populations living in urban areas in several countries. In addition, parental supervision of this hygiene practice is important; however, their lack of knowledge hinders them from fulfilling this role (9-14). In some countries, the use of fluoride toothpastes is a low-cost resource (10), important for the prevention of dental caries, and its application from an early age could minimize its risk. However, its use could have been modified due to the COVID-19 pandemic. Given the limited evidence on this topic, the objective of this study was to determine the use of toothpaste in Peruvian children under 12 years of age during the period 2019-2021.

MATERIALS AND METHODS

The type of study was cross-sectional, and the population was constituted with information from the Demographic and Family Health Survey (ENDES) database prepared by the National Institute of Statistics and Informatics (INEI) of Peru, which constituted the secondary source of data with respect to the years 2019, 2020 and 2021. Only records of children under 12 years of age were considered at the national level, with the final sample size being 34,196 records for 2019, 16,813 for 2020, and 32,023 for 2021 (15-17).

This investigation included records of children under 12 years of age from the Demographic and Family Health Survey database for the years 2019, 2020 and 2021 and who used toothpaste, eliminating records that did not have complete data. The dependent variables were the use of toothpaste and the use of toothpaste with a minimum of 1,000 ppm. The independent variable was the year of application of the survey; and the covariates were the natural region of residence, area of residence, altitude of residence, place of residence, wealth indicator, possession of health insurance, age and sex.

We accessed the INEI website, we downloaded the databases, we combined (merged) them, and the incomplete records were eliminated. The information obtained was exported to Stata SE/15.1, considering a confidence level of 95% and a $p < 0.05$. Descriptive analysis and bivariate analysis were performed using the chi-square statistical test. In the multivariate analysis, Poisson logistic regression was used to obtain crude (PR) and adjusted (aPR) prevalence ratios. The covariates considered in the adjusted models were those that previously reported a bivariate association: natural region, area of residence, place of residence, wealth index, health insurance tenure, age and sex. The `svy` command was used to perform the calculations considering the complex sampling design to obtain representative approximations. The study was accepted and approved (August 15, 2022, with code SIDISI 209325) by the Integrated Research, Science and Technology Management Unit (UIGICT) of the Facultades de Medicina, Estomatología y Enfermería from Universidad Peruana Cayetano Heredia (UPCH), as well as by the Institutional Ethics Committee of the same university (CIE-UPCH).

RESULTS

It was observed that 98.89% ($n = 81,668$) of the study population used toothpaste; however, the use decreased

over the years. Therefore, in 2019, 99.01% (n = 33,585) was registered. In 2020, it was 98.93% (16,545) and in 2021 it decreased to 98.72% (n = 31,538). Statistically significant differences were found (p = 0.031). In addition, 78.79% (n = 46,913) used fluoride toothpaste with a minimum of 1,000 ppm, and its amount increased with the years, presenting 76.65% (n = 17,846), 78.55% (n = 9,517) and 81.46% (n = 19,550) in the years 2019, 2020 and 2021, respectively. Statistically significant

differences were also found (p < 0.001). The sample corresponded mainly to Lima Metropolitana with 32.07% (n = 5,905); 77.38% (n = 33,037) resided in urban areas; 32.07% (n = 5,905) lived in the capital; 78.62% (n = 34,614) lived less than 2,500 meters above sea level; 22.8% (n = 12,060) belonged to the poor quintile; 76.62% (n = 67,508) had health insurance; 72.77% (n = 44,589) were male; and 60.84% (n = 39,918) were aged 6 to 11 (Table 1).

Table 1. Use of toothpaste according to characteristics of Peruvian children under 12 years of age.

Variable	Total		Use of toothpaste				P*	Use of fluoride toothpaste with a minimum 1,000 ppm				P*
			Yes		No			Yes		No		
	n	%	n	%	n	%		n	%	n	%	
Total	83,032	100.00	81,668	98.89	1,364	1.11		46,913	78.79	13,896	21.21	
Year												
2019	34,196	42.90	33,585	99.01	611	0.99		17,846	76.65	6,583	23.35	
2020	16,813	21.28	16,545	98.93	268	1.07	0.031	9,517	78.55	2,806	21.45	<0.001
2021	32,023	35.82	31,538	98.72	485	1.28		19,550	81.46	4,507	18.54	
Natural region												
Lima Metropolitana	5,905	32.07	5,828	99.38	77	0.62		3,064	75.5	1,196	24.5	
Rest of the coast	14,083	26.28	13,777	98.63	306	1.37	<0.001	8,015	78.93	2,887	21.07	<0.001
Highlands	15,716	25.85	15,369	98.37	347	1.63		7,703	78.39	2,917	21.61	
Rainforest	12,157	15.80	12,010	99.17	147	0.83		7,478	85.59	1,687	14.41	
Area of residence												
Urban	33,037	77.38	32,413	98.98	624	1.02	0.002	18,320	77.71	6,564	22.29	<0.001
Rural	14,824	22.62	14,571	98.58	253	1.42		7,940	82.88	2,123	17.12	
Place of residence												
Capital	5,905	32.07	5,828	99.38	77	0.62		3,064	75.5	1,196	24.5	
Small city	14,038	21.09	13,735	98.64	303	1.36	<0.001	7,901	78.91	2,780	21.09	<0.001
Village	13,094	24.22	12,850	98.74	244	1.26		7,355	79.38	2,588	20.62	
Countryside	14,824	22.62	14,571	98.58	253	1.42		7,940	82.88	2,123	17.12	
Altitude												
<2,500 m a. s. l.	34,614	78.62	34,033	99.03	581	0.97	<0.001	19,828	78.93	6,269	21.07	<0.001
>2,500 m a. s. l.	13,247	21.38	12,951	98.36	296	1.64		6,432	78.24	2,418	21.76	
Wealth index												
Very poor	12,422	20.33	12,209	98.62	213	1.38		6,695	83.99	1,589	16.01	
Poor	12,060	22.8	11,865	98.95	195	1.05		6,993	80.88	2,159	19.12	
Middle	9,135	21.7	8,968	99.04	167	0.96	0.114	5,136	77.21	1,876	22.79	<0.001
Rich	6,858	19.05	6,705	98.86	153	1.14		3,672	75.93	1,563	24.07	
Very rich	4,926	16.12	4,807	98.78	119	1.22		2,545	72.63	1,181	27.37	
Health insurance coverage												
Yes	67,508	76.62	66,451	98.89	1,057	1.11	0.891	38,313	79.07	11,299	20.93	0.198
No	15,524	23.38	15,217	98.88	307	1.12		8,600	77.87	2,597	22.13	

Table 1. (Continuation).

Variable	Total		Use of toothpaste				p*	Use of fluoride toothpaste with a minimum 1,000 ppm				p*
			Yes		No			Yes		No		
	n	%	n	%	n	%		n	%	n	%	
Sex												
Male	44,589	72.77	43,833	98.89	756	1.11	0.937	25,026	78.74	7,584	21.26	0.815
Female	38,443	27.23	37,835	98.88	608	1.12		21,887	78.95	6,312	21.05	
Age												
From 0 to 5 years	43,114	39.16	41,876	97.52	1,238	2.48	<0.001	20,317	65.81	9,919	34.19	<0.001
From 6 to 11 years	39,918	60.84	39,792	99.77	126	0.23		26,596	86.41	3,977	13.59	

* p: statistical significance.

Chi-square test.

In the bivariate analysis, an association was found between the use of toothpaste and the variables year, natural region, area of residence, place of residence, altitude and age. In addition, an association was observed between the use of fluoride toothpaste with a minimum of 1,000 ppm and the variables year, natural region, area of residence, place of residence, wealth index and age. In the multivariate analysis,

there was a positive association between the year 2020 and the use of fluoride toothpaste with a minimum of 1,000 ppm, and an aPR = 1.04 (IC 95%: 1.01-1.07; p = 0.004). A positive association was also found between the year 2021 and the use of fluoride toothpaste with a minimum of 1,000 ppm, finding an aPR = 1.12 (95% CI): 1.10-1.15; p < 0.001) (Table 2).

Table 2. Association between toothpaste use and the years 2019-2021 in Peruvian children under 12 years old.

Variable	Use of toothpaste (Yes)						Use of fluoride toothpaste with a minimum of 1,000 ppm (Yes)					
	PR	95% CI	p	aPR ^a	95% CI	p	PR	95% CI	p	aPR ^b	95% CI	p
Year												
2019	Ref.			Ref.			Ref.			Ref.		
2020	0.99	0.99-1.00	0.500	0.99	0.99-1.00	0.862	1.03	0.99-1.03	0.078	1.04	1.01-1.07	0.004
2021	0.99	0.99-0.99	0.010	1.00	0.99-1.00	0.265	1.06	1.04-1.09	<0.001	1.12	1.10-1.15	<0.001
Natural region												
Lima Metropolitana	Ref.						Ref.					
Rest of the coast	0.99	0.98-0.99	<0.001	-	-	-	1.05	1.02-1.08	0.002	-	-	-
Highlands	0.98	0.98-0.99	<0.001	-	-	-	1.04	1.01-1.07	0.010	-	-	-
Rainforest	0.99	0.99-1.00	0.093	-	-	-	1.13	1.10-1.16	<0.001	-	-	-
Area of residence												
Urban	Ref.						Ref.					
Rural	0.99	0.99-0.99	0.004	-	-	-	1.07	1.05-1.09	<0.001	-	-	-
Place of residence												
Capital	Ref.						Ref.					
Small city	0.99	0.98-0.99	<0.001	-	-	-	1.05	1.02-1.08	<0.001	-	-	-
Village	0.99	0.99-0.99	<0.001	-	-	-	1.05	1.02-1.08	<0.001	-	-	-
Countryside	0.99	0.98-0.99	<0.001	-	-	-	1.10	1.07-1.13	<0.001	-	-	-

Table 2. (Continuation).

Variable	Use of toothpaste (Yes)						Use of fluoride toothpaste with a minimum of 1,000 ppm (Yes)					
	PR	95% CI	p	aPR ^a	95% CI	p	PR	95% CI	p	aPR ^b	95% CI	p
Altitude												
<2,500 m a. s. l.	Ref.						Ref.					
>2,500 m a. s. l.	0.99	0.99-0.99	<0.001	-	-	-	0.99	0.97-1.01	0.400	-	-	-
Wealth index												
Very poor	Ref.						Ref.					
Poor	1.01	1.01-1.01	0.035	-	-	-	0.96	0.94-0.98	0.001	-	-	-
Middle	1.01	1.01-1.01	0.012	-	-	-	0.92	0.89-0.94	<0.001	-	-	-
Rich	1.00	0.99-1.01	0.181	-	-	-	0.90	0.88-0.93	<0.001	-	-	-
Very rich	1.00	0.99-1.01	0.417	-	-	-	0.86	0.83-0.90	<0.001	-	-	-
Health insurance coverage												
Yes	Ref.						Ref.					
No	0.99	0.99-1.00	0.891	-	-	-	0.86	0.96-1.01	0.205	-	-	-
Sex												
Male	Ref.						Ref.					
Female	0.99	0.99-1.00	0.937	-	-	-	1.00	0.98-1.03	0.814	-	-	-
Age												
From 0 to 5 years	Ref.						Ref.					
From 6 to 11 years	1.02	1.02-1.03	<0.001	-	-	-	1.31	1.29-1.34	<0.001	-	-	-

PR: prevalence ratio; aPR: adjusted prevalence ratio; 95% CI: 95% confidence intervals.

^a Adjusted by natural region, area of residence, place of residence, altitude and age.^b Adjusted for natural region, area of residence, place of residence, wealth index and age.

DISCUSSION

Backed by more than 70 years of research, the benefits of fluoride toothpastes are firmly established. Toothbrushing with fluoride toothpaste is one of the most effective methods in reducing carious lesions in children and adults (4) and it is one of the most important interventions in the history of oral health. It is the key element in preventing and even reversing the onset and progression of dental caries (18), as it maintains a constant low level of fluoride in the oral environment (19). Current evidence highlights the importance of fluoride concentration and its daily frequency in tooth brushing, which inhibits the demineralization process and favors enamel remineralization through the formation of fluorapatite crystals (18, 20).

This study found that the use of fluoride toothpaste with a minimum of 1,000 ppm in Peruvian children increased over the years. This could be due to the fact that toothbrushing is considered a fundamental self-care behavior for the maintenance of oral health (5), as well as oral health education as it can increase

knowledge about fluoride toothpaste and, in turn, improve behavior with respect to the use of fluoride toothpastes (3, 21), and it could also be due to the change in oral health policies (6). At the same time, this study agrees with the findings of Diaz et al. (22), who observed an increase, although minimal, in the use of fluoride toothpaste with a minimum of 1,000 ppm; however, these authors carried out their research some years before the pandemic. Khan et al. (11) reported an increased use of fluoride toothpastes; however, they noted that the use of non-fluoride toothpaste remained at about one-tenth; this may be due to lack of knowledge about the benefits of fluoride. Avenetti et al. (23) found that one-third of caregivers were unsure of fluoride content, while half of them did report fluoride content; these findings could be due to conflicting messages received by families from clinical and nonclinical sources, which is compounded by the marketing of fluoride-free toothpaste claiming that it is "safe for babies." Another study in Australia reported that half of the preschool children used toothpastes with less than 1,000 ppm, one third used non-fluoride toothpaste and almost one tenth used

toothpaste with 1,000 ppm, which was associated with the higher educational level of the parents (24). In Peru, the use of fluoride toothpaste was found to increase during the year 2020 despite the increase in oral health inequalities during the pandemic (25).

According to the results obtained, the use of fluoride toothpaste in the population studied did not show statistical significance. This finding agrees with that reported by Aiuto et al. (26), who demonstrate the great variability in the use of fluoride toothpaste in different countries and population subgroups. According to these researchers, a large part of the sample was unaware of the type of toothpaste used. In the same way, the meta-analysis performed by Kumar et al. (5) indicates that it was not possible to separate the contribution of fluoride in toothpaste because none of the studies provided data to make this possible.

Geographic characteristics were significantly associated with the use of minimum 1,000 ppm paste. The rainforest was the natural region that reported using more fluoride toothpaste with a minimum of 1,000 ppm, as well as people living in rural areas or in the countryside, compared to coastal areas and departmental capitals. This could be due to the fact that the supply of toothpastes in capital cities is very diverse with different concentrations of fluoride, which leads parents to purchase toothpastes with inadequate concentrations of fluoride, since they are marketed with labels "for children" or "kids" (27). Factors such as geographic remoteness, limited exposure to fluoride, access to dental services, affordability and commercial determinants of health have been shown to play an important role in the persistence of oral health inequalities. Corporate action generally determines the availability, advertising and price of items in an attempt to influence decision making to drive consumption of certain products. There is also evidence that these practices target vulnerable populations, such as marketing to children (28-30).

Based on international experience, the Australian national survey reported that more than one-third of children living in rural and remote areas had more untreated dental caries than those living in major cities, due to a multitude of factors such as lack of water fluoridation, socioeconomic status, and shortage of dental services (20).

Sociodemographic characteristics, such as wealth index and age, had a significant association with the use of toothpaste with minimum 1,000 ppm. Most people belonging to the very poor quintile reported

higher use of fluoride toothpaste with a minimum of 1,000 ppm compared to people belonging to the very rich quintile. This could be because people in the very poor quintile use a single toothpaste for all family members (26), while people in the very rich quintile purchase toothpastes differentiated according to the age of their family members, even acquiring fluoride toothpastes "for children" with less than 1,000 ppm (31, 32).

In terms of age, it was observed that more than half of the children aged 0 to 5 years did use fluoride toothpaste with a minimum of 1,000 ppm, as most children aged 6 to 11 years did. Factors such as socioeconomic status, family educational level and economic income are negatively related to the incidence of dental caries (32). Trinh et al. (33) evaluated the relationship between toothbrushing behavior and sociodemographic characteristics in Australian children. Researchers found that children who lived in high-income families, who were highly educated and who lived in households with two or more children started brushing their teeth at an earlier age.

During the development of the present study, there were limitations. Although national surveys represent important sources of information, they present biases inherent to their methodology, either during the data collection process (respondent recall and information bias) or due to the high variability of the sample size, because not all subjects had records in the study variable. Despite these limitations, this research study is the first in Peru to explore the use of toothpastes in Peruvian children under 12 years of age during the period 2019-2021, with national representativeness, using standardized questionnaires for the data collection process.

The use of toothpastes is a common hygiene practice among the population, but the importance of using fluoride toothpastes with a minimum of 1,000 ppm should be emphasized and promoted as an effective method for the prevention of dental caries. If this practice is established at an early age, it could become a lifelong habit that would help reduce the possibility of suffering dental caries; however, its use is affected by the high cost in some developing countries such as ours. Its use should be tax-exempt as a means of universal oral health prevention, as it is an undeniably effective health investment that is easy for the government to implement. If 1% is reduced in taxes, access to fluoride toothpastes will increase by approximately 1% (13, 19). Awareness of the benefits of using fluoride toothpastes

with a minimum of 1,000 ppm should be raised among all oral health stakeholders.

CONCLUSIONS

98.89% of Peruvian children under 12 years of age do incorporate toothpaste in their oral hygiene during the period 2019-2021; however, its use has decreased over the years, finding statistically significant differences. On the other hand, 78.79% used fluoride toothpaste with a minimum content of 1,000 ppm and its use increased over the years, also showing statistically significant differences. Finally, the year was positively associated with the use of toothpaste containing a minimum of 1,000 ppm fluoride, adjusted for the covariates natural region, area of residence, place of residence, wealth index and age.

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