TOOTH BRUSHING AND FLUORIDE LEVELS IN TOOTHPASTE USED BY PERUVIAN CHILDREN UNDER 12 YEARS OLD

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ABSTRACT

Secondary analysis of data on 41,330 children aged one to 11 from the Demographic and Family Health Survey (ENDES) carried out in 2018. The frequency of brushing and the use of toothpaste were reported according to the level of fluoride (no brushing, adequate, inadequate, did not show/did not use toothpaste, and illegible), according to socioeconomic and geographical variables. The evaluation showed that 7.8% of children did not brush their teeth; there were significant percentage differences (p <0.001) in the use of toothpaste with inadequate fluoride concentration between the extreme categories of the variables: age (12.3%), use of dental services (7.7%), educational level of the person responsible (20.4%), wealth index (17.8%), geographical domain (11.3%), and area of residence (9.1%). A considerable percentage of Peruvian children do not brush their teeth; in addition, a large number of children who brush use toothpastes with a fluoride content that has no preventive effect.

Keywords: Toothbrushing; Toothpastes; Child; Child, Preschool; Peru (source: MeSH NLM).

INTRODUCTION

According to the World Health Organization, oral diseases are the most common group of non-communicable diseases [(1)]. Worldwide, almost four billion people suffer from oral-cavity diseases, being dental caries —which affects 500 million children [(2)]— the most prevalent one. In Peru, the prevalence of caries varies between 80% and 90% in children between the ages of three and 15 [(3,4)], so it is necessary to strengthen and promote the various preventive-promotional measures that have shown to be effective against this disease [(5)].

The most effective measure for the prevention of caries is exposure to fluoride [(5)], which inhibits bacterial production of acids and slows demineralization of tooth enamel [(5)]. Therefore, the practice of brushing with fluoride toothpaste is one of the most cost-effective and recommended methods [(5-7)]. Fluoride toothpastes that are effective in reducing the risk of caries contain more than 1000 parts per million (ppm) of fluoride and should be used in appropriate amounts according to the age [(6,8)].

In 2001, Peru approved the *"Norma Técnica Sanitaria para la Adición de Fluoruros en Cremas Dentales, Enjuagatorios y otros productos utilizados en la Higiene Bucal"*, which establishes that toothpastes for children under six years of age must contain between 250 and 550 ppm of fluoride, and concentrations greater than 1100 ppm of fluoride for adults and children over six years of age [(9)]. Contrary to this norm, in 2017, the *"Guía de Práctica Clínica para la Prevención, Diagnóstico y Tratamiento de la Caries Dental en Niñas y Niños"* of the Peruvian Ministry of Health (MINSA) recommends the use of toothpastes with concentrations of 1000 to 1500 ppm of fluoride from the first dental eruption [(10)]. However, despite the evidence and recommendations [(6,8,10)], some studies report that almost half of the toothpastes sold in Lima had lower amounts of fluoride than recommended [(11,12)].

Although brushing with fluoride toothpaste has increased worldwide in recent decades, the lowest-income population, those living in rural areas, those with lowest levels of education, and those with less access to oral health services use toothpaste with inadequate concentrations of fluoride (less than 1000 ppm) [(5,13,14)].

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The codes included in the article are available in the GitHub repository: https://github.com/ahernandezv/Fluor_ENDES_Peru y OSF: https://osf.io/tdk83/

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This could be the result of lack of knowledge by the population, health staff providing outdated information, and inability to acquire toothpastes with adequate amounts of fluoride, putting the population at greater risk of suffering cavities [7]. Likewise, 15% of Peruvian children under the age of 12 do not brush their teeth daily [15].

In Peru, the 2018 *"Encuesta Demográfica y de Salud Familiar"* (ENDES, in Spanish) gathers information on brushing practice and fluoride levels in toothpaste; however, this information is not available in its annual report (https://bit.ly/30OyM2S). This information would be important in order to focus promotion strategies at the level of the population, dentists, manufacturers, and regulators. Therefore, this study aimed at analyzing the distribution of brushing and the level of fluoride in toothpaste according to socioeconomic and geographical variables in Peruvian children under the age of 12, using the 2018 ENDES.

KEY MESSAGES

Research Motivation. The current oral health prevention guide in Peru establishes the use of toothpaste with fluoride concentration greater than 1000 ppm in children. There is currently no nationally representative information available regarding brushing practice and fluoride level in toothpastes used by children under 12 years of age.

Main Findings. 7.8% of Peruvian children under 12 years of age do not brush their teeth, and many of those who do use toothpaste with inadequate flouride content.

Implications. There is a need to strengthen the promotion of brushing in children as well as the regulation of fluoride levels in toothpaste marketed in Peru.

THE STUDY

The 2018 ENDES is a population-based survey with a sample size of 36,760 dwellings (35,502 interviewed dwellings) that provides information on the demographic dynamics and health status of the Peruvian population. The target population consisted of: a) Private households and their members, habitual residents and those who, although not being residents, stayed in the dwelling the night before the interview; b) One person aged 15 years old or older for each private household; c) All children under 12 years old. More details on the design and sampling of the 2018 ENDES are available in the survey datasheet (https://bit. ly/30OyM2S).

A total of 45,487 children under the age of 12 participated in the 2018 ENDES. Our analysis included a subsample of children between one and 11 years of age (n=41,330) with complete information on all variables of interest (Figure 1). The selection of the age group evaluated was based on the recommendation to start brushing with fluoride toothpaste from the eruption of the first tooth, according to the current clinical practice guide and its application throughout the country [10]. Children under one year of age were excluded, considering that the age of the first tooth eruption is variable (six to ten months from birth).

The practice of brushing with the use of toothpaste according to the level of fluoride was considered the variable of interest, defining the following categories: not brushing, adequate level of fluoride (1000 ppm or more), inadequate level of fluoride (less than 1000 ppm), did not show paste/not use paste, and illegible level of fluoride (includes: no information, fuzzy number, value other than ppm, and other). The fluoride level was determined by the interviewers by direct observation of the toothpaste tube (textual question: Could you please show me the toothbrush and the toothpaste with which (NAME) brushes his/her teeth?), and tooth brushing was reported by the caregiver to the question "Does (NAME) brush his/her teeth using a toothbrush?". The stratification variables were the sex of the minor, age of the minor (categorized in 1-5 years and 6-11 years), use of dental services (less than six months, and more than six months), having health insurance (yes/no), educational level of the person responsible for the minor (no educational level, elementary, secondary and higher), wealth index (lower quintile, second quintile, intermediate quintile, fourth quintile, upper quintile), geographical region (Metropolitan Lima, rest of Coast, Highlands, Jungle), and area of residence (urban/rural).

The databases were downloaded from the website http://iinei.inei.gob.pe/microdata/, imported and processed with R (version 3.6.1, R Foundation for Statistical Computing, Vienna, Austria) and RStudio (version 1.2.1335, RStudio, Inc., Boston, MA). All estimates included the characteristics of the complex sample design and the weighting factors of the 2018 ENDES to show weighted proportions with 95% confidence intervals for each of the included categories. For the analysis of differences between categories of variables, a linear combination of the parameters was used by means of a t-test, setting a value of $p<0.05$ as statistically significant.

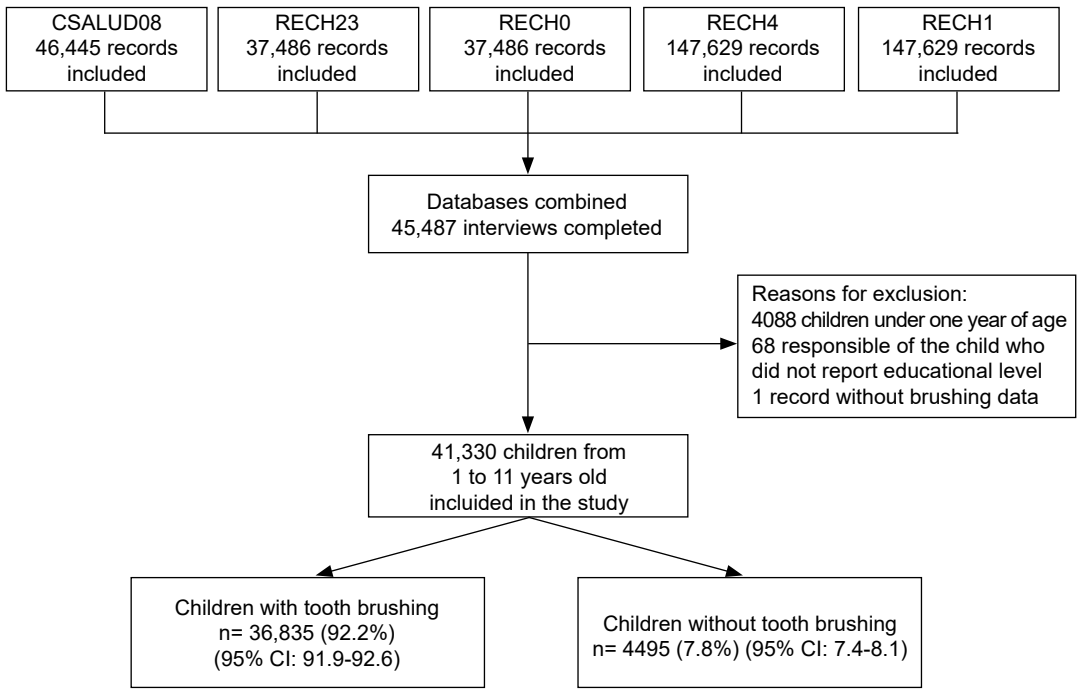

Figure 1. Flowchart showing the selection of participants included in the study

The script including the construction of the variables, archives and codes used for the analysis is available in GitHub https://github.com/ahernandezv/Fluor_ENDES_Peru and OSF https://osf.io/tdk83/, which allows to reproduce the results.

The study did not require the approval of an ethics committee as it is an analysis of secondary data that are in the public domain and freely accessible (http://iinei.inei.gob.pe/microdatos/), which does not allow the identification of participants.

RESULTS

Of the total number of children included in the study (41,330), 50.8% were boys, 55.3% belonged to the 6 to 11-year-old age group, 49% were poor or very poor, 15.3% were not affiliated to health insurance, and 74.4% lived in the urban area (Table 1).

In addition, the highest percentages of non-teeth brushing were observed in one to five year old children (15.8%), those who had received dental care more than six months ago (9.9%), younger children whose guardians did not have any educational level (12.7%), those belonging to the lowest wealth quintile (12.2%), and residents of the Highlands (9.7%) and rural areas (11.9%) (Table 2).

Higher percentages of toothpaste use with inadequate fluoride concentration were shown in one to five year old children (27.0%), those who received dental care during the six months prior to the survey (25.3%), children of parents with higher educational level (28.8%), children belonging to the top wealth quintile (29.5%), residents of Metropolitan Lima (23.7%), and residents of urban areas (22.4%) (Table 2). Statistically significant percentage differences ($p < 0.001$) in the use of toothpaste with inadequate fluoride concentration between the extreme categories of the variables age (12.3%), use of dental care services (7.7%), educational level of the person responsible (20.4%), household wealth index (17.8%), geographical region of residence (11.3%), and area of residence (9.1%) were also evidenced (Table 2).

DISCUSSION

The findings show that 7.8% of Peruvian children under 12 years of age do not brush their teeth. There was also evidence of gradients in the use of toothpaste with inadequate fluoride concentration among the extreme categories of the variables age, use of dental care services, educational level of the person responsible, household wealth index, geographical region of residence, and area of residence. These results account for the low compliance with international recommendations and

Table 1. Characteristic of the sample. Demographic and Family Health Survey (ENDES) 2018 (n=41,330)

Characteristic	n	% (95% CI) *
Sex		
Male	20,966	50.8 (50.1-51.5)
Female	20,364	49.2 (48.5-49.9)
Age (years)		
1-5	23,296	44.7 (44.1-45.2)
6-11	18,034	55.3 (54.8-55.9)
Use of dental care service (months)		
≤ 6	13,196	31.9 (31.1-32.7)
> 6	28,134	68.1 (67.3-68.9)
Having health insurance		
Yes	36,041	84.7 (84.0-85.4)
No	5289	15.3 (14.6-16.0)
Educational level of the person in charge		
No educational level	1273	2.8 (2.5-3.1)
Elementary	11,048	24.1 (23.3-25.0)
Secondary	17,722	42.7 (41.7-43.7)
Higher	11,287	30.4 (29.5-31.3)
Household wealth index		
Very poor	13,799	25.5 (24.6-26.4)
Poor	10,656	23.3 (22.4-24.2)
Medium	7555	20.0 (19.2-20.8)
Rich	5450	16.9 (16.1-17.7)
Very rich	3870	14.3 (13.5-15.1)
Geographical region of residence		
Metropolitan Lima	4682	29.9 (28.9-30.8)
Rest of the Coast	11,596	25.7 (24.7-26.7)
Highlands	14,343	27.2 (26.1-28.4)
Jungle	10,709	17.2 (16.3-18.1)
Area of residence		
Urban	27,069	74.4 (73.7-75.1)
Rural	14,261	25.6 (24.9-26.3)

* The estimates included the weighting factor and sample specifications of the 2018 ENDES.
95% CI: 95% confidence interval

MINSA on the adequate fluoride content in toothpastes to prevent tooth decay, even from the time of the first dental eruption [6-8,10].

Children aged one to five years old presented a higher frequency of not brushing than those aged six to 12 years old, a trend previously reported by other studies [16,17]. This could be attributed to the fact that children at that age require help to brush, and their parents may not be aware of it and may downplay the importance of brushing in the deciduous dentition [18]. The percentage of not tooth brushing was higher in those who did not received dental care within the previous six months, similar to the findings reported in a study on Mexican children aged six to 12 years, which reported a higher probability of frequent brushing in those who received dental care in the 12 months prior to the study [19]. According to these findings, periodic contact with the dentist would help to reinforce the brushing habit in children.

On the other hand, the percentage of non tooth brushing was higher in children whose parents had a lower level of education, consistent with what was reported in other studies where a lower level of education of the head of household parent is associated with a late start of dental brushing, and the frequency and duration of brushing of their children [20]. Likewise, a lower level of family education is related to a lower index of household wealth, a characteristic that in our country is concentrated in the Highlands and in rural areas (https://bit.ly/2rsIuaO). This is consistent with our findings, as the non tooth brushing was higher in the lower wealth quintile, and in those children residing in the Highlands, and in rural areas.

The use of toothpastes with inadequate fluoride concentration was higher by 12.3% in younger children, possibly due to the validity of the 2001 technical norm, which establishes the use of pastes with 250-550 ppm of fluoride content in children under six years of age [9], and there may be dentists who still recommend this type of pastes to their pediatric patients. In addition, parents may purchase toothpastes with inadequate concentrations of fluoride, as these are generally labeled "for children" or "kids", and their use is recommend for children under six years of age [11,12]. Also, children who received dental care in a period of less than six months had a higher frequency of inappropriate fluoride use, which may be related to information provided by dentists that may be based on the current standard.

The highest rates of use of inadequate concentrations of fluoride were found in those children of parents with a higher level of education (28.8%), and with a higher index of wealth in the household (29.8%), possibly because this sector of the population has greater economic capacity to acquire toothpastes for children, which are more expensive and mostly contain inadequate amounts of fluoride [11,12]. In addition, the geographic region that presented the greatest amount of inappropriate use was Metropolitan Lima (23.7%) and the urban area (22.4%). The reason behind this distribution could be the high number of toothpastes with inadequate fluoride content that are sold in the city of Lima [11,12], a situation similar to that reported in other cities on the Peruvian coast [21,22].

In interpreting our results, we should take into consideration that the data used was obtained through

Table 2. Brushing and fluoride level in toothpaste. Demographic and Family Health Survey (ENDES), 2018

Characteristic	Brushing and fluoride level in toothpaste, % (95% CI)					Difference A	Difference B
	Non brushing	Adequate	Inadequate	No show/use	Illegible	Difference (P value) *	Difference (P value) *
Total	7.8 (7.4-8.1)	44.2 (43.2-45.1)	20.1 (19.3-20.8)	25.0 (24.2-25.9)	2.9 (2.7-3.2)	---	
Sex of child							
Male	7.8 (7.4-8.3)	44.9 (43.7-46.0)	19.6 (18.7-20.5)	24.6 (23.6-25.5)	3.1 (2.7-3.4)	0.1 (0.709)	1.0 (0.800)
Female	7.7 (7.3-8.2)	43.4 (42.3-44.5)	20.6 (19.6-21.5)	25.5 (24.5-26.6)	2.8 (2.4-3.1)		
Age of child (years)							
1-5	15.8 (15.2-16.5)	28.5 (27.5-29.4)	26.9 (26.0-27.8)	23.9 (23.1-24.8)	4.9 (4.5-5.4)	14.5 (<0.001)	12.3 (<0.001)
6-11	1.3 (1.0-1.6)	56.8 (55.6-58.1)	14.6 (13.7-15.5)	26.0 (24.9-27.1)	1.3 (1.1-1.6)		
Use of dental care service (months)							
≤ 6	3.1 (2.8-3.5)	44.4 (43.0-45.9)	25.3 (24.0-26.5)	24.1 (22.7-25.3)	3.1 (2.7-3.6)	6.8 (<0.001)	7.7 (<0.001)
> 6	10.0 (9.5-10.4)	44.0 (42.9-45.1)	17.6 (16.8-18.5)	25.6 (24.6-26.5)	2.8 (2.5-3.1)		
Having health insurance							
Yes	7.9 (7.5-8.2)	43.9 (43.0-44.9)	20.4 (19.6-21.1)	24.9 (24.0-25.7)	3.0 (2.7-3.3)	0.7 (0.263)	1.8 (0.076)
No	7.3 (6.5-8.2)	45.4 (43.0-47.7)	18.5 (16.6-20.4)	26.1 (24.0-28.2)	2.7 (2.1-3.3)		
Educational level of the person in charge							
No educational level	12.7 (10.0-15.5)	35.9 (31.2-40.6)	8.4 (6.19-10.5)	42.4 (37.7-47.0)	0.6 (0.02-1.2) †	7.0 (<0.001)	20.4 (<0.001)
Elementary	9.7 (8.9-10.5)	45.1 (43.2-46.9)	11.7 (10.5-12.8)	32.1 (30.6-33.9)	1.4 (1.0-1.8)		
Secondary	7.8 (7.4-8.3)	46.6 (45.2-48.0)	19.4 (18.3-20.5)	23.8 (22.6-25.1)	2.4 (2.0-2.7)		
Higher	5.7 (5.2-6.3)	40.7 (39.2-42.3)	28.8 (27.4-30.3)	19.6 (18.2-21.0)	5.2 (4.6-5.8)		
Household wealth index							
Very poor	12.2 (11.2-13.1)	39.7 (38.0-41.5)	11.7 (10.7-12.7)	35.1 (33.5-36.7)	1.3 (1.0-1.6)	7.2 (<0.001)	17.8 (<0.001)
Poor	7.4 (6.8-8.1)	49.0 (47.3-50.8)	18.2 (16.9-19.5)	23.1 (21.6-24.7)	2.2 (1.7-2.7)		
Medium	6.2 (5.6-6.9)	47.6 (45.6-49.7)	21.7 (20.3-23.2)	21.7 (20.0-23.3)	2.8 (2.2-3.3)		
Rich	5.8 (5.1-6.5)	42.1 (39.8-44.4)	25.3 (23.1-27.5)	22.7 (20.7-24.7)	4.1 (3.3-4.9)		
Very rich	5.0 (4.1-5.9)	41.6 (39.0-44.3)	29.5 (27.2-31.9)	18.1 (15.9-20.2)	5.8 (4.8-6.8)		
Geographical region of residence							
Metropolitan Lima	5.9 (5.2-6.6)	41.5 (39.3-43.8)	23.7 (21.9-25.6)	24.1 (22.1-26.2)	4.8 (4.0-5.5)	3.5 (<0.001)	11.3 (<0.001)
Rest of coast	6.8 (6.3-7.4)	49.9 (48.3-51.4)	20.6 (19.2-21.9)	20.2 (19.0-21.5)	2.5 (2.1-2.9)		
Highlands	9.7 (9.1-10.4)	37.0 (35.5-38.4)	20.5 (19.3-21.6)	30.9 (29.6-32.3)	1.9 (1.6-2.2)		
Jungle	9.4 (8.3-10.5)	51.6 (49.6-53.5)	12.4 (11.3-13.5)	24.6 (23.0-26.2)	2.0 (1.6-2.4)		
Area of residence							
Urban	6.4 (6.0-6.7)	45.6 (44.5-46.8)	22.4 (21.5-23.3)	22.1 (21.2-23.1)	3.5 (3.1-3.8)	5.6 (<0.001)	9.1 (<0.001)
Rural	11.9 (11.0-12.8)	39.8 (38.1-41.5)	13.3 (12.3-14.4)	33.6 (32.0-35.1)	1.4 (1.1-1.7)		

All estimates included the weighting factor and sampling characteristics of the 2018 ENDES
Difference A: difference between extreme non brushing categories
Difference B: difference between extreme categories of inadequate fluoride quantity in toothpaste
* Obtained by means of a t test
† Estimate with coefficient of variation greater than 15% considered as reference 95% CI: 95% confidence interval

interviews involving possible memory and information biases.

However, the pollsters determined the fluoride level by direct observation of the toothpaste. Furthermore, the information could not be verified for a significant percentage of the assessed subjects, as the participants did not show the toothpaste tube, reported not using it or the information was illegible. Despite the limitations, this is one of the first studies in Peru to explore the use of toothpastes according to fluoride concentrations, with national representation.

In conclusion, a considerable percentage of Peruvian children do not brush their teeth; this situation is more frequent in children under five years of age, those who

did not receive dental care in the six months prior to the survey, children of parents with no educational level, children living in poverty, and residents of the Highlands and rural areas. In addition, a large number of children in our country continue to use toothpastes with inadequate fluoride content, with gradients according to age, use of dental care services, educational level of the person responsible, wealth index in the home, geographical region of residence, and area of residence.

Overcoming this problem requires the establishment of a multi-sectoral policy that acts at the level of all its social actors, starting with the updating of the natural guidance (Ministerial Resolution No. 454-2001-SA/DM), and the regulation of its compliance at the level of manufacturers, by the General *"Dirección General de Medicamentos, Insumos y Drogas"* (DIGEMID, in Spanish). Strengthening the promotion of the recommendation for tooth brushing and the use of toothpastes with a fluoride content greater than 1000 ppm from the university level (training of health professionals), school level (children and adolescents) and MINSA level campaigns aimed at raising awareness among health users and health professionals is also necessary.

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