TREND AND FACTORS ASSOCIATED WITH THE FREQUENCY OF TOOTH BRUSHING IN CHILDREN UNDER TWELVE YEARS OLD, PERU 2013-2018

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ABSTRACT

Objetivos. To determine the trend and factors associated with brushing two or more times per day in children under twelve years of age between 2013 and 2018 in Peru. ***Materials and Methods.*** A cross-sectional study was conducted by secondary analysis of data reported by the Demographic and Family Health Survey (ENDES). Information on children with at least one brushing per day was taken into account, considering as an "Adequate Toothbrushing Frequency" (ATF) for those who reported brushing two to more times per day. Percentage measures were generated by geographical area, health, housing, and household characteristics. Factors associated with an ATF were determined by using binary logistic regression for complex surveys, trend variability was identified by joinpoint regression with a 95% confidence. ***Results.*** In 2013, the ATF was 79.0%, increasing to 83.9% by 2018. Four out of 25 geographic areas were identified as having no variation on the ATF, and four others decreased. All sanitary characteristics showed favoring brushing, emphasizing that not sharing the toothbrush generated a 2.30 OR, 95% CI: 1.46 to 3.60. The natural region, type of place of residence, and wealth index quintile affected the ATF. The ATF was higher as the age group increased. ***Conclusions.*** The percentage of ATF has increased in recent years, being favorably influenced by health aspects; in rural areas, this percentage is significantly lower, something that is also evident in the Highland region.

Keywords: Toothbrushing, Health Surveys, Epidemiologic Factors, Oral Hygiene. (Source: MeSH NLM).

INTRODUCTION

Oral health is paramount for general well-being, in which a healthy and functional dentition throughout life will allow essential human functions such as chewing, smiling, speaking and socializing [1]. Dental caries and periodontal disease are conditions of multifactorial etiology, considered global public health problems [2,3], as they lead the ranking of the most prevalent diseases [4]. These conditions can put at risk the integral development of individuals, limiting them in their basic functions and severely affecting their quality of life [5,6]. However, both diseases can be prevented if the modulating factors are adequately controlled: diet, regular visits to the dentist and disorganization of the biofilm by tooth brushing [7,8].

Brushing should be performed by sanitizing all dental surfaces, tongue and gums at a frequency of at least twice a day, one of which is suggested either before bedtime or ideally 30 minutes after each meal [9]; after these critical periods, the acids produced by the metabolism of the biofilm can accelerate dental demineralization, generating microstructural damage that could later manifest as a clinically visible lesion [3]. It should also be considered that regular visits to the dentist, based on the individual risk of each patient, increase the probability of detecting initial pathological signs; in addition, protective habits such as effective and frequent tooth brushing, use of dental floss and mouthwashes, and a balanced diet are associated with a lower risk of dental caries and periodontal disease [7,10,11].

Inadequate oral hygiene is a predictive factor of periodontal disease, increasing the risk from two to five times when compared to individuals with good hygiene [12]; also, dental loss and the presence of oral pathogens have been associated with systemic non-communicable diseases such as diabetes, pneumonia and circulatory diseases [13-15]. Preventive oral health programs have

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been relegated to isolated initiatives compared to general health; however, promoting healthy habits from an early age can be a cost-effective measure, considering that oral diseases in advanced stages are the fourth most expensive health problem to treat [1,16].

To be able to carry out health promotion measures through effective tooth brushing, it is necessary to know the trends of the Peruvian population, especially in vulnerable groups. The objective of the present work was to estimate the frequency of brushing two or more times a day of Peruvian children under 12 years of age —assessing trends between 2013 and 2018— and to determine the associated factors.

KEY MESSAGES

Research Motivation. In Peru, available studies are focused on subpopulations, which are not representative of the national reality, so the situational panorama on current oral hygiene and its changes over time is unknown.

Main Findings. Over the years, there has been a monotonous increase in the percentage of children with adequate tooth brushing frequency, with significant variations according to regions and some health, housing and household characteristics.

Implications. The specific identification of groups that require more attention would help to implement specific health strategies that guarantee improved hygiene and subsequent oral health.

MATERIALS AND METHODS

STUDY DESIGN AND POPULATION

The study was observational and analytical, framed in the cross-sectional design of repeated measurements at the population level [17]. An analysis of secondary sources was carried out using the databases of the Demographic and Family Health Survey (ENDES), conducted throughout Peru between 2013 and 2018 by the National Institute of Statistics and Informatics (INEI), which are publicly available (http:// iinei.inei.gob.pe/microdatos/). The ENDES unit of analysis are habitual residents of private dwellings on a national level, who have stayed overnight in the dwelling selected the night before the survey, following a probabilistic, stratified and two-stage sample (Conglomerates and Dwellings) [18, 19].

The information from the "Oral Health" section of the Health Questionnaire, which includes the records of children under 12 years of age, was used. To obtain the additional variables, it was necessary to merge the Household Questionnaire files on the "Basic Household Data" and "Household Members" sections, as well as the "Household and Housing Characteristics" section; this process was carried out for each year surveyed separately, and then condensed into a single base.

VARIABLES

The dependent variable was the frequency of tooth brushing, which took dichotomized values (once a day and twice to more times a day), generated after the recoding of variable QS811 ("How many times a day") referring to tooth brushing, which originally comes from the Health Questionnaire; this data is reported by the mother, child or other adult in the household under the following values: once a day, twice a day, three times a day, and four or more times a day. Those children who were in the category "2 to more times a day" of the dependent variable were considered as "Adequate Tooth Brushing Frequency" (ABF). This characteristic was identified according to geographical scope by means of the variable "Geographic Identification" (24 regions and the constitutional province of Callao).

Those variables that could be linked to the ABF were selected as independent variables, grouped into three categories: health, housing and household characteristics. The characteristics of the dwelling were all those that correspond to the geographic location and access to services. The aspects that comprise the characteristics of the dwelling were oriented to the functional organization and aspects of its members; the supplementary material (Annex 1) presents the variables included as defined by the ENDES, as well as the new labels and values assigned for the study.

Among the characteristics of the household, the variable age of the child from the health base was categorized according to clinical application criteria into: 1 to 2 years (infants), 3 to 5 years (preschoolers with deciduous dentition), 6 to 8 years (schoolchildren with mixed dentition who need to be brushed by their parents), and 9 to 11 years (adolescents with mixed dentition who do not need to be brushed by their parents). As a complementary measure, the variables "Number of members in the household" and "Number of rooms" were used to calculate the Overcrowding Index (Not overcrowded, Overcrowded), considering as overcrowded those households in which three or more people shared a room [20]. In addition, as this is a trend-based research, a fourth characteristic was considered, related to the study design and corresponding to the survey-year variable.

STATISTICAL ANALYSIS

Data analysis was performed using the statistical package Stata v14.2 (Stata Corporation, College Station, Texas, USA) considering the complex sample design respecting the stratification and identification of ENDES conglomerates, and using the weighting factor for children under 12 years of age entered into the health questionnaire database; all this preparation was carried out using the svy command.

We identified the percentage and 95% confidence interval (CI) for ABF in children under 12 years old, using Pearson's Chi Square test to assess significant differences according to health, housing and household characteristics within each year evaluated; we used a generalized linear modeling (GLM) with binomial family option and link identity to establish the difference and 95% CI between the 2013 and 2018 ABF percentage. A corrected (relative) difference of this variation was established by adjusting it by the 2013 value (2018-2013 difference / 2013 x 100 value).

The correlation between the ABF in each category was assessed by the year evaluated using the Pearson or Spearman-Brown correlation coefficient test (prior identification of normality by Shapiro-Wilk test) in order to establish whether there was directionality in the changes in the percentage estimate of the ABF over the years. In order to multivariate the factors that modified the ABF, a binary logistic regression [21] was carried out—adjusted to all the independent variables—according to the previously defined characteristics; for this purpose, the register of 140,580 subjects that presented complete data for the characteristics of interest was used. It is important to point out that the multivariate model did not consider the variable "Home with Water Pump" (which assesses the impact of access to water in the home as a support for good hygiene measures), since these are part of a total of 113 variables that serve to establish the Wealth Quintile, which if maintained would generate collinearity and inflation of the variance.

The variability in the behavior of the ABF trend through the years (2013 to 2018) was established with the help of the Joinpoint Desktop software version 4.7.0,0 (Division of Cancer Control and Population Sciences, National Cancer Institute), applying a joinpoint regression of percentages with which the Annual Percent Change (APC) was identified [22,23]. For all inferential tests, both bivariate and multivariate, a statistical significance level of 0.05 was used.

ETHICAL CONSIDERATIONS

As it focused on the evaluation of a secondary database, the present study, did not require prior approval by an ethics committee, since the information was publicly available through the INEI portal.

RESULTS

Of the total of 140,589 children under 12 years of age, 3742 (2.7%) correspond to 2013, 17,596 (12.5%) to 2014, 31,632 (22.5%) to 2015, 28,811 (20.5%) were evaluated for 2016, 28,091 (20.0%) in 2017, and finally 30,717 (21.8%) in 2018. The overall age mean was 6.1 ± 3.0, and the values per year were 6.7 ± 2.8 for 2013, 6.7 ± 2.9 for 2014, 6.0 ± 3.0 for 2015, 6.0 ± 3.0 for 2016 as well, and 6.0 ± 3.0 and 5.9 ± 3.0 for 2017 and 2018, respectively.

The evaluation for ABF by geographical area (Table 1) shows variability in the proportions between regions ($p<0.001$) for each year evaluated; the ABF was not the same throughout the years The most outstanding region was Amazonas (87.1%) in 2013, Pasco (88.6%) and Ica (87.4%) in 2014 and 2015 , and La Libertad between 2016 and 2018 (86.8%, 88.5% and 87.3% respectively). The lowest hygiene performance was found in Cusco (55.0%) in 2013, Puno between 2014 and 2017 (62.7%, 63.6%, 77.0%, and 76.7%), and Ucayali occupied the last position (68.1%) in 2018.

The variability between 2013 and 2018 identifies that the region with the highest percentage increase in ABF was Cusco (35.6%); and other sixteen regions also improved in different scales. Four regions (Ica, Huanuco, Junin, Cajamarca) did not show important variations, while other four regions presented a reduction between -1.0% to -12.5% (Figure 1).

The percentage changes were related to the year evaluated. The Ayacucho region showed the highest correlation coefficient ($r=0.912$ and $p=0.011$); this expresses an accompanied variation increasing through the years. The region with the lowest correlation coefficient was Tacna ($r=-0.018$; $p=0.011$); the data show that the changes are different for each geographical area and have not always been consistent with the passage of years.

The trend analysis (Figure 2) identified an ABF value of 1.06% (95% CI: 0.49%; 1.63%); this analysis shows that

Table 1. Distribution of adequate tooth brushing frequency in children under 12 years according to geographical area, Peru, 2013-2018

Geographical Area	2013 % (95% CI)	2014 % (95% CI)	2015 % (95% CI)	2016 % (95% CI)	2017 % (95% CI)	2018 % (95% CI)	2013 - 2018 difference (95% CI)* %	P value of the difference 2013 - 2018*	Correlation Coefficient**	P value of the Correlation**
Amazonas	87.1 (78.3 to 92.7)	84.6 (80.2 to 88.1)	86.9 (84.1 to 89.2)	85.0 (81.4 to 88.0)	86.2 (83.9 to 88.3)	86.0 (83.5 to 88.2)	-1.1 (-8.5 to 6.3)	0.761	-0.139†	0.793
Ancash	80.9 (71.8 to 87.6)	83.9 (79.0 to 87.8)	83.0 (78.2 to 87.0)	85.2 (81.9 to 88.0)	85.3 (81.6 to 88.3)	85.6 (82.8 to 88.0)	4.7 (-3.7 to 13.0)	0.269	0.885†	0.019
Apurímac	75.8 (66.4 to 83.3)	78.8 (73.8 to 83.1)	84.0 (79.4 to 87.7)	82.4 (78.3 to 85.9)	80.2 (75.0 to 84.6)	82.2 (79.0 to 84.9)	6.4 (-2.7 to 15.4)	0.161	0.625†	0.185
Arequipa	74.0 (63.3 to 82.4)	71.5 (65.7 to 76.7)	72.7 (68.9; 76.2)	77.1 (73.4 to 80.5)	79.5 (75.8 to 82.8)	78.5 (74.4 to 82.2)	4.5 (-5.9 to 15.0)	0.385	0.831†	0.041
Ayacucho	72.2 (65.6 to 78.0)	75.0 (70.2 to 79.3)	81.4 (78.1 to 84.4)	82.1 (78.7 to 85.1)	85.7 (82.5 to 88.3)	83.5 (80.4 to 86.1)	11.3 (4.4 to 18.1)	0.001	0.912†	0.011
Cajamarca	86.3 (77.9 to 91.8)	85.6 (81.0 to 4.89)	85.4 (82.5 to 87.9)	85.8 (81.9 to 88.9)	88.4 (85.4 to 90.9)	85.8 (83.1 to 88.1)	-0.5 (-7.9 to 6.8)	0.887	0.303†	0.559
Callao	85.4 (70.8 to 93.3)	85.8 (82.0 to 88.9)	87.0 (84.3 to 89.2)	85.9 (82.8 to 88.5)	85.6 (82.6 to 88.1)	87.2 (84.8 to 89.3)	1.9 (-9.4 to 13.1)	0.732	0.515†	0.296
Cusco	55.0 (42.8 to 66.6)	64.4 (59.1 to 69.3)	76.5 (72.2 to 80.3)	75.3 (70.3 to 79.6)	77.0 (73.0 to 80.6)	74.6 (70.2 to 78.4)	19.5 (6.6 to 32.4)	0.002	0.600‡	0.208
Huancavelica	70.0 (54.7 to 81.9)	71.9 (65.8 to 77.3)	75.6 (70.7 to 79.9)	72.5 (65.0 to 79.0)	66.0 (59.6 to 71.8)	77.2 (73.2 to 80.8)	7.2 (-7.4 to 21.7)	0.347	0.203†	0.700
Huanuco	84.9 (77.2 to 90.4)	75.7 (70.7 to 80.1)	83.9 (80.6 to 86.7)	81.8 (78.7 to 84.5)	81.1 (78.0 to 83.8)	84.9 (82.3 to 87.1)	0.0 (-7.0 to 7.0)	0.992	0.058‡	0.913
Ica	86.4 (76.8 to 92.4)	84.4 (80.9 to 87.3)	87.4 (84.5 to 89.9)	84.4 (81.2 to 87.1)	87.1 (84.8 to 89.1)	87.2 (84.8 to 89.3)	0.8 (-7.2 to 8.9)	0.833	0.348†	0.499
Junin	79.2 (73.3 to 84.0)	73.8 (67.2 to 79.4)	76.1 (71.6 to 80.1)	74.0 (69.3 to 78.1)	79.2 (74.8 to 83.0)	79.2 (75.6 to 82.4)	0.0 (-6.3 to 6.4)	0.991	0.287†	0.582
La Libertad	81.9 (74.1 to 87.7)	79.7 (73.4 to 84.8)	83.0 (79.7 to 85.9)	86.8 (83.9 to 89.3)	88.5 (85.8 a 90.7)	87.3 (84.8 a 89.4)	5.4 (-1.8 a 12.6)	0.155	0.874†	0.023
Lambayeque	78.8 (65.8 to 87.8)	84.6 (80.7 to 87.9)	83.4 (80.0 to 86.4)	79.3 (73.9 to 83.8)	85.2 (82.1 to 87.9)	85.7 (83.2 a 87.9)	6.9 (-4.4 to 18.3)	0.222	0.567†	0.240
Lima	81.0 (73.5 to 86.7)	85.3 (82.9 to 87.3)	84.9 (83.2 to 86.4)	86.0 (84.3 to 87.6)	86.4 (84.8 to 87.9)	85.8 (84.3 a 87.1)	4.8 (-2.0 to 11.6)	0.163	0.771‡	0.072
Loreto	82.8 (77.9 to 86.8)	79.2 (75.1 to 82.7)	82.1 (77.8 to 85.7)	82.5 (78.3 to 85.9)	84.7 (81.9 to 87.2)	87.3 (85.2 a 89.1)	4.4 (-0.5 to 9.3)	0.068	0.776†	0.070
Madre de Dios	83.2 (74.3 to 89.4)	72.9 (68.7 to 76.7)	78.5 (73.8 to 82.6)	77.4 (73.7 to 80.6)	71.9 (67.7 a 75.8)	72.8 (69.2 a 76.1)	-10.4 (-18.7 a -2.1)	0.014	-0.682†	0.136
Moquegua	74.5 (68.6 to 79.5)	79.5 (75.2 to 83.2)	80.4 (76.6 to 83.7)	79.4 (75.9 to 82.5)	74.6 (70.7 to 78.1)	79.7 (75.3 a 83.5)	5.3 (-1.6 to 12.1)	0.133	0.314‡	0.544
Pasco	69.9 (61.9 to 76.8)	88.6 (85.5 to 91.0)	82.4 (79.0 to 85.4)	86.2 (83.0 to 88.8)	84.0 (80.4 to 87.1)	79.7 (75.8 a 83.2)	9.9 (1.4 to 18.3)	0.023	0.317†	0.541
Piura	78.7 (72.1 to 84.2)	82.9 (79.0 to 86.3)	82.8 (80.1 to 85.2)	82.0 (78.2 to 85.3)	85.1 (82.3 to 87.6)	85.3 (82.0 a 88.1)	6.6 (-0.2 to 13.4)	0.052	0.861†	0.028
Puno	66.1 (58.1 to 73.2)	62.7 (56.0 to 68.9)	63.6 (58.6 to 68.3)	64.4 (57.8 to 70.5)	65.2 (59.4 to 70.6)	70.4 (65.1 a 75.3)	4.4 (-4.9 to 13.7)	0.364	0.585†	0.223
San Martin	78.4 (72.1 to 83.6)	82.3 (77.4 to 86.3)	83.4 (79.7 to 86.6)	84.8 (82.1 to 87.2)	85.1 (82.4 to 87.4)	84.9 (81.8 a 87.6)	6.5 (0.0 to 13.0)	0.056	0.881†	0.020
Tacna	77.5 (62.6 to 87.6)	77.8 (72.9 to 82.1)	76.5 (72.3 to 80.3)	80.6 (76.5 to 84.1)	77.6 (73.9 to 81.0)	76.7 (72.7 a 80.2)	-0.8 (-14.0 to 12.4)	0.902	-0.018†	0.973
Tumbes	74.8 (65.2 to 82.4)	83.3 (79.2 to 86.8)	83.0 (80.0 to 85.6)	82.4 (79.9 to 84.6)	83.3 (80.6 to 85.6)	80.0 (77.3 a 82.4)	5.2 (-3.9 to 14.3)	0.257	0.116‡	0.827
Ucayali	70.9 (62.5 to 78.1)	76.4 (72.5 to 80.0)	74.3 (70.4 to 77.9)	77.0 (72.5 to 80.9)	76.7 (73.4 to 79.7)	68.1 (65.0 a 71.1)	-2.8 (-11.2 to 5.7)	0.510	-0.152†	0.773
Total	79.0 (76.7 to 81.2)	80.7 (79.6 to 81.7)	82.1 (81.3 to 82.9)	82.0 (81.1 to 82.9)	84.0 (83.3 to 84.7)	83.9 (83.2 a 84.5)	4.8 (2.5 to 7.2)	<0.001	0.959†	0.003

* Difference established between the percentage estimators for 2013 and 2018 through binary logistic regression with link identity.
**Correlation established between the years and the percentage estimator of 2 to more brushing per day for each geographical space.
† Pearson's correlation coefficient.
‡ Spearman-Brown correlation coefficient.

there is a monotonous (single behavior) upward linear trend in the data collected transversely over the years (p<0.001).

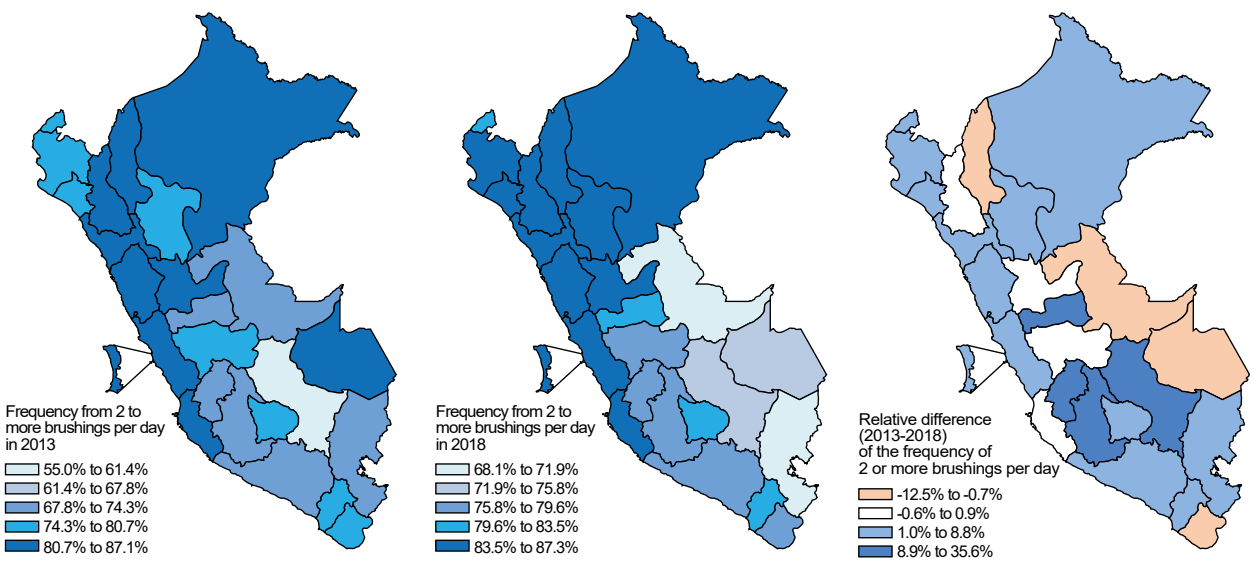
With respect to the distribution of ABF according to their characteristics (Table 2), it was found that all health aspects considered in bivariate form were positively associated, although only having received information on oral hygiene (r=0.924; p=0.009) and having insurance by EsSalud (r=0.880; p=0.021) were factors that showed permanent significant association in all the years (p<0.05). In addition, it is evident that having military health insurance has modified the ABF by 22.3% between 2013 and 2018 (p=0.039).

Considering the characteristics of the dwelling, regarding the type of place of residence, living in an urban area was favorable for the ABF with an increasing behavior over the years (r=0.938; p=0.006). From 2014 to 2018, the findings show that the highest quintile of socioeconomic well-being has stood out in ABF compared to the others; the trend identified shows that the lower the quintile, the lower the ABF percentage (p<0.001). Regarding the evaluation of household characteristics, the only factor that presented a favorable association in the greatest number of years (four out of five) was the age group in which the child was between 2014 and 2018 (p<0.001), which has intensified with the passage of time to a greater extent for those between three and five years (r=0.955; p=0.003).

The multivariate logistic model (Table 3) found that the passage of time increased directly, although not harmoniously, the probability of ABF with respect to 2013; all health characteristics were statistically significant, with prior dental care (OR 1.37, 95% CI 1.30 to 1.44) and oral hygiene information (OR 1.38, 95% CI 1.31 to 1.45) standing out. Not sharing the brush is favorable for ABF (OR 2.30, 95% CI 1.46 to 3.60). Housing characteristics show that, with respect to the region of origin, children from the highlands have a lower probability of ABF compared to those from Metropolitan Lima; geographically living in a rural area has a negative impact on the ABF (OR 0.87, 95% CI 0.81 to 0.94) with respect to the urban area. All of the wealth quintiles assessed demonstrated a negative impact on the ABF with respect to children in the top quintile. The age group was the only factor in the household that was significantly linked to the frequency of hygiene presented in a directly proportional way, where the older the child, the greater the ABF probability, considering the group of one to two years as the reference category.

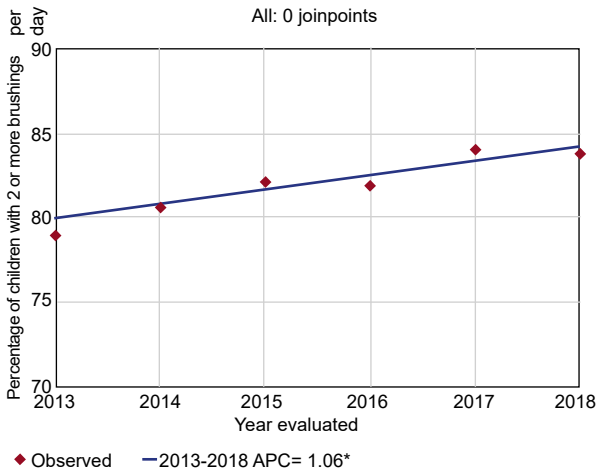
DISCUSSION

The improvement in brushing habits is of vital importance to prevent the most common diseases, establishing two brushes a day as a good indicator of healthy living [24]. This research work reports the growing trend in ABF in Peru, as well as in its different regions, being the low socioeconomic stratum populations the ones that presented a lower ABF.



The relative difference was calculated by adjusting for the 2013 value (2018-2013 difference/2013 x 100 value).

Figure 1. Distribution of adequate frequency of tooth brushing in children under 12 by region and its relative difference, ENDES Peru 2013-2018.



* Indicates that the Annual Percent Change (APC) is significantly different from zero with - significance level = 0.05

Figure 2. Trend of adequate tooth brushing frequency in children under 12 in Peru, 2013-2018

Rural populations use health services less than urban populations, and they are the first to show lower levels of ABF [25]. Visits to the dentist increase with age, socioeconomic stratum and monthly income of the family, mainly requesting evaluations, restorative and/or specialized treatments that oblige them to be referred to hospital centers.

Developing countries, similar to Peru, show lower ABF values, an example being the Iranian report in which 75% of preschool children brush their teeth at least once a day; 28% of individuals in that study began brushing before the age of two. There is evidence on the correlation between oral hygiene index and oral health-related quality of life [26]. In addition, a systematic review establishes that children with one or more teeth presenting caries lesions have negative consequences for school performance and attendance when compared to children with healthy teeth [27]; ABF trends in developed countries show better educational adherence [28]. Most of the research works, as well as this study, show that brushing frequencies increase with age.

Trend studies show a rise in percentages of individuals with an ABF over time, similar to the findings in this paper. In the Czech Republic, a report of 1994-2014 trends on the frequency of toothbrushing in children showed, through a binominal logistic regression, an increase in all the evaluated groups, showing a higher rate in the twelve year age group[28], a finding independent of the socio-economic stratum, something that was not found in the present study.

In Scandinavian countries, the ABF ratios are close to 100%. Despite the high adherence rate, trend surveys conducted in Norway every four years (between 1985 and 1997) showed that children between 11 and 15 years old presented slight increases in ABF, with statistically significant variability for the years 93 and 97. Respondents showed ABF values above 95% in all years included in the report [29]. In Denmark, as in the present work, the rates of adherence to an ABF were higher in children and adolescents of a high socioeconomic stratum [30], increasing the gap of social inequities for health care.

Determining the success of a public health intervention requires obtaining baseline information about the problem to be addressed, so that the impact of the change generated during and after the intervention can be assessed. Although national surveys represent tools that allow this objective to be met, they still present biases inherent to their methodology, either during the data collection process or due to the high variability of the sample. It is important to consider that the data reported by ENDES is of a sample type, so they may provide an optimistic picture of the real problem around the ABF; the variability of oral hygiene in children within and between clusters is something that cannot be controlled in secondary population data; we request that this fact is taken into account when referencing these studies, as it represents an important limitation. This fact highlights the need for baseline studies throughout the population, applying methodologies that can overcome the memory bias presented by the current ENDES oral health survey, where self-reported information is being used despite its recognized risk of bias.

The limitations of this work lie in the absence of an intraoral evaluation of the individuals who participated in the survey, to assess the presence of dental caries or oral hygiene index values. In these research studies, parents are surveyed and their ability to perform the hygiene of their children is not evaluated; the attitudes of parents regarding the importance of toothbrushing has a direct correlation on the quality of life [26]. Previous reports conclude that raising parents' awareness through education about the importance of brushing and visits to the dentist increases ABF and dental office visits [8,31]. Sharing a toothbrush has been linked to the decrease in adherence and ABF trends, something that could be considered as an inherent part of living in poverty and not having the means to acquire a toothbrush for each member of the family.

Health promotion improves quality of life but requires a commitment to practicing healthier behaviors; this can only be achieved when oral health promotion is implemented

Table 2. Distribution of adequate tooth brushing frequency in children under 12 years of age according to the sanitary characteristics of the dwelling and of the household, Peru, 2013-2018

Characteristics	2013		2014		2015		2016		2017		2018	
	% (95% CI)	P value*	% (95% CI)	P value*	% (95% CI))	P value*	% (95% CI)	P value*	% (95% CI)	P value*	% (95% CI)	P value*
Have you ever been seen at a dentist's office?												
No	76.8 (74.0 to 79.4)	0.059	75.9 (74.3 to 77.5)	<0.001	78.6 (77.4 to 79.8)	<0.001	77.0 (75.4 to 78.5)	<0.001	79.6 (78.3 to 80.8)	<0.001	79.6 (78.5 to 80.7)	<0.001
Yes	80.8 (77.4 to 83.9)		84.2 (83.0 to 85.2)		84.8 (83.9 to 85.7)		85.8 (85.0 to 86.7)		86.3 (85.5 to 87.1)		86.1 (85.3 to 86.9)	
Received information on oral hygiene?												
No	76.7 (73.3 to 79.8)	0.005	78.2 (76.6 to 79.8)	<0.001	79.3 (77.9 to 80.7)	<0.001	79.6 (78.2 to 81.0)	<0.001	81.8 (80.4 to 83.0)	<0.001	81.3 (80.1 to 82.4)	<0.001
Yes	82.4 (79.6 to 84.9)		84.0 (82.8 to 85.2)		85.6 (84.7 to 86.4)		85.5 (84.6 to 86.4)		86.6 (85.7 to 87.5)		86.4 (85.6 to 87.2)	
Does not know / Does not remember	74.0 (49.5 to 89.2)		78.4 (65.8 to 87.2)		77.3 (64.9 to 86.2)		81.2 (65.7 to 90.6)		83.5 (63.7 to 93.5)		79.9 (61.5 to 90.9)	
Answer given by the child Do	76.5 (72.4 to 80.2)		78.0 (76.3 to 79.7)		80.0 (78.7 to 81.2)		79.6 (78.2 to 81.0)		81.9 (80.6; to 83.2)		82.3 (81.1 to 83.4)	
Do you share toothbrush?												
Yes	51.0 (22.8 to 78.6)	0.032	61.9 (42.9 to 77.9)	0.014	54.7 (29.7 to 77.5)	0.007	72.9 (56.9 to 84.5)	0.136	79.7 (59.6 to 91.2)	0.555	54.5 (27.7; 78.9)	0.006
No	79.1 (76.8 to 81.3)		80.7 (79.7 to 81.8)		82.2 (81.4 to 83.0)		82.0 (81.1 to 82.9)		84.0 (83.3 to 84.7)		83.9 (83.2; 84.6)	
Do you use toothpaste for brushing?												
No	66.0 (47.9 to 80.4)	0.075	61.5 (53.0 to 69.3)	<0.001	64.8 (58.3 to 70.7)	<0.001	65.8 (59.0 to 72.0)	<0.001	65.0 (57.9 to 71.5)	<0.001	70.8 (64.9 to 76.0)	<0.001
Yes	79.2 (76.9 to 81.4)		80.9 (79.8 to 81.9)		82.2 (81.4 to 83.0)		82.1 (81.2 to 83.0)		84.2 (83.5 to 85.0)		84.0 (83.4 to 84.7)	
Do you have insurance?												
No	77.6 (73.1 to 81.6)	0.388	79.8 (77.8 to 81.7)	0.264	81.7 (80.2 to 83.2)	0.574	81.4 (79.5 to 83.2)	0.462	82.1 (80.5 to 83.5)	0.002	82.4 (81.1 to 83.7)	0.007
Yes	79.7 (77.1 to 82.0)		81.0 (79.8 to 82.1)		82.2 (81.3 to 83.1)		82.2 (81.2 to 83.1)		84.7 (83.8 to 85.5)		84.3 (83.6 to 85.1)	
Are you insured through Essalud?												
No	77.7 (75.2 to 80.0)	0.020	79.3 (78.1 to 80.4)	<0.001	81.3 (80.3 to 82.2)	<0.001	81.4 (80.3 to 82.4)	0.001	83.2 (82.3 to 84.0)	<0.001	82.7 (81.9 to 83.5)	<0.001
Yes	83.1 (78.7 to 86.8)		84.8 (82.8 to 86.6)		85.0 (83.7 to 86.2)		84.3 (82.8 to 85.7)		86.1 (84.7 to 87.4)		86.6 (85.5 to 87.7)	
Military insurance?												
No	79.2 (76.9 to 81.3)	0.086	80.6 (79.5 to 81.6)	0.068	82.0 (81.2 to 82.8)	0.008	82.0 (81.1 to 82.8)	0.159	83.9 (83.2 to 84.7)	0.045	83.8 (83.2 to 84.5)	0.459
Yes	64.1 (42.6 to 81.1)		87.4 (80.0 to 92.4)		88.6 (84.0 to 92.1)		85.9 (80.3 to 90.1)		88.9 (84.0 to 92.4)		86.4 (78.8 to 91.6)	
Do you have comprehensive health insurance?												
No	79.9 (76.5 to 83.0)	0.340	82.4 (81.0 to 83.7)	<0.001	83.4 (82.4 to 84.3)	<0.001	83.0 (81.7 to 84.1)	0.043	84.4 (83.4 to 85.3)	0.222	84.9 (84.0 to 85.7)	<0.001
Yes	77.9 (75.0 to 80.5)		78.5 (77.0 to 79.9)		80.9 (79.7 to 82.1)		81.2 (79.9 to 82.4)		83.5 (82.5 to 84.5)		82.5 (81.5 to 83.5)	
Do you have insurance by insurance company?												
No	79.0 (76.7 to 81.2)	0.809	80.5 (79.5 to 81.5)	0.003	82.0 (81.2 to 82.8)	0.019	82.0 (81.1 to 82.9)	0.464	83.8 (83.1 to 84.5)	<0.001	83.8 (83.1 to 84.4)	0.131
Yes	82.1 (48.7 to 95.7)		93.5 (85.6 to 97.2)		89.7 (83.5 to 93.7)		79.4 (70.9 to 85.9)		92.0 (87.7 to 94.9)		88.7 (82.0 to 93.1)	
Do you have private insurance?												
No	78.9 (76.6 to 81.1)	0.033	80.6 (79.5 to 81.6)	0.038	82.1 (81.2 to 82.9)	0.475	82.0 (81.1 to 82.9)	0.421	84.0 (83.2 to 84.7)	0.172	83.8 (83.1 to 84.5)	0.078
Yes	96.4 (76.5 to 99.5)		88.5 (81.0 to 93.3)		84.6 (76.9 to 90.1)		85.4 (76.0 to 91.6)		88.4 (81.6 to 92.9)		89.0 (83.1 to 93.0)	
Region of origin												
Metropolitan Lima	78.7 (71.5 to 84.5)	0.151	85.1 (82.8 to 87.2)	<0.001	85.0 (83.3 to 86.5)	<0.001	86.1 (84.4 to 87.7)	<0.001	86.5 (84.9 to 88.0)	<0.001	86.2 (84.8 to 87.6)	<0.001
Rest of the Coast	82.7 (78.7 to 86.0)		82.8 (80.8 to 84.7)		84.0 (82.7 to 85.2)		83.4 (81.9 to 84.8)		85.5 (84.3 to 86.6)		85.2 (84.0 to 86.3)	
Highlands	75.7 (72.1 to 79.0)		74.7 (72.8 to 76.6)		78.5 (77.0 to 79.9)		78.6 (76.7 to 80.3)		79.5 (78.0 to 80.9)		79.7 (78.4 to 81.0)	
Jungle	79.6 (76.5 to 82.4)		80.2 (78.3 to 82.0)		81.9 (79.9 to 83.7)		81.5 (79.5 to 83.3)		83.5 (82.0 to 84.9)		83.3 (82.1 to 84.4)	

* Comparison with the once-a-day brushing ratio, using Pearson's Chi-Square test.
** Difference established between the percentage estimators for 2013 and 2018 through binary logistic regression with link identity.
*** Correlation established between the years and the percentage estimator of 2 to more brushings per day for each category of the assessed characteristic.
† Pearson's correlation coefficient.
‡ Spearman-Brown correlation coefficient.

(Continued on page 569)

Table 2. Distribution of adequate tooth brushing frequency in children under 12 years of age according to the sanitary characteristics of the dwelling and of the household, Peru, 2013-2018 *(Continued from page 568)*

Characteristics	2013		2014		2015		2016		2017		2018	
	% (95% CI)	P value*	% (95% CI)	P value*	% (95% CI)	P value*	% (95% CI)	P value*	% (95% CI)	P value*	% (95% CI)	P value*
Type of area of residence												
Urban	81.0 (77.9 to 83.7)	0.004	82.4 (81.1 to 83.6)	<0.001	83.5 (82.7 to 84.3)	<0.001	83.6 (82.7 to 84.4)	<0.001	84.9 (84.1 to 85.7)	<0.001	84.5 (83.7 to 85.3)	<0.001
Rural	74.7 (71.5 to 77.7)		76.3 (74.6 to 78.0)		80.1 (78.5 to 81.5)		79.9 (78.1 to 81.5)		81.2 (79.6 to 82.6)		81.7 (80.4 to 83.0)	
Wealth quintile												
Lower quintile	74.0 (70.1 to 77.5)	0.107	77.4 (75.5 to 79.3)	<0.001	80.8 (79.1 to 82.4)	<0.001	80.8 (78.9 to 82.5)	<0.001	82.1 (80.5 to 83.5)	<0.001	83.0 (81.7 to 84.2)	<0.001
Second quintile	79.5 (75.4 to 83.1)		77.6 (75.6 to 79.5)		80.4 (78.9 to 81.8)		80.2 (78.6 to 81.7)		83.3 (81.8 to 84.6)		81.6 (80.1 to 83.1)	
Intermediate quintile	80.6 (75.2 to 85.1)		80.3 (78.0 to 82.4)		82.7 (81.2 to 84.2)		81.6 (80.1 to 83.1)		83.2 (81.5 to 84.7)		82.9 (81.4 to 84.4)	
Fourth quintile	83.2 (76.8 to 88.1)		82.2 (79.9 to 84.3)		83.5 (81.8 to 85.1)		85.1 (83.4 to 86.6)		84.9 (83.0 to 86.7)		85.4 (83.8 to 86.9)	
Upper quintile	78.4 (71.0 to 84.3)		88.3 (86.2 to 90.2)		87.3 (85.7 to 88.8)		87.5 (85.6 to 89.1)		88.1 (86.2 to 89.7)		87.9 (86.2 to 89.4)	
Home with water pump												
No	78.8 (76.3 to 81.0)	0.203	80.5 (79.4 to 81.5)	0.103	82.0 (81.2 to 82.8)	0.400	81.8 (80.8 to 82.7)	<0.001	84.1 (83.3 to 84.8)	0.633	83.6 (82.9 to 84.3)	0.002
Yes	86.3 (73.9 to 93.3)		83.7 (79.9 to 87.0)		83.8 (79.4 to 87.5)		87.3 (84.7 to 89.5)		83.3 (79.7 to 86.3)		87.4 (85.2 to 89.4)	
Household structure												
No adults	48.9 (20.3 to 78.2)	0.205	100.0 (100.0 to 100.0)	0.294	99.8 (98.1 to 100.0)	0.293	-	0.764	-	0.381	-	0.118
One adult	79.2 (71.8 to 85.0)		78.9 (75.1; 82.2)		84.5 (81.5 to 87.1)		81.1 (77.7 to 84.1)		83.4 (80.8 to 85.7)		82.3 (79.4 to 84.9)	
Two opposite-sex adults	78.8 (75.6 to 81.8)		81.0 (79.6 to 82.4)		82.0 (80.9 to 83.1)		82.1 (80.8 to 83.3)		84.3 (83.2 to 85.3)		84.7 (83.8 to 85.6)	
Two same-sex adults	88.6 (79.6 to 94.0)		76.7 (70.1 to 82.2)		79.5 (74.8 to 83.6)		81.4 (76.5 to 85.5)		81.7 (76.0 to 86.3)		80.4 (75.6 to 84.5)	
Three or more related adults	78.3 (74.6 to 81.5)		80.5 (79.1 to 81.9)		82.3 (81.1 to 83.4)		82.2 (80.9 to 83.4)		83.7 (82.6 to 84.8)		83.4 (82.4 to 84.5)	
Unrelated adults	86.2 (73.5 to 93.4)		84.2 (78.8 to 88.4)		77.9 (68.4 to 85.2)		79.2 (73.1 to 84.3)		87.4 (83.0 to 90.8)		82.9 (77.7 to 87.1)	
Sex of the head of household												
Male	77.9 (75.2 to 80.4)	0.024	81.0 (79.9 to 82.0)	0.163	81.9 (80.9 to 82.8)	0.152	82.1 (81.1 to 83.1)	0.390	84.2 (83.0 to 4.85)	0.345	84.0 (83.2 to 84.8)	0.457
Female	83.4 (79.2 to 86.9)		79.4 (77.1 to 81.5)		83.1 (81.6 to 84.6)		81.3 (79.5 to 83.0)		83.4 (81.8 to 84.9)		83.4 (81.9 to 84.8)	
Educational level of the head of household												
No education	77.0 (72.3 to 81.0)	0.417	78.6 (76.4 to 80.5)	<0.001	81.1 (79.7 to 82.4)	0.086	81.6 (79.9 to 83.2)	0.086	83.7 (82.4 to 84.9)	0.174	84.1 (82.9 to 85.2)	0.027
Elementary	80.8 (77.3 to 84.0)		79.8 (78.1 to 81.4)		81.9 (80.4 to 83.2)		81.6 (79.9 to 83.1)		85.0 (83.8 to 86.2)		83.3 (81.9 to 84.5)	
Secondary	77.8 (73.3 to 81.8)		81.6 (79.9 to 83.1)		82.9 (81.1 to 84.5)		81.9 (80.5 to 83.2)		83.0 (81.6 to 84.3)		83.0 (81.6 to 84.2)	
Higher	81.0 (75.2 to 85.7)		84.5 (82.3 to 86.5)		83.5 (81.7 to 85.2)		84.9 (83.0 to 86.6)		84.3 (82.3 to 86.1)		85.8 (84.3 to 87.2)	
Head of household studying during the evaluation year												
No	78.6 (75.5 to 81.3)	0.588	81.0 (79.7 to 82.1)	0.430	81.7 (80.6 to 82.8)	0.350	81.9 (80.9 to 83.0)	0.857	83.5 (82.6 to 84.4)	0.057	83.6 (82.8 to 84.4)	0.224
Yes	79.8 (76.2 to 82.9)		80.2 (78.7 to 81.7)		82.6 (81.2 to 83.8)		82.1 (80.6 to 83.5)		84.9 (83.7 to 86.0)		84.4 (83.3 to 85.5)	
Age group of the child (years)												
1 to 2	74.1 (67.3 to 80.0)	0.168	70.7 (67.5 to 73.8)	<0.001	72.5 (70.2 to 74.7)	<0.001	71.2 (69.0 to 73.3)	<0.001	73.7 (71.7 to 75.6)	<0.001	73.9 (72.1 to 75.6)	<0.001
3 to 5	78.0 (74.3 to 81.3)		77.8 (76.0 to 79.5)		80.5 (79.4; 81.7)		80.4 (79.1 to 81.6)		83.2 (82.1 to 84.3)		83.6 (82.6 to 84.6)	
6 to 8	79.5 (75.7 to 82.8)		83.7 (82.4 to 85.0)		83.4 (82.2 to 84.6)		83.9 (82.6 to 85.0)		85.5 (84.2 to 86.6)		86.0 (85.0 to 87.0)	
9 to 11	81.1 (77.9 to 83.9)		82.8 (81.4 to 84.2)		85.0 (83.9 to 86.1)		84.7 (83.4 to 85.9)		86.7 (85.5 to 87.8)		85.3 (84.2 to 86.4)	
Lives in overcrowded house												
No	79.0 (76.2 to 81.6)		81.6 (80.4 to 82.7)		82.4 (81.5 to 83.3)		83.3 (82.3 to 84.2)	<0.001	85.1 (84.2 to 85.9)	<0.001	84.5 (83.7 to 85.2)	0.012
Yes	79.1 (75.1 to 82.6)	0.959	78.6 (76.8 to 80.4)	0.003	81.7 (80.1 to 83.1)	0.411	80.2 (78.6 to 81.7)		82.0 (80.6 to 83.3)		82.6 (81.4 to 83.8)	

Comparison with the once-a-day brushing ratio, using Pearson's Chi-Square test.
** Difference established between the percentage estimators for 2013 and 2018 through binary logistic regression with link identity.
*** Correlation established between the years and the percentage estimator of 2 to more brushed per day for each category of the assessed characteristic.
† Pearson's correlation coefficient.
‡ Spearman-Brown correlation coefficient.
Script: estimate calculation not applicable.

Table 3. Multivariate identification of factors associated with adequate tooth brushing frequency in children under 12 years of age, Peru, 2013-2018

Variables	OR	95% CI	P value
Year evaluated (Trend)			
2013		Reference	
2014	1.08	0.92 a 1.26	0.346
2015	1.21	1.04 a 1.40	0.015
2016	1.19	1.02 a 1.39	0.024
2017	1.29	1.11 a 1.50	0.001
2018	1.28	1.10 a 1.48	0.002
Have you ever received dental care?			
No		Reference	
Yes	1.37	1.30 a 1.44	<0.001
Did you receive information about			
No		Reference	
Yes	1.38	1.31 a 1.45	<0.001
Does not know / Does not remember	0.96	0.69 a 1.33	0.813
Answer given by the child	1.13	1.07 a 1.18	<0.001
Do you share toothbrush?			
Yes		Reference	
No	2.30	1.46 a 3.60	<0.001
Do you use toothpaste for brushing?			
No		Reference	
Yes	1.72	1.49 a 1.99	<0.001
Do you have health insurance?			
No		Reference	
Yes	1.10	1.04 a 1.16	0.001
Region of origin			
Metropolitan Lima		Reference	
Rest of the coast	1.03	0.96 a 1.12	0.403
Highlands	0.66	0.60 a 0.72	<0.001
Jungle	0.93	0.84 a 1.02	0.101
Type of area of residence			
Urban		Reference	
Rural	0.88	0.81 a 0.95	0.001
Wealth quintile			
Lower quintile	0.88	0.79 a 0.98	0.018
Second quintile	0.73	0.66 a 0.80	<0.001
Intermediate quintile	0.72	0.66 a 0.79	<0.001
Fourth quintile	0.80	0.73 a 0.87	<0.001
Upper quintile		Reference	
Age group (years)			
1 to 2		Reference	
3 to 5	1.58	1.49 a 1.68	<0.001
6 to 8	1.91	1.79 a 2.03	<0.001
9 to 11	1.96	1.82 a 2.10	<0.001

Model adjusted by household characteristics: Household structure, sex of the head of household. educational level of the head of household. head of household studying during the evaluation year, lives in overcrowded house.

at the community level involving various actors [32]. Recent studies have shown that education from an early age has an impact on the creation of these protective behaviors [8,10]. A strategy implemented in New Zealand [33] using text message (SMS) reminders for ABF proved to promote its increase significantly, which could become a viable alternative for remote communities or populated centers where there is no health service nearby.

In Peru, the Result-Based Budget (RBB) program establishes government initiatives based on results in the population through the goods and services required to achieve them, which institutionalizes a policy that makes the project managers accountable and oblige them to present the obtained results, allowing to analyze the cost-effectiveness of the measures implemented [34]. This modality involves the definition of results and products since the project phase (goods and services), and the costs required for its implementation. It also guarantees a significant change in the availability of information, and the management of it by decision-makers to ensure transparency in public management. By means of oral health education and the implementation of an awareness program on the importance of brushing and the use of one brush per person—involving community actors and possible technological measures such as reminders per text message—the burden of oral diseases could be reduced in an effective and inexpensive way, thus improving the quality of life of the most vulnerable populations. The fact that positive associations with the availability of health services have been demonstrated should be taken as a stimulus to expand these outcomes to a greater percentage of individuals, in order to increase ABF in the Peruvian population.

The present research work concludes that the ABF percentage has increased in the last six years, being favorably influenced by health aspects; at the rural level, this percentage is significantly lower, something that is also evidenced in the highlands. Health service extension projects may be an alternative to increase the percentages of adherence to a ABF practice in vulnerable populations in remote areas where health services are presented, and the risk of dental cavities and periodontal disease can be reduced from an early age.

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