Dental fluorosis frequency and its association with the socio-economic level at a rural area in Cotopaxi province, Ecuador

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Frecuencia de fluorosis dental y su asociación con el nivel socioeconómico en parroquia rural de Cotopaxi, Ecuador

ABSTRACT

Objective: To determine dental fluorosis frequency by using the DEAN and TF Indexes on 4- and 15-years old children, and its correlation with the socioeconomic level reported by their parents. **Methods:** A descriptive and analytical cross-sectional study were proposed and applied to a 115 students (4-15 years old) sample, enrolled in an educational institution located in Pujilí, Cotopaxi, Ecuador. After fulfilling the inclusion criteria, underwent a clinical assessment of their four permanent incisors, registered by photographic examination using the DEAN and Thylstrup and Fejerskov (TF) Indexes, to detect the presence of dental fluorosis. Having the children's legal representatives filled out the INEC socio-economic survey, the collected data were analyzed through the statistical package SPSS v24. **Results:** Results showed the presence of fluorosis in low or moderate rates according to DEAN and 2 in TF without any difference in the fidelity detection between the two indexes; and no economic factor influence on the fluorosis causes was detected. **Conclusions:** There was not difference between the indexes used in the detection of fluorosis, with moderate rates found; the economic factor was not relevant.

Key words: Fluorosis; Dental; Socioeconomic factors; Epidemiology; Rural health; Child; Adolescent.

RESUMEN

Objetivo: determinar la frecuencia de fluorosis dental mediante el empleo del índice DEAN y TF en escolares entre 4 a 15 años, y su correlación con el nivel socioeconómico reportado por sus padres. **Métodos:** se plantea un estudio transversal descriptivo, en una muestra de 115 estudiantes entre 4 a 15 años, matriculados en una unidad educativa de Pujilí, Cotopaxi, Ecuador. Tras cumplimiento de los criterios de inclusión los menores fueron sometidos a una valoración clínica de sus cuatro incisivos permanentes, registrados mediante fotografías y estas evaluadas empleando los índices DEAN y Thylstrup and Fejerskov (TF), para detectar la presencia de fluorosis dental. Sus representantes legales llenaron la encuesta socio económica INEC. Los datos recolectados fueron analizados a través del paquete estadístico SPSS v24. **Resultados:** los resultados mostraron presencia de fluorosis en grados leves según DEAN y 2 en TF, sin una diferencia en cuanto a la fidelidad de detección entre los dos índices; la influencia del factor económico en la presencia de fluorosis no fue detectada. **Conclusiones:** no existió diferencia entre los índices empleados en la detección de fluorosis, encontrándose grados leves; el factor económico no fue relevante.

Palabras clave: fluorosis dental; factores socioeconómicos; epidemiología; salud rural; niño; adolescente.

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Introduction

Dental fluorosis constitutes a hypomineralization, triggered by the excessive consumption of fluoride during the dental tissue formation process (1). Clinically, it becomes evident as a white or brown stain that negatively affects both primary and permanent teeth at different degrees depending on the systemic compromise (2). The presence of these lesions is related to the excess of fluoride present in the water, at levels between 1.4 to 2.5 ppm (3, 4)

Fluoride is used in the prevention of dental cavities when administered in adequate concentrations, 0.7 to 1 ppm (5). Its incorporation in amounts that exceed these values with a high frequency can cause a negative effect in enamel development (6). Topical fluoride such as toothpaste, increases at a rate of 6% for every 500 ppm above 1000 ppm of fluoride showed with factors associated with fluorosis (7) highlighting an upper value limit of 1500 ppm of fluoride (6) present in the mouthwash for weekly use of sodium fluoride (0.2% 900 ppm F) or for daily use 0.05% (225 ppm F) can trigger fluorosis (8).

In patients who have a higher risk of getting caries, fluoride gel neutral (5000 ppm F), acidified phosphate fluoride (5000 ppm F), stannous fluoride (1000 ppm F) are suggested to be applied every 3 to 6 months, finding the fluoride, in some food products, was reported in tea plant for infusion (7).

In 1996, the Ministry of Public Health of Ecuador carried out an evaluation considering the fluoride concentration in the water supply, with results that show high concentrations in certain areas, mainly in the central highlands provinces of Ecuador (9). The presence of this pathology has been related to the socio-economic status of the person suffering from it (10), with no studies confirming this association (11). The dental fluorosis identification process requires the use of protocols based mainly on the visualization of the tooth surface, as well as the use of indexes that allow to determine the degree of aggression the tooth suffers (12).

The DEAN Index was developed in 1942, with the purpose of identifying the severity and distribution of this pathology in various communities, it considers values that change from 0 to 5, and assesses the vestibular faces of teeth 11, 12, 21, and 22 (13, 14). The Thylstrup and Fejerskov Index (TF) was designed to refine, modify, and extend the original concepts established by DEAN, constituting to a more sensitive classification systems, which would allow recording changes on the enamel extension. The TF uses a scale from 0 to 9, which corresponds to the histological changes that characterize dental fluorosis, and the concentrations of the elements found in fluorotic enamel after examining the vestibular surfaces (8, 15).

Having this information in mind, the objective of this study was to determine the frequency of dental fluorosis between 4 to 15 years old school children, from Guangaje parish, Pujilí, Cotopaxi, Ecuador, by using the DEAN and TF indexes relating it to the socioeconomic level reported by their parents. The study also sought to establish the degree of concordance between the indexes used for dental fluorosis diagnosis.

Methods

This is a descriptive and analytical cross-sectional study, carried out on children who have free access to health provided by the Ecuadorian state in the Ministry of Public Health.

Additionally, these children regularly attended the educational institution "Dr. Edmundo Carbo", in Guangaje parish located in the Pujilí canton belonging to the province of Cotopaxi, due to its central geographical location near the volcanic zone called Quilotoa.

The sample size was determined by applying a finite sample formula to a universe of 165 children according to Ecuadorian Institute of Statistics and Census (2010). The sample was established according to a convenience sample method, it was made up of 115 children between 4 and 15 years old, considering the population even from ages 4 to 6 years based on research where rash has been reported in permanent teeth (16).

The results indicated that very few individuals affected with fluorosis in this age group, however, there was the lesion and their corresponding parents or legal representatives, who agreed to participate in the study. It was considered as inclusion criteria that the schoolchildren present 4 definitive upper incisors in the oral cavity, and that these are clinically visible.

Once the inclusion criteria were verified, the legal representatives of the participants were asked to fill out the INEC (Ecuadorian Institute of Statistics and Census), the entity in charge of the statistical management of Ecuador, socio-economic survey, which is structured by 4 items: home characteristics, access to technology, level of education and economic activity at home.

Based on the final addition of the obtained scores, the participant's family was identified in 4 socioeconomic groups, such as: A: high (845.1 to 1000 points); B: medium high (696.1 to 845 points); C +: typical medium (535.1 to 696 points); C-: medium low (316.1 to 535 points); D: low (0 to 316 points) (17). Each of the surveys was identified with codes to preserve the confidentiality of the participants.

Subsequently, a clinical dental examination was performed with intraoral photographic registration. During this procedure, the protocol for the identification of fluorotic lesions (18, 19) with biosafety standards was respected. Dental plaque and food debris from the surface of the teeth to be evaluated, were removed with sterile gauze. The imaging technique was performed with a Canon EOS 600D (Japan) professional photographic camera 18-megapixel CMOS sensor, ISO 100, f/22, 1/125 parameters; standardized for distance and light intensity, mitigating any light interference.

The patients were placed at 40 to 50 cm from the camera. For the evaluation of dental fluorosis, care was taken to identify each image, in such a way that the registration of the patient's dental enamel surface coincides with the codes of the survey previously performed.

Each image was examined and classified following the criteria of the DEAN and TF indices, according to the consensus of three expert examiners. The values were collected and stored in a previously prepared Excel template; these data were analysed with the SPSS v24 program. Using the Kappa Cohen coefficient, an agreement was reached between the examiners, they verified the homogeneity ($p<0.001$) showing similarity regarding the value provided by each evaluator, and it was verified with the Kolmogorov-Smirnov Normality test. Kappa scores for inter-rater agreement with the expert panel for the main categories (1–5) demonstrated good to very good agreement (kappa: 0·64–0·89) for all examiners.

In addition, the Pearson correction was achieved between the TF and DEAN indices. For the association between fluorosis and socioeconomic status, the level of fluorosis on

the TF index was considered as the main outcome variable. To determine the association between the variables, the Poisson regression model with a robust estimator was applied. In summary, univariate models were performed and those with a significance of p≤0.25 were included in a multivariate model.

Ethical considerations

This research respected the principles of the Declaration of Helsinki (2013), and World Medical Association (2008). Additionally, this study was developed with the approval of the Ethics Committee of Universidad Central del Ecuador, code 248-FO-G-2019, issued July 30, 2019. All research participants reviewed and signed the informed consent and assent form for those participants under 18 years of age. These documents were an indispensable requirement to proceed with the data collection.

Results

When making a comparison between the TF Index and the DEAN Index (Table 1), it has been obtained that 20.0% of those who in the Dean index are presented with a nominal level, in the scale of TF corresponds to the normal translucency of the enamel, likewise, the questionable level that has 15.7% on the Dean scale, coincides in 13% with the level of thin and opaque lines of the TF scale and 2.6% with pronounced opaque lines.

In TF, the percentage of 24.3% of the very light level in Dean coincides with 1.7% with thin and opaque lines, 21.74% with pronounced opaque lines, and 0.87% with the fusion of opaque lines; the value of the light level of 22.6% also coincides with the fusion level of opaque lines in 20.87% and with deep opaque lines in 0.87%, in the same sense of the analysis, it is observed that 12.2% of moderate is the same value that presents a complete surface with marked opacity on the TF scale.

Finally, of the 4.3% of the severe levels in the Dean index, 2.6% corresponds to an opaque surface with loss of external enamel in TF; as well as 0.87% for opaque enamel and bands <2 mm in height and 0.87% with loss of external enamel in irregular areas.

A total of 115 participants were recruited; of which, 49.6% were female, with a mean age of 9.76 years (SD = 3.21). When analysing the diagnosis of fluorosis, with the use of Dean's index, we found that of the evaluated participants: 20.87% (n = 24) were code 0, 15.65% (n = 18) code 1, 25.22 % (n = 29) code 2, 21.74% (n = 25) code 3, 12.17% (n = 14) code 4 and 4.35% (n = 5) code 5. When analysing the diagnosis of fluorosis with the use of the TF index, we found that of the evaluated participants: 20.0% (n = 23) were code 0, 15.65% (n = 18) code 1, 23.48% (n = 27) were code 2, 24.35% (n = 28) code 3, 12.17% (n = 14) code 4, 2.61% (n = 3) code 5, 0.87% (n = 1) code 6, 0, 87% (n = 1) code 7, 0.00% (n = 0) code 8 and 0.00% (n = 0) code 9. Table 2 shows the mean and standard deviations of the different INEC dimensions.

Regarding the analysis using the INEC stratification survey, the socioeconomic level with the highest frequency found among the evaluated participants was the low socioeconomic level (91.3%, n = 105); which, when related to the degree of fluorosis reported, did not show any relationship.

Table 1. Cross table between Thylstrup and Fejerskov Index (TF) and Dean Index.

			Index de Dean						Total
		Nominal	Questionable	Very Mild	Mild	Moderate	Severe		
Index de Thylstrup y Fejerskov (TF)	Normal enamel translucency	Count	23	0	0	0	0	0	23
		% total	20,0%	0,0%	0,0%	0,0%	0,0%	0,0%	20,0%
	Thin and opaque lines	Count	1	15	2	0	0	0	18
		% total	0,9%	13,0%	1,7%	0,0%	0,0%	0,0%	15,7%
	Pronounced opaque lines	Count	0	3	25	1	0	0	29
		% total	0,0%	2,6%	21,7%	0,9%	0,0%	0,0%	25,2%
	Blending of opaque lines	Count	0	0	1	24	0	0	25
		% total	0,0%	0,0%	0,9%	20,9%	0,0%	0,0%	21,7%
	Full surface with marked opacity	Count	0	0	0	1	14	0	15
		% total	0,0%	0,0%	0,0%	0,9%	12,2%	0,0%	13,0%
	Opaque surface with loss of external enamel	Count	0	0	0	0	0	3	3
		% total	0,0%	0,0%	0,0%	0,0%	0,0%	2,6%	2,6%
	Opaque enamel and bands < 2 mm high	Count	0	0	0	0	0	1	1
		% total	0,0%	0,0%	0,0%	0,0%	0,0%	0,9%	0,9%
	Loss of external enamel in irregular areas	Count	0	0	0	0	0	1	1
		% total	0,0%	0,0%	0,0%	0,0%	0,0%	0,9%	0,9%
Total		Count	24	18	28	26	14	5	115
% total			20,9%	15,7%	24,3%	22,6%	12,2%	4,3%	100,0%

Source: Prepared by the authors based on the results obtained.

Table 2. Mean and standard deviation of INEC dimensions.

INEC Dimension	Mean(±SD)
Home characteristics	143.17(34.70)
Level of education	5.81(5.98)
Economic activity	35.28(15.31)
Access to technology	4.53(10.52)
Consumption habits	29.80(17.18)
INEC Dimension	Mean(±SD)
Home characteristics	143.17(34.70)
Level of education	5.81(5.98)
Economic activity	35.28(15.31)
Access to technology	4.53(10.52)
Consumption habits	29.80(17.18)

Source: Prepared by the authors based on the results obtained.

Table 3. Poisson regression shows the association between different INEC dimensions and fluorosis grade with TF and DEAN indexes.

	TF Index >4						DEAN Index >2					
	Univariable Model			Multivariable Model[b]			Univariable Model			Multivariable Model[b]		
	RR	95%CI	p	RR	95%CI	p	RR	95%IC	p	RR	95%CI	p
Age	1.42	1.21-1.67	<0.001				1.04	1.00-1.09	0.02	1.05	0.99-1.05	0.05
Gender Male[Ref] Female	1 4.07	0.46-35.3	0.43				1.00 1.04	0.79-1.38	0.75			
INEC Dimension												
Home characteristics	1.00	0.98-1.01	0.76				1.00	0.99-1.00	0.96			
Level of education	0.90	0.75-1.08	0.27				0.97	0.95-1.00	0.10	0.23	0.98-1.00	0.25
Economic activity	1.00	0.97-1.03	0.82				0.99	0.98-1.00	0.05	0.23	0.98-1.00	0.03
Access to technology	1.00	0.95-1.05	0.84				1.00	0.99-1.01	0.11	0.11	0.99-1.02	0.01
Consumption habits	1.12	1.00-0.90	0.94				0.99	0.98-1.01		0.87		

RR: Risk Ratio 95%CI: 95% Confidence interval p: Significance level (p<0.05) Ref: Reference category b: Adjusted model with p≤0.25 variables

Source: Prepared by the authors based on the results obtained.

In the Poisson regression model between the different dimensions of the INEC questionnaire and the presence of fluorosis with the indexes TF and DEAN, a highly significant association was found between age and the presence of fluorosis, assuming that for each year of life the individuals have 1.42 and 1.04 times the risk of developing fluorosis in grades >4 TF and >2 DEAN, respectively.

In the multivariate model, significant associations were observed between the dimensions of economic activity (p=0.03), access to technology (p=0.01), and DEAN fluorosis index (Table 3). In the correlation analysis between the TF and Dean indices, a correlation of 0.97 was observed, which was considered optimal.

Discussion

The results of this study partially agree with those of other investigations that have been presented in the literature. Regarding the prevalence of dental fluorosis, it was found that, in three rural areas of Ecuador, the most frequent degree of fluorosis according to the TF index was grade 2 in 36.5% of the cases (11). This coincides with studies carried out in other cities in Latin America; in Asunción, 20% of schoolchildren between 5 and 12 years old presented fluorosis in grades 1 to 3, according to Dean's index (20). In a study of the prevalence of fluorosis in 12-year-old schoolchildren in Montevideo, 54% of cases had a TF score of 1 and 27.3% had a TF of 2 (21). In other words, in the studies mentioned, a mild severity of dental fluorosis occurs more frequently.

In our study, it was observed that in the univariate model the socioeconomic level is not a significant factor associated with fluorosis; however, in the multivariate model we found a significant association between economic activity and technology access. These results could be assumed as participants with better economic situation and better access to technology also assure access to more accurate information (4, 22).

The fact of being aware about good-quality water consumption and avoiding the intake of high fluoride products becomes crucial in the development of fluorosis (11, 14, 23). In contrary, we must emphasize this significance level could be leaded due to the studied population having a low and medium-low socioeconomic status, high variability in the INEC dimensions, and an unbalanced sample size (24). In the same way, TF index has more grades to classify dental fluorosis than DEAN index, this suggests that individuals are grouped in different proportions, which can alter statistical analysis (12).

The noncorrelation between fluorosis and socioeconomic level coincides with a study performed in Brazil (10), in contrast to a study from Mexico, which found significant differences in the severity of fluorosis between low and medium socioeconomic groups (25). In a study done in Uruguay, significant differences were obtained in relation to socioeconomic level. Contrary to the two aforementioned investigations, its studied population was distributed in various socioeconomic strata, associating the presence of fluorosis with high socioeconomic levels (21).

The reason for these associations could be related to access to fluorinated products of common and commercial use to which families are exposed, according to their purchasing power and to the regulation of water quality by governments, in agreement with the

standard recommendations of the World Health Organization (26). Studies indicate that tooth brushing plus the use of toothpaste without a regulated dosage could be a determining factor for the presence of dental fluorosis (11, 23).

Regarding the comparison of diagnostic indices, studies of the prevalence of fluorosis and other dental pathologies present a great methodological diversity, which makes it difficult to make comparisons (27). A strength of this study was that two standardized indices were used to determine the presence of fluorosis, with a high degree of similarity in diagnosis among investigators. The dilemma of choosing which index to employ for the diagnosis of dental pathology will be framed in the fact that any of these will be useful, as long as it responds to our diagnostic objectives and allows us to establish an adequate plan for the patient. It should also be adequate for the decision-making of public health policies when epidemiological studies are developed.

In order to improve public health strategies, it is necessary to accomplish new studies to observe in a better way if the socioeconomic level and other aspects have a direct influence on the incidence of dental fluorosis. A limitation in the present study was the small population; however, it allowed an approximation to the frequency of dental fluorosis in the Guangaje population. Two diagnostic indices were used without finding an association with the socioeconomic level of the population; however, it is necessary to carry out studies with greater representativeness of the Ecuadorian population.

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Authors' contributions

Katherine Masabanda-Olivares: Participated in the conception and design, review of the literature, writing of the article, and final approval. Juan Marcos Parise-Vasco: Participated in the conception and design, writing of the article, academic advice, and final approval David Arroyo-Bonilla: Contributed to the critical review of the article, statistics, technical advice, and final approval. Ana Armas-Vega: Participated in the conception and design, providing technical advice, and final approval.

Conflicts of interest

The authors declare that they have no conflict of interest in relation to the subject of the study.

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