Prevalence of Dental Caries in 12-Year-Olds in San Pedro de Macorís, DR

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Objective: Dental caries is one of the most prevalent chronic diseases in children. Currently, no data are available on dental caries prevalence in the Dominican Republic. The purpose of this study was to estimate the prevalence of dental caries in school-attending 12-year-olds in San Pedro de Macorís, Dominican Republic.

Methods: A cross-sectional epidemiological study using a probabilistic sample, stratified by type of school (public/private) and gender, was conducted. Two calibrated examiners conducted the evaluations of oral soft/hard tissues. Caries experience was summarized in terms of prevalence; the number of decayed, missing, and filled teeth (DMFT) and surfaces (DMFS); and the significant caries (SiC) index, in all the participants, and by gender and school type. Logistic and Poisson regression models were used to compare caries experience by sex and school type.

Results: Four hundred and two 12-year-olds enrolled in 14 public and 11 private schools were evaluated. The overall dental caries prevalence was 73%. The mean DMFS was 3.87, the mean DMFT was 2.64, and the SiC index was 5.07. Girls had significantly higher mean DMFS, DMFT, and SiC indices than did boys. Public school attendees had significantly higher DMFS, DMFT, and SiC indices than did those children attending private schools. The decayed (D) component accounted for 71% of the DMFT value.

Conclusion: The WHO's goal of all 12-year-olds having a DMFT less than or equal to 3 was met by all the participants in our study. Girls and public-school attendees carry the burden of the disease. The high D component of the index suggests that there are unmet dental-caries needs. This information will assist in the design and implementation of future primary and secondary prevention programs. [*P R Health Sci J 2020;39:210-215*]

Key words: Dental caries, DMFT, DMFS, Epidemiology, Prevalence, Children

Dental caries, one of the most prevalent diseases, worldwide, is a major public health concern affecting the quality of life of those who have the disease (1, 2). This preventable disease develops through a long-term complex interaction between acid-producing bacteria and fermentable carbohydrates (2). Risk factors for dental caries may vary based on race, culture, ethnicity, socioeconomic status, and the political context in which a given patient lives (3). It is, therefore, important to study the course of the disease across both lifespan and different populations.

In addition, dental caries is an important cause of school absenteeism (4) and work absences for parents (5). If untreated, severe dental caries can affect food choices and nutritional status (6) and can lead to life-threatening conditions (7, 8). In the U.S., the prevalence of dental caries (2010–2011) in children aged 12 to 19 was almost 60% (9, 10). In Puerto Rico, the prevalence reported in the last islandwide study was 71% (11). Despite the decline in dental caries in school-aged children in countries with well-established economies (12), health disparities persist among different socioeconomic groups, all over the world (11).

Traditionally, the decayed, missing, and filled teeth/surface (DMFT/DMFS) indices have been used to estimate the distribution of dental caries in a given populations (13, 14). Since these indices have some limitations, the significant caries

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(SiC) index was developed to identify the gaps in the existing indices and to identify oral health disparities (15).

The DR is a nation on the island of Hispaniola, which is itself a part of the Greater Antilles in the Caribbean region; the DR has a population of over 10 million. It has a developing economy, with a per capita income of US $9,400 and a Gini index of 47.20 (16). In 1997, the DR reported a high DMFT index (4.4), with a prevalence of 95% (17, 18). There are no recent dental caries data in the DR; however, a recent study conducted in the capital, Santo Domingo, revealed a high DMFT (7.5) in adolescents aged 12 to 14 (19).

It is important to have information about the caries status of pre-adolescents/adolescents in other areas of the DR, ensuring that that information gathered includes school type (public or private) to serve as a proxy for socio-economic status. These data are essential to the design of a nationwide study that would enable the construction of a national dataset useful for public oral health planning (20).

The purpose of this study was to estimate the prevalence of dental caries in 12-year-olds attending school in San Pedro de Macorís, DR.

Methods

Selection and Description of the Study population

This cross-sectional study was conducted from September through December 2013. The study design was approved by the University of Puerto Rico Institutional Review Board (Protocol No. 0360213) and the "*Consejo Nacional de Bioética en Salud (CONABIOS)*" of the DR.

Sample selection

Our population of interest consisted of 12-year-olds attending public and private schools in San Pedro de Macorís. In 2010, the city had 195,307 inhabitants, of which 3,922 were 12 years old (16). According to the Education Department, there were 3,691 12-year-olds enrolled in public and private schools in 2012 (21).

A multistage, probability sample design of 12-year-old children attending public and private schools was used for the accurate estimation of caries prevalence in the target population. The sample sizes for the public and private schools were determined using a confidence level of 95% and prevalence estimate of 65%, with 5% precision, for 28 clusters from the initial population size of around 3,700 students. Statistical power was also confirmed for a 20% difference in caries prevalence by school type, assuming a caries prevalence of 52.08% for private schools and 71.84% for public schools, using the 1:1.8 ratio for private vs. public schools. Due to the absence of data from the DR, the prevalence assumptions were based on the results of a similar cross-sectional study conducted in Puerto Rico in 2011 (11). Assuming a nonresponse rate of 20% and taking into account the design effect due to clustering, the final sample was set at 420 (270 from public and 150 from private schools). Each school was stratified by gender, with boys and girls being randomly selected. At each of the selected schools, a list of 12-year-olds was requested; upon its receipt, we randomly selected 10 boys and 10 girls, using a random number generator.

Recruitment

A letter was sent to the Department of Education of San Pedro de Macorís requesting permission to conduct the study in the community. Each participating school was then visited by the research team, which comprised 2 dental examiners, including the principal investigator (PI), a research coordinator, 2 trained recorders, and a trained interviewer.

To initiate the process, the PI then spoke with the 12-year-old children enrolled in the school, explaining the study and emphasizing the voluntary nature of their potential participation. The PI provided an informed consent form and a medical questionnaire to be given to each child's parent(s) or guardian(s). The inclusion criteria for the study were as follows: 1) being 12 years of age, 2) having an ASA I or ASA II classification (22).

We excluded children who did not assent, whose parents/guardians did not provide a signed consent form, and who had orthodontic appliances.

Study procedures

Prior to the initiation of the study, all the dental examiners and recorders were trained and calibrated following a modified National Institute of Dental and Craniofacial Research (NIDCR) criteria for the DMFT/S indices. Thirty 12-year-olds participated in a training and calibration exercise conducted in a nonparticipating public school in San Pedro de Macorís. Ten percent of the examinations were repeated at random to assess inter-examiner reliability during the study. The Spearman correlation coefficient for inter-examiner reliability was 0.91 for DMFT and 0.93 for DMFS. The weighted Kappa statistic was 0.87 (95% CI: 0.74–0.99) for caries prevalence, 0.82 (95% CI: 0.73–0.91) for DMFS, and 0.79 (95% CI: 0.68–0.90) for DMFT.

Examinations

Preceding the clinical exam and in a private area, a trained interviewer obtained the child's assent and conducted a questionnaire on oral health knowledge and habits. Following these data collection steps, the examiners completed the oral examinations.

Prior to the dental examination, each child received a toothbrush and a toothpaste to brush his or her teeth (under supervision). Clinical exams were conducted using portable dental equipment. The 2 examiners used a headlight and loupe to perform the dental examinations. Dental-caries assessments were conducted following the visual–tactile criteria, using an unmarred, non-magnifying front-surface dental mirror, air, and a #23 dental explorer. The explorer was used to gently remove plaque and debris and to check for surface integrity. Each tooth was air-dried to detect color changes, surface contour,

cavities, restorations, and sealants. Upon completion of the oral examination, the participants received oral hygiene instructions and an oral health status report. The data were recorded on a modified NIDCR data entry form.

Data management & Statistical analysis

Data were entered into Research Electronic Data Capture (REDCap) software. All data management and statistical analyses were conducted using SAS statistical software, version 9.3 (SAS Institute, Cary, NC). All hypothesis testing was conducted at a 0.05 level of statistical significance.

All observations were weighted using inverse-probability weighting, which were later normalized to avoid inflation of statistical power. Descriptive statistics were calculated for caries prevalence, DMFS, DMFT, and SiC indices for all the participants, with strata defined by gender (male, female), school type (public or semi-official vs. private), and the combination of gender and school type (4 categories). P-values were obtained from logistic (for caries prevalence) and Poisson regression models (for DMFT, DMFS, and SiC indices), which included both gender and school type.

Results

Twenty-eight schools were selected out of a total of 138 schools; the administration of one of the selected private schools was not willing to participate in the study, and 2 public schools were closed by the time of the study initiation. Thus, 25 schools were included in the study (11 private [n = 157] and 14 public [n = 245]). Of the 420 children invited to the study, 402 (95.7%) completed the study. The reasons for non-participation were absenteeism (n = 9), the presence of orthodontic appliances (n = 3), and lack of parental consent (n = 6).

Table 1 shows that 55% of children in the study were female, with nearly 61% of all children being enrolled in public schools. The overall prevalence of dental caries was 73%, with a mean DMFS index of 3.87 (95% CI: 2.98–4.76) and a mean DMFT index of 2.64 (95% CI: 2.08–3.20). The SiC index in this group was 5.07 (95% CI: 4.28–5.85) (Table 2).

Table 4 displays the distribution of the DMFS/T index components. The D component of the DMFS was 94.95%, the M component was 2.15%, and the F component, 2.90% (Table 4). The distribution of components was similar for the DMFT index.

Gender

A higher prevalence of dental caries (77%) was observed in girls compared to boys (67%), and this difference was statistically significant after adjusting for school type (p = 0.03). Similarly, the DMFS and DMFT indices were significantly higher in girls (DMFS: 4.21; DMFT: 2.95) compared to boys (DMFS: 3.34; DMFT: 2.15; p<0.001 for both comparisons) (Table 3).

School type

There was no statistically significant difference in prevalence between public vs. private schools (p = 0.08). The mean DMFS index was significantly higher in public (4.10) than in private (3.34) schools (p = 0.001). A similar finding was observed for the DMFT index (2.82 in public vs. 2.23 in private; p<0.01). The SiC index was significantly higher in public schools compared to private schools (6.06 and 4.80, respectively; p<0.01) (Table 3).

Table 2. SiC index in 12-year-olds in San Pedro de Macorís, Dominican Republic, in all the participants as well as by gender and school type (2013).

	SiC index						
	N	Wt N	Mean	SE	95% CI		P-Value[1]
All	175	169	5.07	0.38	4.28	5.85	
Gender							
Female	77	81	6.04	0.33	5.36	6.72	0.07
Male	68	49	5.11	0.53	4.01	6.20	
School type							
Public	83	87	6.06	0.37	5.27	6.85	<0.01
Private	58	45	4.80	0.47	3.75	5.86	

[1] P-values were obtained from Poisson regression models, weighted according to the sampling weights.

Table 1. Caries prevalence, DMFS/T scores, and SiC index in 12-year-olds in San Pedro de Macorís, Dominican Republic, in all the participants as well as by gender and school type (2013).

	N	Wt N	Caries prevalence				DMFS					DMFT				
			%	95% CI		P-Value[1]	Mean	SE	95% CI		P-Value[2]	Mean	SE	95% CI		P-Value[2]
All	402	402	73.25	69.70	76.80		3.87	0.43	2.98	4.76		2.64	0.27	2.08	3.20	
Gender																
Female	223	244	77.36	72.38	82.34	0.03	4.21	0.29	3.61	4.81	<0.001	2.95	0.22	2.50	3.41	<0.001
Male	179	158	66.89	59.59	74.18		3.34	0.66	1.97	4.70		2.15	0.34	1.45	2.86	
School type																
Public	245	279	76.65	62.99	90.31	0.08	4.10	0.58	2.85	5.35	0.001	2.82	0.35	2.07	3.57	<0.01
Private	157	123	68.18	61.10	75.26		3.34	0.52	2.18	4.51		2.23	0.23	1.71	2.75	

[1]P-values were obtained from logistic regression models, weighted according to the sampling weights. [2]P-values were obtained from Poisson regression models, weighted according to the sampling weights.

Table 3. Caries prevalence, DMFS/T scores, and SiC index in 12-year-olds in San Pedro de Macorís, Dominican Republic, comparing gender and school-type groups (2013).

Strata	N	Wt N	Caries Prevalence		DMFS			DMFT			SiC Index				
			Percent	P-value[1]	Mean	SE	P-value[2]	Mean	SE	P-value[2]	N	Wt N	Mean	SE	P-Value[2]
Girls, public	140	176	80.75	0.001	4.43	0.31	<0.001	3.19	0.21	<0.001	56	64	6.00	0.39	<0.01
Boys, public	105	103	66.52	0.88	3.54	1.01	0.06	2.20	0.52	0.60	40	28	5.70	0.58	0.03
Girls, private	83	69	68.67	0.89	3.65	0.66	0.04	2.36	0.32	0.28	30	25	5.23	0.64	0.15
Boys, private (ref.)	74	55	67.57	-	2.96	0.41	-	2.07	0.21	-	28	21	4.29	0.27	-

[1]P-values were obtained from logistic regression models, weighted according to the sampling weights. [2]P-values were obtained from Poisson regression models, weighted according to the sampling weights.

Table 4. Dental caries indices by component[1] in permanent teeth of 12-year-olds in San Pedro de Macorís, Dominican Republic (2013).

Component	DMFT						DMFS					
	Percent per Component[2]			Number of teeth affected/child			Percent per Component[2]			Number of teeth affected/child		
	%	SE	95% CI	Mean	SE	95% CI	%	SE	95% CI	Mean	SE	95% CI
D	96.46	1.90	92.54 - 100.00	2.55	0.29	1.96 - 3.14	94.95	2.13	90.56 - 99.33	3.53	0.42	2.67 - 4.39
M	1.32	0.67	0.06 - 2.69	0.04	0.02	0.00 - 0.09	2.15	1.02	0.05 - 4.25	0.22	0.11	0.02 - 0.45
F	2.23	1.55	0.98 - 5.43	0.05	0.03	0.02 - 0.12	2.90	1.55	0.30 - 6.10	0.12	0.04	0.03 - 0.20

[1]Percentage and number of teeth affected per child (mean, SE, and 95% confidence intervals). [2]Percentages for each component of DMFT and DMFS were calculated in those with a DMFS>0.

Gender and School type

The highest prevalence of caries was observed among girls in public schools (80.75%). This group also had the highest DMFS, DMFT, and SiC indices (4.43, 3.19, and 6.0, respectively) (p-values comparing to boys in private schools were <0.01 for all indices) (Table 3).

Discussion

This cross-sectional study estimated the prevalence and extent of dental caries in 12-year-olds from San Pedro de Macorís, DR, using the mean DMFT/S indices and the SiC index. The SiC index was introduced in 2000 to bring attention to those individuals with the highest dental caries scores (15). In our study, the overall prevalence of dental caries was 73%, indicating a significant reduction compared to the prevalence of 95% that was reported in a 1977 study conducted in the DR (17). Public/private school attendance has been used as a proxy for socioeconomic status, with private school attendance signifying that a family has a higher socioeconomic status (11, 23–27).

Children in public schools presented a statistically significantly higher mean DMFS/T and SiC index, as well as having a higher percentage of the unfilled component of the indices, compared to private school attending children. These health inequalities suggest an association between caries and socioeconomic status, as well as inequalities in access to dental services. Studies have suggested that oral health disparities persist in countries with developing economies, such as those of the DR and Puerto Rico (11). In Puerto Rico, from 1997 to 2010, dental caries showed a reduction of 10% in 12-year-olds. Nevertheless, the difference (gap) in caries indicators between those attending public and private schools increased. In the same study, all dental caries indicators presented significantly higher prevalences in girls compared to boys (11).

It has been reported that adolescent girls are twice as likely as boys to suffer severe caries, which statistic was identified using the SiC index (26). Higher odds of caries incidence/severity have also been reported in female toddlers and preschoolers (28, 29). In contrast, other studies have reported no significant difference by gender (30). The gender differences observed in the present study could be attributed to the earlier eruption of teeth in girls (31, 32), salivary composition and flow rate, hormonal fluctuations, dietary habits, and genetic variations, among others (33). Additional studies are needed to assess the nature and determinants of gender-related caries differences.

The results of this study indicated that the boys and girls from public schools in San Pedro de Macorís had a lower DMFT index (2.60) than did children attending private schools. These findings suggest that children, particularly public-school attendees, would benefit from having better access to dental care.

Because of the multifactorial nature of the dental caries process and the fact that the disease is very dynamic, studies on risk assessment tend to be complex, with multiple variables challenging a given prediction at different times during an individual's life (34). A variety of factors are involved in the caries process, including sugar consumption, oral hygiene habits, and fluoride exposure, among others (35–37). A recent critical review by Sheiham and James indicated that tooth decay is a diet-mediated disease and that oral hygiene and fluoride play an important role in modifying caries development (35).

Regarding fluoride, fluoridated drinking water is not available in the DR; however, high concentrations of natural fluoride have been reported in the Enriquillo Region. A water fluoridation program was conducted in the Cibao Central Region from 1982 to 1984; however, this program was discontinued, except in San Juan de la Maguana, because of the lack of chemical resources and the lack of equipment maintenance/supervision. A study conducted in 1993 in the DR concluded that only 5% of the communities had fluoride concentrations higher than 0.7 mg/L (38). Later, the Kellogg Foundation provided funding to initiate or optimize salt fluoridation programs; however, the salt industry was destroyed in the late 90s due to climatic phenomena (39). As of 2011, a fluoridated salt program has yet to be implemented (39). Regarding the availability of fluoride in the drinking water in San Pedro de Macorís, no recent data have been publicly reported. Drinking-water analyses to determine current fluoride concentrations, nationwide, are required prior to the implementation of national oral health policies. Most worldwide reports reveal a decrease in caries prevalence in children and young adults (40–43). The study in San Pedro de Macorís demonstrates that the World Health Organization (WHO) goal for the year 2000 of all 12-year-olds having a DMFT of less than or equal to 3 was achieved by all the participants in our study (44); however, the mean DMFT/S score is high compared to those reported in other Caribbean nations (40). In the countries Cuba and Jamaica, apart from cultural and lifestyle differences, there are public policy programs on community fluoridation. In Cuba, there are limited water fluoridation programs, a national program for fluoridated salt consumption, and a national school program of fluoride rinses and varnishes. In Jamaica, there is a national salt fluoridation program (45).

Data from the present study will be used in the design and implementation of oral health promotion programs to reduce oral health gaps in children residing in San Pedro de Macorís, DR. The questionnaire findings will be presented in a future publication.

One limitation of this study is that the results cannot be generalized to the entire island because San Pedro de Macorís is a single province in the DR. Moreover, there is a possibility that, due to the lack of radiographic data, some interproximal non-cavitated lesions might not have been detected. Another study limitation may be the lack of individual-level economic data and the use of a surrogate socioeconomic measure (school type); however, any misclassification is expected to be non-differential and would, most likely, introduce only a small amount of bias.

Conclusions

The highest prevalence of caries in children from San Pedro de Macorís, DR, was observed in girls in public schools. The mean DMFT, DMFS, and SiC indices, as well as the D component of the DMFT/S, were significantly higher in public school–attending girls compared to both girls and boys attending private schools, suggesting that there are oral health disparities and care access barriers. It is important to conduct an islandwide study assessing dental caries status and to design and implement prevention strategies. Oral health disparities can be eliminated only when targeted by well-designed studies and supported by prevention efforts.

Resumen

Objetivo: La caries es una de las enfermedades crónicas más frecuentes. Actualmente, no hay datos disponibles sobre la prevalencia de caries en la República Dominicana. El propósito de este estudio fue estimar la prevalencia de caries en niños de 12 años que asistían a la escuela en San Pedro de Macorís, República Dominicana. Métodos: Se realizó un estudio epidemiológico transversal utilizando una muestra probabilística, estratificada por tipo de escuela (público/privado) y género. Dos examinadores realizaron las evaluaciones. La experiencia de las caries se resumió en términos de prevalencia, número de dientes y superficies cariados, perdidos y obturados (CPOD y CPOS) y el Índice Significativo de Caries (SiC), entre todos los participantes, por género y tipo de escuela. Se utilizaron modelos de Regresión Logística y de Poisson para comparar por género y tipo de escuela. Resultados: Cuatrocientos dos niños de 12 años en 14 escuelas públicas y 11 privadas fueron evaluados. La prevalencia general de caries dental fue 73%. Los índices promedios fueron: CPOS=3.87, CPOD=2.64 y SiC=5.07. Las niñas presentaron un promedio más alto de CPOS, CPOD y SiC en comparación con los niños. Los niños de escuelas públicas tenían índices CPOS, CPOD y SiC significativamente más altos que los que asistían a escuelas privadas. El componente cariado (C) representó el 71% del índice CPOD. Conclusión: El objetivo de la OMS de un CPOD≤3 se cumplió en todos los participantes en nuestro estudio. El alto índice de dientes cariados sugiere que las necesidades de caries dental no se están cumpliendo. Esta información ayudará en el diseño e implementación de futuros programas preventivos.

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References

1. Petersen PE, Bourgeois D, Ogawa H, Estupinan-Day S, Ndiaye C. The global burden of oral diseases and risks to oral health. Bull World Health Organ. 2005;83:661-669.
2. Selwitz RH, Ismail AI, Pitts NB. Dental caries. Lancet. 2007;369:51-59.
3. Fontana M, Santiago E, Eckert GJ, Ferreira-Zandona AG. Risk Factors of Caries Progression in a Hispanic School-aged Population. J Dent Res. 2011;1189-1196.
4. Agaku IT, Olutola BG, Adisa AO, Obadan EM, Vardava CI. Association between unmet dental needs and school absenteeism because of illness or injury among U.S. school children and adolescents aged 6-17 years, 2011-2012. Prev Med. 2015;72:83-88.

5. Ribeiro GL, Gomes MC, de Lima KC, Martins CC, Paiva SM, Granville-Garcia AF. Work absenteeism by parents because of oral conditions in preschool children. Int Dent J. 2015;61:331-337.
6. Touger-Decker R, Mobley CC; American Dietetic Association. Position of the American Dietetic Association: oral health and nutrition. J Am Diet Assoc. 2007; 2007;107:1418-1428
7. Assael LA. Tooth Decay. J Oral Maxillofac Surg. 2010;68:237-238.
8. Moazzam AA, Rajagopal SM, Sedghizadeh PP, Zada G, Habibian M. Intracranial bacterial infections of oral origin. J Clin Neurosci. 2015;22: 800-806.
9. Dye BA, Thornton-Evans G, Li X, Iafolla TJ. Dental caries and sealant prevalence in children and adolescents in the United States, 2011–2012. NCHS Data Brief. 2015;191:1-8.
10. Marcenes W, Kassebaum NJ, Bernabé E, et al. Global Burden of Oral Conditions in 1990-2010: A Systematic Analysis. J Dent Res. 2013;92: 592-597.
11. Elias-Boneta AR, Toro MJ, Rivas-Tumanyan, et al. Persistent oral health disparity in 12-year-old Hispanics: a cross-sectional study. BMC Oral Health. 2016;16:1-10.
12. Sgan-Cohen HD, Evans RW, Whelton H, Villena RS, MacDougall M, Williams DM; IADR-GOHIRA Steering and Task Groups. IADR Global Oral Health Inequalities Research Agenda (IADR-GOHIRA(R): A call to action. J Dent Res. 2013;92:209-211.
13. Klein H, Palmer CE. Sex differences in dental caries experience of elementary school children. Public Health Rep. 1938;53:1685-1690.
14. Burt BA, Baelum V, Fejerskov O, Kidd E. Dental Caries: The disease and its clinical management. 2nd ed. Oxford, England: Blackwell Munksgaard; 2009:123-126.
15. Ditmyer M, Dounis G, Mobley C, Schwarz E. Inequalities of caries experience in Nevada youth expressed by DMFT index vs. Significant Caries Index (SiC) over time. BMC Oral Health. 2011;11:1-10.
16. Oficina Nacional de Estadística de la Republica Dominicana IX Censo Nacional de Población y Vivienda, 2010. Available at: http://censo2010.one.gob.do/volumenes_censo_2010/vol1.pdf. Accessed December 13, 2019.
17. Secretaria de Estado de Salud y Asistencia Social. Organización Panamericana de la Salud. Fundación Kellogg. Estudio Epidemiológico de Salud Bucal en Niños de 6, 7, 8, 12, y 15 años de Escuelas Públicas de Republica Dominicana: Protocolo de Investigación. 1997; 1-26.
18. Federation Dentaire Internationale (World Dental Federation). The Oral Health Atlas; 2009.
19. Collins J, Bobadilla M, Fresno MC. Indicadores de Riesgo Cariogénico en Adolescentes de Santo Domingo Republica Dominicana. Rev Clin Periodoncia Implantol Rehabil Oral. 2008;1:86-89.
20. Psoter WJ, Saint Jean HL, Morse DE, et al. Dental Caries in twelve- and fifteen- year-olds: results from the basic oral health survey in Haiti. J Public Health Dent. 2005;65:209-214.
21. Departmento de Educacion, San Pedro de Macoris, 2012.
22. Daabiss M. American Society of Anaesthesiologists physical status classification. Indian J Anaesth. 2011;55:111-115.
23. Elías-Boneta AR, Crespo Kebler K, Gierbolini CC, Toro Vizcarrondo CE, Psoter WJ. Dental caries prevalence of twelve year olds in Puerto Rico. Community Dent Health. 2003;20:171-176.
24. Irigoyen ME, Luengas IF, Yashine A, Mejía AM, Maupomé G. Dental caries experience in Mexican schoolchildren from rural and urban communities. Int Dent J. 2000;50:41-45.
25. Adekoya-Sofowora CA, Nasir WO, Oginni AO, Taiwo M. Dental caries in 12-year-old suburban Nigerian school children. Afr Health Sci. 2006;6:145-150.
26. Piovesan C, Mendes FM, Antunes JLF, Ardenghi TM. Inequalities in the distribution of dental caries among 12-year-old Brazilian schoolchildren. Braz Oral Res. 2011;25:69-75.
27. Morales Olivo E. La importancia de la preparación universitaria en estudiantes en desventaja social y económica. Revista Griot. 2012;5:18-27.
28. Ismail AI, Sohn W, Lim S, Willem JM. Predictors of dental caries progression in primary teeth. J Dent Res. 2009;88:270-275.
29. Declerck D, Leroy R, Martens L, et al. Factors associated with prevalence and severity of caries experience in preschool children. Community Dent Oral Epidemiol. 2008;36:168-178.
30. Wyne AH. Caries Prevalence, Severity, and Pattern in Preschool Children. J Contemp Dent Pract. 2008;9:24-31.
31. Joshi N, Sujan SG, Joshi K, Parekh H, Dave B. Prevalence, severity, and related factors of dental caries in school going children of Vadodara City - An epidemiological study. J Int Oral Health. 2013;5:35-39.
32. Martinez-Mier EA, Zandona AF. The impact of gender on caries prevalence and risk assessment. Dent Clin North Am. 2013;57:301-315.
33. Lukacs JR, Largaespada LL. Explaining sex differences in dental caries prevalence: Saliva, hormones, and "life-history" etiologies. Am J Hum Biol. 2006;18:540-555.
34. Fontana M, Santiago E, Eckert GJ, Ferreira-Zandona AG. Risk Factors of Caries Progression in a Hispanic School-aged Population. J Dent Res. 2011;90:1189-1196.
35. Sheiham A, James WP. A new understanding of the relationship between sugars, dental caries and fluoride use: implications for limits on sugars consumption. Public Health Nutr. 2014:10:2176-2184.
36. Gil GS, Morikava FS, Santin GC, Pintarelli TP, Fraiz FC, Ferreira FM. Reliability of self-reported toothbrushing frequency as an indicator for the assessment of oral hygiene in epidemiological research on caries in adolescents: a cross-sectional study. BMC Med Res Methodol. 2015;15:14.
37. Carey CM. Focus on fluorides: update on the use of fluoride for the prevention of dental caries. J Evid Based Dent Pract. 2014;14:95-102.
38. Baez R, Beltran E. Organización Panamericana de la Salud. Análisis Institucional de Costo-Beneficio Programa Nacional de Fluoruración de la Sal. Santo Domingo, República Dominicana, 1997.
39. Piovano S, Bordoni N. et al. Informe sobre fluoruración de la sal. Rev. Fac. Odontol. (B.Aires). 2011;26:35-41.
40. World Health Organization. Oral Health Country/Area Profile Programme [World Health Organization Web site]. Malmö, Sweden: Department of Noncommunicable Diseases Surveillance/Oral Health, WHO Collaborating Centre, Malmö University. Available at: http://www.who.int/oral_health/databases/malmo/en/index.html . Accessed on December 9, 2019.
41. Hugoson A, Koch G, Hallonsten AL, Norderyd J, Aberg A. Caries prevalence and distribution in 3-20-year-olds in Jönköping, Sweden, in 1973, 1978, 1983, and 1993. Community Dent Oral Epidemiol. 2000;28:83-89.
42. Steiner M, Menghini G, Marthaler TM, Imfeld T. Changes in dental caries in Zurich school-children over a period of 45 years [in German]. Schweiz Monatsschr Zahnmed. 2010;120:1084-1104.
43. Schuller AA, van Dommelen P, Poorterman JH. Trends in oral health in young people in the Netherlands over the past 20 years: a study in a changing context. Community Dent Oral Epidemiol. 2014;42:178-184.
44. World Health Organization. Oral Health Information Systems [World Health Organization Web site]. Available at: https://www.who.int/oral_health/action/information/surveillance/en/. Accessed on December 9, 2019.
45. Marthaler TM. Salt fluoridation and oral health. Acta Med Acad 2013; 42:140-155.