

Publication Types: Research

## Evolution of caries and fluorosis in schoolchildren of the Canary Islands (Spain): 1991, 1998, 2006

Gladys Gómez-Santos <sup>1</sup>, González-Sierra MA <sup>2</sup>, Vázquez-García-Machiñena J <sup>3</sup>

(1) Coordinator of the Oral Health Program. Health Promotion Service. General Directorate for Public Health. Canary Islands Health Service

(2) Professor of Statistics and Operational Research. University of La Laguna

(3) Expert of the Oral Health Program. Health Promotion Service. General Directorate for Public Health. Canary Islands Health Service

### Correspondence:

Dr. Gladys Gómez Santos

Dirección General de Salud Pública

Rambla General Franco 53

38006 Santa Cruz de Tenerife

E-mail: [ggomsan@gobiernodecanarias.org](mailto:ggomsan@gobiernodecanarias.org)

Received: 22/05/2007

Accepted: 11/07/2008

### Indexed in:

-Index Medicus / MEDLINE / PubMed  
-EMBASE, Excerpta Medica  
-SCOPUS  
-Índice Médico Español  
-IBCS

Gómez-Santos G , González-Sierra MA, Vázquez-García-Machiñena J. Evolution of caries and fluorosis in schoolchildren of the Canary Islands (Spain): 1991, 1998, 2006. *Med Oral Patol Oral Cir Bucal*. 2008 Sep;13(9):E599-608.

© Medicina Oral S. L. C.I.F. B 96689336 - ISSN 1698-6946

<http://www.medicinaoral.com/medoralfree01/v13i9/medoralv13i9p599.pdf>

### Abstract

The aim of this work is to assess the evolution of caries and fluorosis prevalence and indices at 7 and 12 years of age in the Canary Islands through three cross epidemiological studies conducted in 1991, 1998 and 2006.

The three studies followed a similar methodology, using the WHO diagnosis criteria and indications, except for the assessment of fluorosis, which was measured with the "Thylstrup and Fejerskov" index. The examining dentists were trained and calibrated in an area with high endemic fluorosis. The three studies took a sample of 1000 students for each age group.

At 7 years of age, the decayed, and filled teeth (dft) varied from 1.42 in 1991 to 1.14 in 1998 and 1.37 in 2006. At 12 years of age, the Decayed, Missing, and Filled Teeth (DMFT) went from 1.86 to 1.21 and 1.51 in the three studies respectively and the significant caries index (SiC) went from 4.28 to 3.15 and 3.72. At this age, the Filled Rate rose from 24.05% in 1991 to 30.43% in 1998 and to 37.20% in 2006. In relation to fluorosis, at 12 years of age the percentage of healthy or fluorosis-free schoolchildren in the Canary Islands between the first and the second studies went down from 73% to 61.3% and went up to 78.5% in 2006, with a noticeable fall in the prevalence of children with severe and moderate fluorosis.

Despite the fluctuations of caries shown in the three studies, at 12 years of age the Canary Islands have remained in the low level of caries of the WHO classification from 1991 up to now. The evolution in the prevalence of dental fluorosis shows the effect of the measures taken, 10 years after they were started.

**Key words:** Caries, fluorosis, school-children, DMFT, SiC, Filled Rate.

### Introduction

Scientific evidence about the protective role of fluoride in the public water supply in caries prevention is broad and conclusive (1), even though it is the massive use of fluoride toothpaste that has been the most important cause of the reduction of caries in developed countries since the 70s (2). However, an excessive intake of fluoride in children under 8 years of age may cause dental fluorosis (3), a pathology that is endemic in certain areas of the Canary Islands (4, 5).

The complexity of the public drinking water supply systems in the Canary Islands makes fluoride concentration very variable between the different centres of population. At present, all the systems for drinking water supply for public use in the Islands of Lanzarote, Fuerteventura, La Palma, La Gomera and El Hierro show fluoride concentration values below 0.7 mg/l. By contrast, in the islands of Gran Canaria and Tenerife, there are large variations between the different individual centres of population of each municipality and, in many of them, the concentration

of 1.5 mg/l recommended by the WHO to prevent caries without causing fluorosis is exceeded (6).

The aim of this work is to assess the evolution of caries prevalence and the caries and filled rates at 7 and 12 years of age and to analyze the evolution of fluorosis prevalence and the Thylstrup and Fejerskov Index (TFI) at 12 years of age through the epidemiological studies of 1991, 1998 and 2006 (4, 5, 7).

### Methodology

In 1991 the General Directorate for Public Health carried out in the Canary Islands the First Epidemiological Study of Oral Health in school children of the Canary Islands at 7 and 12 years of age. This study assessed the caries, periodontal condition and fluorosis, following the WHO criteria for this type of studies (4, 7, 8). A second study was carried out later on, in 1998 (5), which also included a group of 14-year-olds, and a third epidemiological study was likewise made in the year 2006 (9).

The three studies, directed by the same person and with the participation of the same statistical advisor, have followed a similar methodology. The file for "Simplified Valuation of Oral Health (WHO)" (10) was used, except for the valuation of fluorosis, which was measured with the "Thylstrup and Fejerskov" index (11).

Previously, the examining odontostomatologists were trained and calibrated, with plaster moulds with natural teeth and with groups of students of each of the age groups considered, in an area with high endemic fluorosis. Throughout the studies, the intra-observer consensus was maintained by duplicating 10% of their examinations.

The three surveys were conducted in the geographical area of the Spanish Region of the Canary Islands, which is administratively divided into 2 provinces, which are subdivided into 34 and 53 municipalities. This is apart from the geographical reality of the seven islands: Tenerife, La Palma, La Gomera and El Hierro making up the province of Santa Cruz de Tenerife, and Gran Canaria, Lanzarote and Fuerteventura making up the province of Las Palmas. It can be summarized indicating that the administrative units of interest are: the province, the islands and the "comarcas" or groups of boroughs.

Since the population is in the compulsory schooling period, centers of education were also an important entity in our studies, which we have divided into public centers and private/semi-private centers. The list of these centers was provided by the Regional Education Ministry of the Government of the Canary Islands.

Finally, taking into account the results of the first study, the concentration of fluoride in publicly supplied water was considered of interest from the second study onwards, with a division being made between <1.5 ppm and >1.5 ppm.

#### - Design of the sample

A two-stage sample was selected, for each one of the age

groups considered separately, stratified in the first stage units. The first stage units are formed by the school centers. School centers were stratified according to a triple criterion: comarca, type of center and fluoride concentration in the water. The second stage units are formed by the school children of the selected centers for each age group of interest, which were those children who were already 7 and 12 years of age or who were going to turn 7 and 12 during the period of field work and who were normally in 2nd year of primary school and 1st year of secondary school or their equivalents, respectively, except for some repeating students found in lower grades. In order to do this, we requested the Regional Education Ministry to provide us with the lists of school children attending the selected centers with their birth dates. School children who did not have, at the moment of the examination, the consent document signed by their parents were excluded and replaced by others from a reserve list.

#### - Size of the sample

Taking into account the results obtained in previous epidemiological studies, our economic resources and time conditions, a sample with a size of 1000 students was adopted in the three studies for each age group. Given the small population size of the comarcas of La Gomera and El Hierro, the size of the sample was increased to 25 school children in each age group, with the aim of having estimates of the DMFT based on an acceptable size of sample. This excess of sample was only taken into consideration in the analysis by Islands and comarcas; in any other type of analysis, the cases were suitably adjusted to eliminate this excess.

#### - Selection of the sample

For the sampling units of the first stage, a simple random sampling among the school centers was made, in accordance with the sample sizes of each stratum and in such a way as to avoid the number of school children observed from each school and age group going over thirty. A list of students of the age of interest in each selected school was requested in order to subsequently conduct a simple random sampling among the students in accordance with the number of school children corresponding to each school in relation to their belonging to each stratum. Depending on the cases, it was necessary to arrange a second visit to the school, in order to complete the sample.

#### - Acquisition process

The surveys made in the sampling were recorded in a magnetic storage device, with double recording, and they were included in an excel file. Afterwards a verification of the recordings was conducted by checking 10% of the sample. Subsequently a data purge was carried out relating to codes and categories verification and logic inconsistencies. Finally, the information was transferred to the statistical software SPSS.

#### - Statistic analysis

The statistic analysis was carried out on a Pentium

personal computer using the SPSS 12 program. The descriptive information was presented, for each one of the aspects of oral health studies, in accordance with the whole of the Canary Region and then separated by provinces, islands and regions, as well as broken down by sex, ownership of the school, concentration of fluoride in public water supply and socio-professional category, according to the classification of Domingo Salvany and Marcos Alonso (12). In order to know the category that each student belongs to, in the 1998 and 2006 studies, 12 year-old students were personally asked, at the moment of the examination, about the occupation of their father and mother. These details were recorded and then the occupation of the parent with the lowest number category in the Salvany and Alonso scale was selected, that is, the most economically favoured category. If there were any doubts, these were confirmed with the teaching staff. In the case of separated parents, the category of the parent with whom the student resided most of the time was chosen. For 7-year-old students, this information could be obtained from the teaching staff. Later on, for the presentation of the results, the 7 categories of the scale were regrouped in 5 sub-categories: 1-2, 3, 4, 5-6 and 7.

Several modules were applied for the making of tables and statistical comparisons. Specifically, we have used the following statistical procedures:

- Descriptive statistics: frequency, arithmetic media, standard deviation and percentages.
- Confidence intervals for the mean
- Confidence intervals for a proportion according to Wilson
- T of Student
- Analysis of the variation of a factor. Multiple comparisons according to Ryan- Einot-Gabriel-Welsch.
- Squared Chi for the comparison of proportions. Multiple comparisons with Bonferroni adjustment.
- Kappa coefficient.

The programs used in these calculations were: T-Test, Oneway, Frequencies, Crosstabs, Means and Report of the software SPSS.

## Results

### - Caries prevalence

- Cohort of 7 years:

In the cohort of age 7, in primary dentition, the proportion of children with a record of caries went down in the Canary Islands, going from 46.1% in 1991 to 38.1% in 1998 ( $p < 0,05$ ). In the year 2006, the caries prevalence went up to 41.6%, which was not a significant change (Fig.1).

By province, in Santa Cruz de Tenerife, prevalence went down between the first two studies, from 46.6% to 34.2% ( $p < 0,05$ ) and in Las Palmas there was a non-significant reduction from 45.7% to 41.4%. In 2006 in Santa Cruz de Tenerife, it went up to 35.1% and in Las Palmas it went up to 47.1%. These changes were not statistically significant.

By island, between 1991 and 1998 there were statistically significant drops in Tenerife and El Hierro and in the rest of the islands there were non-significant reductions. In 2006, there were no significant changes by islands in comparison to 1998.

By sex, between 1991 and 1998 there was a reduction, only significant in the case of males, and from 1998 to 2006 there were no significant changes.

According to the owners of the school, between 1991 and 1998 there was a fall which was only significant in relation to the population attending publicly-owned schools and in 2006, there were no changes in comparison to 1998.

In relation to fluoride concentration, there have still not been any changes in caries prevalence between 1998 and 2006.

- Cohort of 12 years of age:

At 12 years of age, in permanent dentition, in the Canary Islands between 1991 and 1998, the proportion of children with a record of caries fell from 58.82% to 45% ( $p < 0,05$ ) and in 2006 this figure went up to 51.9% ( $p < 0,05$ ) (Fig.1).

By province, in Santa Cruz de Tenerife, between 1991 and 1998 the caries prevalence fell from 61.2% to 49.2% ( $p < 0,05$ ) and in Las Palmas there was also a significant reduction from 56.6% to 41.5%. In 2006, in Santa Cruz de Tenerife, it dropped to 44.3% and in Las Palmas, it went up to 58.2%. Only this last change was statistically significant.

By island, between 1991 and 1998, there were significant reductions in Tenerife, La Palma and Gran Canaria and in the rest of the islands there were no significant changes. In 2006, the only statistically significant change compared to 1998 was an increase in the caries prevalence in Gran Canaria.

By sex, there was a significant fall in both genders between 1991 and 1998, and in the year 2006 an increase occurred in both genders, which was more significant among males.

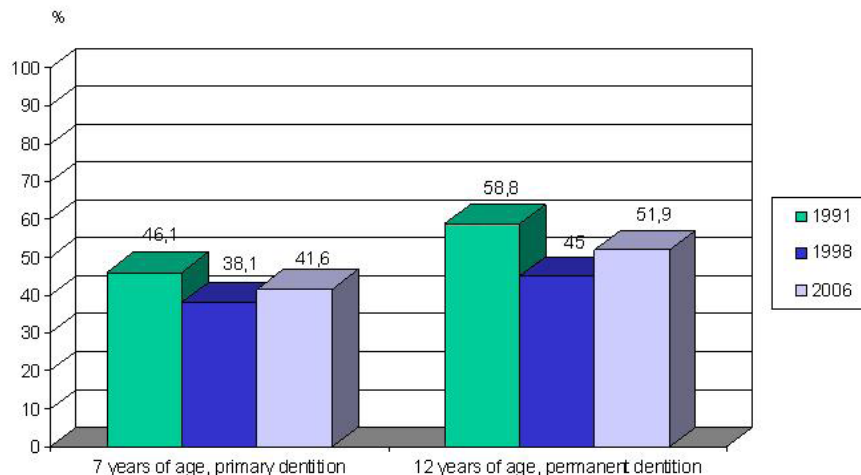
By school ownership, between 1991 and 1998 there was a decline in the caries prevalence both in students at publicly-owned schools and at private schools ( $p < 0,05$ ) and in 2006 there was a statistically significant increase in the students at publicly-owned schools and a non-significant reduction in students attending private schools.

Looking at fluoride concentration, a significant increase can be observed between 1998 and 2006 in students attending schools located in areas where fluoride concentration in public supply water is  $< 1.5$  ppm, going from 47.5% to 52.8% while there was a non-significant increase in areas with fluoride concentration above 1.5 ppm, from 29.4 % to 40 %.

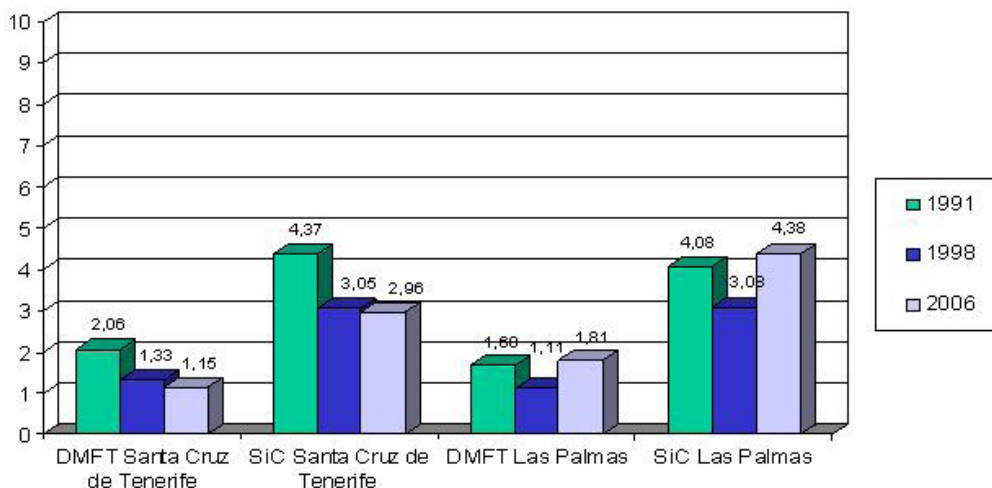
### - Caries rates and filled rates.

- Cohort of 7 years of age:

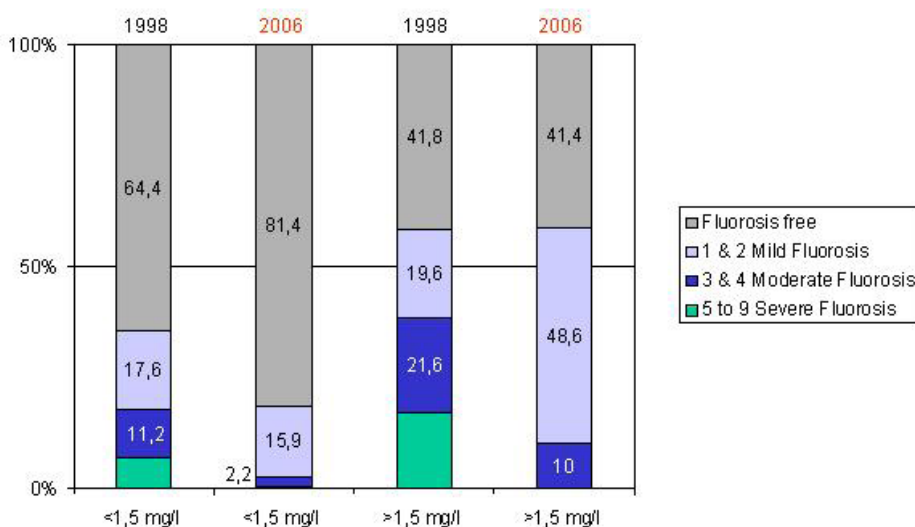
Conducting a comparative analysis between the dft rate at 7 years of age corresponding to the three epidemiological studies of 1991, 1998 and 2006 for the whole of the Ca-



**Fig. 1.** Evolution of caries prevalence in the Canary Islands at 7 years of age in primary dentition and at 12 years of age in permanent dentition. 1991, 1998 and 2006.



**Fig. 2.** Evolution of the DMFT index and of the SiC (Significant Caries Index) in the Canary Islands at 12 years of age by provinces. 1991, 1998 and 2006.



**Fig. 3.** Evolution of Fluorosis Prevalence at 12 years of age in the Canary Islands between 1998 and 2006, depending on the fluoride concentration in public supply water (mg/l). Thylstrup and Fejerskov Index.

nary islands, there is a fall from 1.42 to 1.14 between the first two studies and an increase between 1998 and 2006, rising to 1.37, both changes being statistically significant ( $p < 0.05$ ).

Comparing by province, the dft rate between 1991 and 1998 went down from 1.45 to 1.01 ( $p < 0.05$ ) in the province of Santa Cruz de Tenerife. By contrast, in the province of Las Palmas, it went from 1.39 to 1.24, which is not a significant difference. In 2006, it remained the same in Santa Cruz de Tenerife (1.01) while in Las Palmas it rose from 1.24 to 1.65 ( $p < 0.05$ ).

In the comparison by islands, between 1991 and 1998, although most of the values remained unchanged or were reduced, only the dft reductions observed in the islands of Tenerife and El Hierro are significant ( $p < 0.05$ ). In 2006 there were no significant changes in the islands except for an increase in Gran Canaria ( $p < 0.05$ ).

Between 1991 and 1998, by sex, there was a dft reduction both in males and in women, though this reduction is only significant in the case of females ( $p < 0.05$ ). By contrast, in 2006 there was a dft increase that was only significant in women ( $p < 0.05$ ).

Depending on the ownership of the school, between 1991 and 1998 a favourable evolution is also noticed, even though the dft reduction is only significant in publicly-owned schools. By contrast, in 2006, there is an increase which is only significant in publicly-owned schools.

In relation to fluoride concentration, between 1998 and 2006 there is a dft increase in students attending schools that are located in areas in which fluoride concentration in public supply water is  $< 1.5$  ppm, going from 1.20 to 1.42 ( $p < 0.05$ ) and there is a non-significant reduction (from 0.71 to 0.41) in areas with fluoride concentration over 1.5 ppm.

In respect of the Filled Rate (FR) (dt/dmft) at 7 years of age in primary dentition in the Canary Islands, it has gone from 6.73% in 1991 to 6.64% in 1998 and to 10.49% in 2006.

By province, big differences can be observed in its evolution, going in Santa Cruz de Tenerife from 8.02% to 6.68% and to 15.75% in 1991, 1998 and 2006, respectively, and in Las Palmas from 5.54% to 6.62% and to 7.75%, in the three studies, respectively.

By island, the most favourable changes occurred in Tenerife and La Palma, which at present in 2006 have the highest FR values: 15.95% and 16.39% respectively. The lowest values are those of La Gomera and El Hierro, with nil FR values in both islands since the dt was 0, both in 1998 and in 2006 in both of them.

By socio-professional category, an FR increase is observed in all categories between 1998 and 2006, with higher FR in the most favoured categories. In the last study in 2006, the following values were obtained: 27.81% in category 1-2, 16.67% in category 3; 9.81% in category 4 and 6.89% in category 5-6.

This is consistent with the differences observed depending on school ownership. In 1991, the FR among students of publicly-owned schools was 6.01% and among students of private schools it was 11.06%. These figures went up to 6.34% and 9.57% respectively in 1998 and, in 2006, to 8.89% and 18.89% respectively.

• Cohort of 12 years of age:

Table 1 shows the comparative analysis between the DMFT at 12 years of age corresponding to 1991, 1998 and 2006. For the whole of the Canary Region, there was a statistically significant DMFT fall between 1991 and 1998 going from 1.86 to 1.21. By contrast, from 1998 to 2006 there was a slight increase in the DMFT, reaching a value of 1.51 ( $p < 0.05$ ).

Between 1991 and 1998, we can see a reduction in the rates of both provinces ( $p < 0.05$ ), going from 2.06 to 1.33 in Santa Cruz de Tenerife and from 1.68 to 1.11 in Las Palmas. By contrast, between 1998 and 2006 the evolution in both provinces is different, with stagnation in the province of Santa Cruz de Tenerife, being the DMFT value 1.15 and with a significant increase ( $p < 0.05$ ) in Las Palmas, reaching a value of 1.81 (Fig.2).

Among the islands in the western province, in Tenerife and La Palma there was a significant reduction between 1991 and 1998, but in 2006 there is a situation of stagnation. There were no significant changes in the rest of the islands. In the islands of the eastern province, a reduction is seen in Gran Canaria ( $p < 0.05$ ) between 1991 and 1998, while there was a significant increase in 2006. The changes that occurred in Lanzarote and Fuerteventura were not statistically significant.

In relation to fluoride concentration, it is observed that between 1998 and 2006 there was a significant increase ( $p < 0.05$ ) in students attending schools located in areas in which fluoride concentration in public supply water is  $< 1.5$  ppm, going from 1.30 to 1.56 and there was a non-significant increase (from 0.63 to 0.91) in areas with fluoride concentration above 1.5 ppm.

The SiC (Significant Caries Index), which is defined as the mean DMFT of the third with highest caries scores (13) and which is used as complementary to the DMFT, at 12 years of age in the Canary Islands went from a value in 1991 of 4.28 to 3.15 in 1998 and 3.72 in 2006.

By province, the evolution of this index in Santa Cruz de Tenerife went from 4.37 in 1991 to 3.05 in 1998 and to 2.96 in 2006. By contrast, in Las Palmas it went down from 4.08 to 3.08 and later on it went up to 4.38 (Fig.2).

Out of the seven islands, only Tenerife had a reduction of the SiC in the three studies, going from 4.50 in 1991 to 3.42 in 1998 and to 2.92 in 2006. In the rest of the islands there was a different evolution of the index in 1998 and 2006, but at present all islands have values under those of 1991, except the island of Gran Canaria.

The Filled rate (FR) at 12 years of age (DT/DMFT) in the Canary islands went from 24.05% in 1991 to 30.43% in 1998 and to 37.20% in 2006.

**Table 1.** Comparisons of the DMFT indices in the studies of 1991, 1998 and 2006 for the variables Province, Island, Sex, Ownership, Socio-Professional Category and Fluoride Concentration, at 7 and 12 years of age.

	7 years of age			Signif	CI	12 years of age			Signif	CI
	1991	1998	2006			1991	1998	2006		
	dft	dft	dft			DMFT	DMFT	DMFT		
Canary Islands	1.42	1.14	1.37	*	b ca	1.86	1.21	1.51	*	b c a
<b>PROVINCE</b>										
S.C.Tenerife	1.45	1.01	1.01	*	cb a	2.06	1.33	1.15	*	cb a
Las Palmas	1.39	1.24	1.65	*	ba c	1.68	1.11	1.81	*	b ac
<b>ISLAND</b>										
Tenerife	1.40	0.95	0.96	*	bc a	1.90	1.30	1.07	*	cb a
La Palma	2.00	1.72	1.69	NS		3.70	1.91	1.93	*	bc a
La Gomera	1.40	0.79	0.52	NS		1.72	0.66	1.20	NS	
El Hierro	2.08	0.77	0.84	*	bc a	2.40	1.17	1.16	NS	
Gran Canaria	1.26	1.11	1.49	*	ba ac	1.60	0.84	1.76	*	b ac
Lanzarote	1.97	1.95	1.94	NS		2.32	2.57	1.93	NS	
Fuerteventura	2.26	1.79	2.50	NS		1.89	2.39	2.17	NS	
<b>SEX</b>										
Masculine	1.49	1.28	1.46	NS		1.52	1.06	1.30	*	b ca
Feminine	1.34	0.99	1.26	*	b ca	2.21	1.36	1.73	*	b c a
<b>OWNERSHIP</b>										
Public	1.60	1.23	1.49	*	b ca	1.99	1.30	1.70	*	b c a
Private/Semi-private	0.84	0.66	0.93	NS		1.39	0.75	0.80	*	bc a
<b>SOCIO-PROFES. CAT.</b>										
1-2		0.62	0.68	NS	(-0.41,0.28)		1.00	0.85	NS	(-0.19,0.48)
3		0.89	1.07	NS	(-0.72,0.37)		1.01	0.86	NS	(-0.28,0.59)
4		1.24	1.41	NS	(-0.46,0.12)		1.26	1.55	*	(-0.55,-0.03)
5-6		1.26	1.50	NS	(-0.60,0.12)		1.30	1.95	*	(-0.99,-0.31)
7		1.67	1.82	NS	(-0.92,0.63)		1.54	1.80	NS	(-1.19,0.67)
<b>FLUORIDE CONCENT.</b>										
Below 1.5 ppm		1.20	1.42	*	(-0.41,-0.02)		1.30	1.56	*	(-0.44,-0.08)
Over 1.5 ppm		0.71	0.41	NS	(-0.07,0.66)		0.63	0.91	NS	(-0.72,0.14)

a=1991 b=1998 c=2006; contiguous letters (ba) means that there is no mean difference; separate letters (a b) indicates a mean difference.

In case there are just two means, the confidence interval for the difference between two means is indicated.

\* = SIGNIFICANT AT 0.05

NS = NON-SIGNIFICANT AT 0.05

MEDIA COMPARISON

**Table 2.** Comparisons of the Prevalence of Fluorosis (%) using the Thystrup and Fejerskov (TF) index in the studies of 1991, 1998 and 2006 for the variables Province, Island, Sex, Ownership, Socio-Professional Category and Fluoride Concentration, at 12 years of age. (TF 1-2: mild fluorosis; TF 3-4: moderate fluorosis; TF 5-9: severe fluorosis).

	Fluorosis 1991			Fluorosis 1998			Fluorosis 2006			Signif
	n	Healthy	TF-1 to 2	n	Healthy	TF-1 to 2	n	Healthy	TF-1 to 2	
Canary Islands	1124	73.0	15.7	1084	61.3	17.9	987	78.5	18.2	0.5
<b>PROVINCE</b>										
S.C.Tenerife	530	81.3	10.8	491	62.9	17.1	449	77.7	18.0	0.4
Las Palmas	594	65.7	20.0	593	59.9	18.5	538	79.2	18.4	0.6
<b>ISLAND</b>										
Tenerife	470	79.6	11.9	441	63.7	15.4	397	75.3	19.9	0.5
La Palma	46	93.5	2.2	35	51.4	40.0	40	97.5	2.5	0.0
La Gomera	25	96.0	4.0	30	60.0	13.3	25	100.0	0.0	0.0
El Hierro	25	92.0	0.0	30	86.7	13.3	25	84.0	16.0	0.0
Gran Canaria	507	61.3	22.7	497	53.1	21.5	423	76.4	20.6	0.7
Lanzarote	59	93.2	0.0	60	98.3	1.7	69	98.6	1.4	0.0
Fuerteventura	28	85.7	14.3	36	88.9	5.6	46	76.1	23.9	0.0
<b>SEX</b>										
Male	568	73.6	15.1	539	57.7	18.0	490	77.1	20.4	0.6
Female	557	72.5	16.2	544	64.9	17.6	496	80.0	15.9	0.4
<b>SCHOOL OWNERSHIP</b>										
Public	886	72.3	15.1	897	58.4	19.7	777	75.5	20.7	0.6
Private/Semi-private	238	75.6	17.6	187	74.9	9.1	210	89.5	9.0	0.0
<b>SOCIO-PROFES. CAT.</b>										
1-2										
3				173	65.9	17.9	166	77.7	19.3	0.6
4				138	65.2	14.5	92	76.1	19.6	0.0
5-6				443	63.2	14.0	352	79.5	17.3	0.6
7				290	53.4	24.1	328	79.0	18.3	0.3
<b>FLUORIDE CONCENT.</b>				39	64.1	28.2	49	77.6	16.3	2.0
Below 1.5 ppm										
Over 1.5 ppm				931	64.4	17.6	917	81.4	15.9	0.5
				153	41.8	19.6	70	41.4	48.6	10.0

\* = SIGNIFICANT AT 0.05  
 NS = NON-SIGNIFICANT AT 0.05  
 Δ = NOT APPROPRIATE  
 PROPORTIONS COMPARISON

By provinces, there are differences in the evolution, going from 29.58% to 27.04% and to 37.01% in 1991, 1998 and 2006 respectively, in Santa Cruz de Tenerife, and from 18% to 33.79% and 37.30% respectively in Las Palmas.

Among the islands, the most favourable evolution took place in Lanzarote, which together with La Gomera and La Palma, shows at present the highest FR values: 44.36%, 50% and 49.35% respectively.

By socio-professional category, there was an important FR increase in categories 3, 4 and 5-6 (categories referred to occupations that are more economically disadvantaged) between 1998 and 2006 and a slight reduction in categories 1-2 and 7 (which are the category of workers with most economically-favoured occupations and the category of persons that cannot be classified according to their occupation, respectively). The values of this index in both studies were 45.75% vs 41.82% in category 1-2, 49.43% vs 59.31% in category 3, 19.88% vs 39.41% in category 4, 30.84% vs 31.81% in category 5-6 y 38.33% vs 35.45% in category 7.

Depending on the ownership of the school, there was an increase of FR in the three studies, both in students of publicly-owned schools and in students of private or semi-private schools. In 1991 the FR among students of publicly-owned schools was 20.50% and among students of private schools was 43.03%. This figures changed in 1998 to 27.68% and 53.19% respectively and in 2006 to 34.92% and 55.03% respectively.

#### - Fluorosis

In respect of fluorosis in permanent dentition at 12 years of age, the results are presented grouping grades 1 and 2 of the Thylstrup and Fejerskov Index in the category of mild fluorosis, grades 3 and 4 as moderate fluorosis and grades 5 to 9 as severe fluorosis (Table 2). In the Canary Islands we have seen a reduction of the percentage of healthy or fluorosis-free children between the first and the second study, going down from 73% to 61.3%, and increasing to 78.5% in 2006 ( $p < 0,05$ ). Despite the clear reduction in the fluorosis prevalence between 1998 and 2006, the most striking detail is the noticeable reduction of the prevalence of children with severe and moderate fluorosis.

In the year 2006, the prevalence of mild fluorosis was similar in both provinces, around 18%, but the addition of prevalence of moderate and severe fluorosis was higher in Santa Cruz de Tenerife than in Las Palmas.

Assessing the evolution by islands, only Tenerife and Gran Canaria have suffered significant changes. After the increase observed between 1991 and 1998, we see a reduction between 1998 and 2006, the percentage of fluorosis-free children going from 63.7% to 75.3% in Tenerife and from 53.1% to 76.4% in Gran Canaria.

By socio-professional category a statistically significant reduction of this pathology is observed between 1998 and 2006 in most of the categories.

In relation to fluoride concentration, between 1998 and

2006 a significant increase is observed in the percentage of fluorosis-free children among the students that attend schools located in areas in which fluoride concentration in water of public supply is  $< 1.5$  ppm, going from 64.4% to 81.4%. By contrast, in areas with fluoride concentration above 1.5 ppm, the percentage of fluorosis-free children did not change (41.8 vs 41.4%), but there was a clear move of students between the fluorosis categories, with a reduction of severe and moderate fluorosis and an increase of mild fluorosis. (Fig.3).

## Discussion

### - Caries

In relation to caries, it is observed that in the Canary Islands the evolution between 1991, 1998 and 2006 was similar to that observed in national epidemiological studies, with a reduction at first and a slight increase later on, which in the national study of 2005 (14) and in some other Spanish regions with studies close in time to ours (15) results in stabilization. However, there are no statistically-significant differences between our present caries rates (dft at 7 years of age and DMFT at 12 years of age) and the national values of 2005 (14), even though the comparison at 7 years of age is made with the group of 5-6 years of age in the national study.

Despite the changes occurring in relation to caries in the last three epidemiological studies, the Canary Islands have a low caries level according to the WHO classification (DMFT at 12 years of age from 1,2 to 2,6).

Other rates such as the filled rate show that treatment is increasing and that there are fewer caries left untreated, as has happened in the three national studies. However, our present filled rates are lower than national average both at 7 years of age in primary dentition (10.49% vs 22.9%) and at 12 years of age (37.20% vs 52.9%).

In relation to the SiC, a reduction has occurred; that is to say, among children with the highest number of caries, the intensity of the SiC has been subject to reduction and our present values at 12 years of age are very similar to the figures of the national averages of 2005 (3.72 vs 3.52).

### - Fluorosis

With regard to Fluorosis, it is advisable to make it clear that the effect observed at 12 years of age is the consequence of an excessive intake of fluoride in, approximately, the first eight years of the life of these children, during the formation of the definitive dentition. Therefore, the pathology observed for example at 12 years of age, in 2006, is the result of a process that started approximately between 1994 and 2001. In addition to this, due to the existence of immigration movements between the different geographical areas, in some cases these effects are the result of an intake of water with excess of fluoride in a location different from the place where the student lives at present.

The decline detected between the last two studies shows





Servicio Canario de la Salud; 2000 [cited 2008 Jan 9]. Available from: [http://www.gobiernodecanarias.org/sanidad/scs/3/3\\_5/3\\_5\\_1/\\_fter\\_3/psbc/programa.jsp](http://www.gobiernodecanarias.org/sanidad/scs/3/3_5/3_5_1/_fter_3/psbc/programa.jsp).

19. Gómez Santos G, Armas Navarro A, Mena Esteva I, Martín Sabina A M, Arencibia Pérez MT. Consumo de agua embotellada en escolares de Canarias. Repercusiones en la salud bucodental. *Rev Esp Nutr Comunit*. 1998 Nov;14 (3):204-6.

20. Real Decreto 140/2003, de 7 de febrero, por el que se establecen los criterios sanitarios de la calidad del agua de consumo humano. *BOE*. 2003 Feb 21;(45):7228-45.