Caries incidence, effect of preventive measures, and caries prediction in Uruguayan children

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In 1988, 100 12- to 13-year-old children from two neighborhoods in Montevideo with different standards of living were examined. Twenty-three children with large numbers of mutans streptococci, lactobacilli, or decayed surfaces or a combination of these factors were considered to be at high risk of developing caries. Twelve of these 23 children were selected for special preventive measures. A second examination was made 18 months later, at which 81 of the originally 100 children were studied. The clinical and microbiologic variables were tested for their ability to predict caries by calculating their sensitivity, specificity, the positive and negative predictive values. The incidence of new DMFS was significantly higher in the children from the low than in those from the high socioeconomic area. It was also significantly higher in the children considered being at high risk than in those at low risk at the start of the study. Preventive measures reduced the caries risk. The highest sensitivity was obtained with the clinical test, whereas the highest specificity was obtained with the combined clinical and microbiologic tests. The findings indicate that methods for identifying children at risk which started to be used in Scandinavia 20 years ago could be applied in the Uruguayan population of today. It is valuable to know this, as the resources for both treatment and prevention are very limited. □ *Caries risk; dental caries; lactobacilli; mutans streptococci; socioeconomic factors*

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In 1988, a study was conducted on 12- to 13-year-old children from two different socioeconomic areas in Montevideo. The prevalence of dental caries was similar in the two areas, but the distribution of decayed surfaces and cariogenic microorganisms differed (1).

Various factors, such as socioeconomic, clinical, and microbiologic conditions, have been associated with the risk of future caries. A good correlation has been found between earlier caries experience and future caries activity (2–7). The microorganisms mainly associated with dental caries are mutans streptococci and lactobacilli. These microorganisms have been used to select children with a high caries risk and to monitor the effect of preventive measures (8, 9).

The Uruguayan dental service is only able to treat a fairly small proportion of dental caries. Consequently, it is important to try to prevent the development of dental caries and to concentrate the limited resources on the children who need them most.

The purpose of this study was to examine the incidence of dental caries in Uruguayan children from different socioeconomic areas and to test the effect of preventive measures in children selected for a high caries risk. The predictive value of clinical and microbiologic factors was also examined.

Materials and methods

Subjects

In the spring of 1988 a base-line examination was made of 100 12- to 13-year-old children from two neighborhoods in Montevideo with different socioeconomic conditions.

The two areas are Pocitos and Piedras Blancas. Pocitos is situated on the southern seacoast of Montevideo. It is the most densely populated area of the city; the buildings are high and spread along the coast. Piedras Blancas is a neighborhood in the northern part of Montevideo, situated far away from the coast and close to the city limit. The buildings are run down, some of them delapidated. The dental service in Pocitos is provided by private practitioners, whereas in Piedras Blancas both public clinics and private practitioners provide the dental service. Only emergency cases are treated in the public clinics. Fluoride toothpastes are available, and the use of these depends on the family income and the parents' interest in dental health. The parents of the children in Pocitos had a higher educational level and occupations involving higher incomes than those in Piedras Blancas (1).

Eighteen months after the base-line examination the

Table 1. Incidence of DMFS during an 18-month period in different groups of Uruguayan children

Group	*n*	Mean ± SD	Range	*p*
Pocitos (higher socioeconomic area)	35	0.7 ± 1.7	0–7	< 0.0005*
Piedras Blancas (lower socioeconomic area)	34	2.7 ± 3.1	0–14	
Low-risk group	58	1.2 ± 2.1	0–8	< 0.001†
High-risk control group	11	4.2 ± 4.0	0–14	
High-risk test group	12	1.8 ± 1.7	0–4	< 0.1 NS*

* The statistical method used was the Mann–Whitney U-test.
† The statistical method used was Student's *t* test.

children were re-examined and the results of this second examination are reported here.

Clinical and microbiologic examinations

The methods used were described in detail in the previous paper (1); in brief, they were as follows. The clinical examination was performed in natural light, using plane mouth mirrors and sharp probes. Dental caries was recorded only when definitive cavitation was present in accordance with the criteria issued by the WHO (10). The caries incidence was calculated as the number of new DMFS for each child during the 18-month study period. The number of mutans streptococci and lactobacilli in paraffin-stimulated saliva samples was determined using the micro-pipette method described by Westergren & Krasse (11).

Selection of groups

At the base-line examination 23% of the children (23 subjects) were considered to be at high risk of caries.

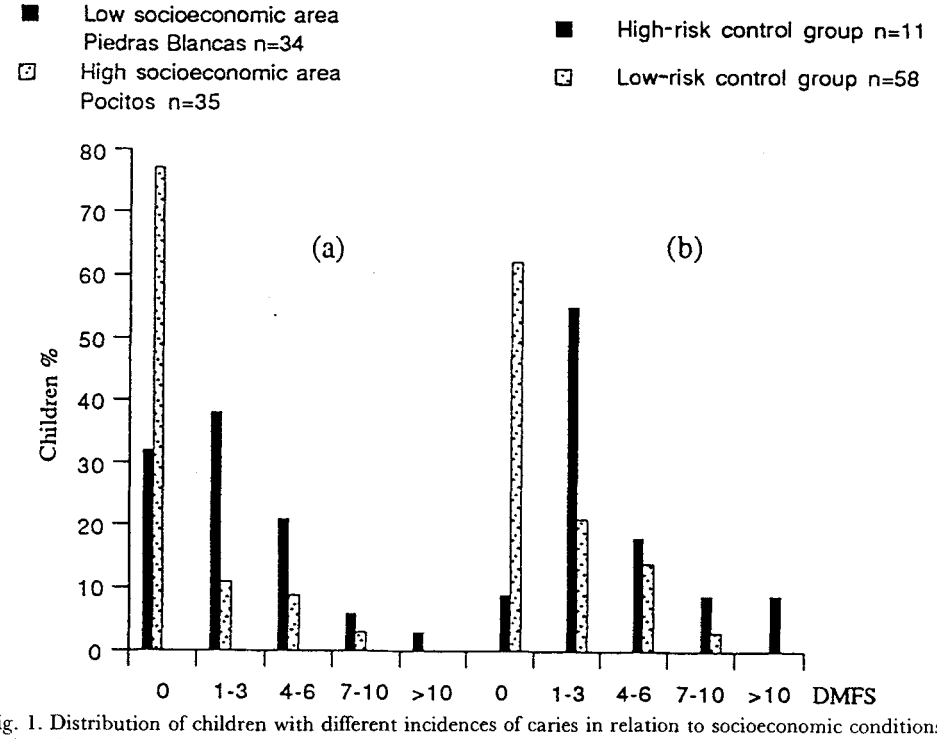

Fig. 1. Distribution of children with different incidences of caries in relation to socioeconomic conditions (1a) and caries risk at the start of the study (1b). Average new DMFS in Piedras Blancas = 2.7; average new DMFS in Pocitos = 0.7.

Twenty-two had a combination of more than 3 decayed surfaces, more than 10^4 colony-forming units (CFU) of mutans streptococci per milliliter of saliva and more than 10^4 CFU lactobacilli per milliliter saliva, and 1 child had more than 10 decayed surfaces, more than 10^4 CFU mutans streptococci and 10^3–10^4 CFU lactobacilli. Twenty of the 23 children at risk came from the lower socioeconomic area, Piedras Blancas, and 3 from the higher socioeconomic area, Pocitos. This high-risk group was divided at random into a control group and a test group. In the high-risk test group of 12 children, 9 came from Piedras Blancas and 3 from Pocitos. Eight of these children were girls and four were boys. Of the 11 children in the high-risk control group 8 were girls and 3 were boys, and all of them came from the lower socioeconomic area. The remaining 58 children were considered to be at low risk. Of these children 23 came from Piedras Blancas and 35 from Pocitos. At the second examination 19 of the original 100 children had changed school or moved to another neighborhood. All of these children belonged to the low-risk groups. As a result, a total of 81 children were studied at the second examination. Of these, 12 had been treated with special preventive measures. The other 69 children, including those in the high-risk control group, had followed their normal routine with their own dentists.

Preventive measures

The children in the high-risk test group were given information about dental caries and instructions in oral hygiene and diet. Open lesions were treated. Once a month the children received professional tooth cleaning, were supplied with 2500 ppm fluoride toothpaste (Abarly), and were asked to rinse their mouth for 1 min a day with 5 ml NaF 0.05% fluoride solution (Abarly). The effect of the treatment was monitored in the high-risk test group by microbiologic examination at the monthly visit. The children who had a reduction in the cariogenic microflora were praised, and those who did not were encouraged to make additional efforts to improve their dietary habits, dental hygiene, and preventive measures. Four children, who after these preventive measures had more than 250,000 CFU mutans streptococci per milliliter saliva, received topical application of 1% w/w chlorhexidine gel (ICI) in vinyl applicators at two appointments (12). Eighteen months after the base-line examination all 81 children were regrouped on the basis of the combination of factors used for the risk selection.

Prediction methods

The clinical and microbiologic variables used were tested for their ability to predict caries by calculating their sensitivity and specificity. The positive (PV +) and negative (PV −) predictive values (3, 13, 14) were also analyzed. Different screening levels were tested. The validation criterion was DS > 1. The children in the high-risk test group were excluded from this analysis. Thus, this analysis was done on 69 children, 34 from Piedras Blancas and 35 from Pocitos.

Table 2. Correlation coefficients of each predictor and the increment of DMFS in Pocitos, Piedras Blancas, and the total population (totally, 69 children, high-risk test group excluded)

Variables	Pocitos	Piedras Blancas	Total population
Mutans streptococci	0.04 NS	0.38*	0.29**
Lactobacilli	0.36*	0.33*	0.36**
DS	0.11 NS	0.52**	0.48**
Mutans streptococci, lactobacilli	0.23 NS	0.51*	0.46*
Mutans streptococci, lactobacilli, DS	0.11 NS	0.56**	0.49**

The correlation between the incidence of DMFS and single variables was tested with simple regression analysis. The correlation between the incidence of DMFS and multiple variables was tested with multiple regression analysis. Probabilities: * < 0.05; ** < 0.01; NS = not significant.

Statistical analysis

Differences in the clinical variables were analyzed, using the Mann–Whitney U-test and Student's *t* test. The correlation between different clinical and microbiologic variables was tested, using simple and multiple regression analysis.

Results

The incidence of DMFS in relation to the socioeconomic conditions and to the assessment of risk at the start of the study is given in Table 1. The children in the high-risk test group were excluded from the comparison of the two socioeconomic areas.

The mean numbers of new DMFS were 0.7 ± 1.7 (range, 0–7) for Pocitos and 2.7 ± 3.1 (range, 0–14) for Piedras Blancas. The difference was statistically significant ($p < 0.0005$). The results are illustrated in Fig. 1a. Seventy-seven per cent of the children from Pocitos had no new lesions, whereas only 32% of those living in Piedras Blancas had no new cavities. On the other hand, 5% of the children from Piedras Blancas had one to six new lesions, compared with only 2% from Pocitos (Fig. 1a).

Table 1 also illustrates the incidence of new DMFS in relation to the risk of caries at the start of the study. In the low-risk group the mean number of new DMFS was 1.2 ± 2.1 (range, 0–8), compared with 4.2 ± 4.0 (range, 0–14) in the high-risk group. The difference between these groups was statistically significant ($p < 0.001$). Sixty-two per cent of the children had no

Table 3. Sensitivity (Sens) and specificity (Spec) (%) for each test in Pocitos (P), Piedras Blancas (PB), and the total population (T, high-risk test group excluded)

Test*	$Sens_P$	$Spec_P$	$Sens_{PB}$	$Spec_{PB}$	$Sens_T$	$Spec_T$
$> 10^6$ ms	29	71	64	33	52	55
$> 10^4$ lbc	57	64	60	47	59	57
$> 10^6$ ms and $> 10^4$ lbc	14	96	50	57	38	80
$> 10^4$ ms and $> 10^4$ lbc, > 3 DS or $> 10^4$ ms and $> 10^3$ lbc, > 10 DS	0	100	29	67	19	86
> 1 DS	75	37	92	45	88	39

* ms = mutans streptococci; lbc = lactobacilli.

Table 4. Positive (PV +) and negative (PV −) predictive values* for each test

Test*	PV^+_P	PV^-_P	PV^+_{PB}	PV^-_{PB}	PV^+_T	PV^-_T
$> 10^6$ ms	20	80	39	58	33	73
$> 10^4$ lbc	29	14	47	40	43	25
$> 10^6$ ms and $> 10^4$ lbc	50	84	43	63	44	75
$> 10^4$ ms and $> 10^4$ lbc, > 3 DS or $> 10^4$ ms and $> 10^3$ lbc, > 10 DS	0	80	36	58	36	71
> 1 DS	26	83	79	71	55	69

* P = Pocitos; PB = Piedras Blancas; T = total population.
† ms = mutans streptococci; lbc = lactobacilli.

new DMFS in the low-risk group, compared with 9% in the high-risk group (Fig. 1b).

The effect of the preventive measures on the children in the high-risk test group is also shown in Table 1. The mean number of new DMFS was 1.8 ± 1.7 (range, 0–4) in this group, compared with 4.2 ± 4.0 in the high-risk control group, but this difference was not statistically significant. However, none of the children in the high-risk test group had more than 4 new DMFS, whereas 2 of the 11 children in the high-risk control group had more than 7 DMFS.

The distribution of the children at risk changed considerably between 1988 and 1990. In 1990 none of the children in the high-risk test group was considered to be at high risk; that is, none of them had the combination of factors used for the risk selection at the start of the study. In the high-risk control group, on the other hand, 28% of the children were still at high risk in 1990, but even in this group a large proportion of children now satisfied the criteria indicating low risk.

Table 2 shows the correlation coefficients for the different predictors and the increment of DMFS in Pocitos, Piedras Blancas, and the total population. DS, mutans streptococci, lactobacilli, and the combination of these three were acceptable for the three groups (values ranged between 0.29 and 0.56)

Table 3 shows the sensitivity and specificity of each test. The same screening level produced different sensitivity and specificity levels in the three studied groups. For example, 10^6 mutans streptococci displayed a low sensitivity but a high specificity in Pocitos, whereas in Piedras Blancas the sensitivity was high but the specificity was low. In Piedras Blancas and in the total population the highest sensitivity was obtained with the clinical test (92% and 88%, respectively). The highest specificity in each of the three groups was obtained with the combined microbiologic and clinical test (100%, 67%, and 86%, respectively).

With one exception—the clinical test in Piedras

Table 5. Number of individuals predicted to be at risk of developing new caries and mean number of DS for each test

Test*	No. of individuals† and average DS increment in parentheses		
	P	PB	T
$> 10^6$ ms	11(0.1)	21(1.0)	32(0.7)
$> 10^4$ lbc	12(0.6)	19(1.3)	31(1.0)
$> 10^6$ ms and $> 10^4$ lbc	2(0.5)	16(1.2)	18(1.1)
$> 10^4$ ms and $> 10^4$ lbc, > 3 DS or $> 10^4$ ms and $> 10^3$ lbc, > 10 DS	0	11(1.2)	11(1.2)
> 1 DS and < 13 DS	22(0.7)	24(1.5)	46(1.1)

* ms = mutans streptococcis; lbc = lactobacilli
† P = Pocitos; PB = Piedras Blancas; T = total population.

Blancas—the positive predictive values (PV +) were low (Table 4). With the same test the negative predictive values (PV −) were high in all groups.

Table 5 shows the number of individuals predicted by each test as being at risk of developing caries and the actual mean number of new DS in these individuals during the 18-month period. In all the groups the clinical test showed most individuals at risk, and the average numbers of new DS were 0.7, 1.0, and 1.1 for Pocitos, Piedras Blancas, and the total population, respectively.

Discussion

The incidence of DMFS in the two socioeconomic areas were distinctly different. The children in Piedras Blancas had almost four times as many new DMFS as those in Pocitos. The difference between the two areas is associated with differences in socioeconomic conditions, earlier caries experience, and the number of cariogenic bacteria at the start of the study. At the base-line examination the sugar intake was roughly the same in the two groups (1).

Eighty-seven per cent of the children at high risk of developing caries were from Piedras Blancas according to the clinical and microbiologic criteria at the start of the study. Moreover, the children in Piedras Blancas, whose parents were less well educated (1), had three times as many new DMFS as those in Pocitos. These observations are in accordance with those of Martinsson (15) and Stecksén-Blicks (16), who stated that the beneficial effect of well-educated mothers on their children's dental health may be due to the fact that the mothers put into practice more effectively updated knowledge about the prevention of caries. The more information they receive and the more chance they have to make use of organized dental care, the better they do so. The socioeconomic conditions also determined the professional dental care that the children received.

The incidence of caries was also influenced by earlier dental caries experience, mutans streptococci and lactobacilli. Sixty-two per cent of the children in the low-risk group had no new DMFS, whereas 91% in the high-risk control group developed new lesions. Taking into account that the low-risk group included the 35 children from Pocitos (Table 1), it is possible to conclude that the biologic factors combined with the socioeconomic ones are more important for future caries prediction than the biologic or socioeconomic factors considered separately.

When microbiologic conditions were used as predictors, the same screening level produced different results in the two populations. One explanation for this might be the presence of more decayed surfaces in Piedras Blancas than in Pocitos at the start of the study and the fact that these surfaces harbored more cariogenic microorganisms than the filled surfaces in Pocitos. The difference between the two populations in terms of the reservoirs for cariogenic microorganisms could also be the reason that the specificity generally was lower in Piedras Blancas than in Pocitos. The specificity improved when clinical and microbiologic factors were combined, and this is in accordance with the observations made by other investigators (8, 14, 17–23). Klock & Krasse (24) and Alaluusua et al. (17) stated that the best prediction of caries activity could be obtained by combining essential factors of caries development, and in a recently published study very high values for sensitivity and specificity were obtained when a combination of bacterial challenge and protective factors was used for prediction (25).

Intensive preventive measures did not reduce the incidence of dental caries in the high-risk test group significantly. However, none of the children in the high-risk test group had more than four new lesions, whereas two children in the high-risk control group had more than seven new DMFS. The preventive measures changed the distribution of children at risk. As a result, the risk of future caries should have been diminished.

In the high-risk test group open lesions were treated, and comprehensive preventive measures were applied. Such a program is totally unrealistic, and the next step will be to examine which preventive methods are most cost-effective in this population. This pilot study indicates, however, that the methods for identifying children at risk used in Scandinavia 20 years ago, when the caries activity there was high, can be applied in the Uruguayan population of today. This is of value to know, as the resources for both treatment and prevention are very limited.

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