Rampant Early Childhood Dental Decay: an Example from Italy

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Abstract

Objectives: *This study sought to estimate the prevalence and related prediction factors for dental caries in 3- to 5-year-old children in Rome, Italy.* ***Methods:*** *From a sample of 2,025 children, 1,494 (73.8%) were included in the analysis. Children with at least two primary maxillary incisors showing evidence of caries experience were considered affected by rampant early childhood dental decay (RECDD). Behavioral and socioeconomic variables, mutans streptococci counts, diet, and nutritional status were investigated for their association with RECDD using regression analysis.* ***Results:*** *The prevalence of any caries was 27.3 percent, and was 7.6 percent for RECDD. Among all children, mean dft and dt scores per person were 1.1 (SD=2.4) and 0.9 (SD=2.3), respectively; among those classified as having RECDD, scores were 6.9 (SD=4.2) and 6.7 (SD=4.3), respectively. Children with RECDD had 56 percent of all the decayed teeth in the sample. Low and medium social classes, use of a baby bottle filled with sweetened beverages, high salivary mutans streptococcal levels, and malnutrition were directly associated with RECDD; milk and yogurt consumption and low Plaque Index scores were inversely associated with the condition.* ***Conclusions:*** *The high prevalence of RECDD suggests that the implementation of preventive programs should be a priority for dental public health. Because of its high prevalence among children as young as 3 years of age, preventive measures targeted toward pregnant women and toddlers should be developed and tested, while kindergarten students could be used for monitoring RECDD prevalence and for detection of communities at risk. [J Public Health Dent 2000;60(3):159-66]*

Key Words: early childhood caries, rampant caries, rampant early childhood dental decay, preschool children, behavior, socioeconomic status, mutans streptococci, milk, yogurt.

One of the patterns of early childhood caries (ECC) is characterized by lesions that first affect the primary maxillary incisors and then rapidly involve other teeth following their eruption (1-3). This disease is caused by the same factors involved in other patterns of childhood caries. It is associated with prolonged and frequent consumption of cariogenic substrates, mainly due to inappropriate use of the nursing bottle filled with sweetened solutions (4), with early colonization and high levels of cariogenic bacteria (5), and with predisposing conditions of the host, like malnutrition (6).

The majority of children with rampant caries belong to immigrant populations, ethnic minorities, and low socioeconomic strata (7,8). Because of their poor economic conditions, these children in many countries tend to receive care at public institutions (8,9). The cost of treating children with rampant caries is high (10,11). For example, the Vermont Department of Health spends over $1 million each year in its treatment (12). Besides the costs associated with treatment of severe ECC, an even more compelling aspect of this disease is that it seems to be largely preventable if children are exposed to preventive programs at an early age (9). For these reasons, the control of rampant caries should be a priority for public health programs. Knowledge of its prevalence and risk factors is essential for estimating funds and other resources needed for the prevention and treatment of this disease.

In Italy, dental treatment through public services is free for all children younger than 6 years of age. Many infants and toddlers who receive care in public programs have rampant caries, but population data on the condition are lacking. In the present study, we estimate the prevalence and severity of ECC in a sample of 3- to 5-year-old children living in the city of Rome. Differences in factors associated with rampant early childhood dental decay (RECDD) and with less serious forms of the disease also are studied. We used the RECDD terminology to be consistent with Horowitz (2), who used a similar term: "rampant infant and early childhood dental decay."

Methods

Sampling Procedure. All 3- to 5-year-old children residing in Rome in 1996 (n=103,572) were the target population of the present study. For practical reasons, the sample was selected from children (n=97,039) who attended kindergartens in that year, or 93.7 percent of the target population.

A sample size of 1,900 subjects was determined based on an estimated prevalence for ECC of 5 percent (13-16) and a sampling error of 1 percent. We arbitrarily assumed that 5 percent of children would not agree to participate in the study, so we increased the sample size to 2,000 subjects. From a list of all Rome kindergartens in 1996 (n=1,022), kindergartens were randomly selected and all children who were enrolled were included until a total sample of 2,000 children was reached. This sampling procedure resulted in 22 kindergartens with 2,025 children in attendance. No incentives for participation were provided for children or their families.

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TABLE 1
List of Explanatory Variables Investigated

Background	
1	Age (years)
2	Sex: 0=male, 1=female
3	Immigrant background: 0=none, 1=at least one parent from developing country
4	Low socioeconomic level (dummy variable): 0=high and medium, 1=low
5	Medium socioeconomic level (dummy variable): 0=high and low, 1=medium
6	Self-assessed number of decayed, filled, missing teeth of mother
Diet	
7	Daily milk consumption, in liters
8	Daily yogurt consumption, in number of pots
9	Cariogenic diet: 0=0–1, 1=2 or more daily intakes of sucrose-containing foods and beverages between meals
Fluoride and oral hygiene	
10	Fluoride tablets and/or mouthrinses: months of regular use
11	Frequency of daily toothbrushing: 0=none/irregular, 1,2,3
12	Use of fluoridated toothpaste: 0=no/nonfluoridated toothpaste, 1=yes
13	Plaque Index (PlI): 0=PlI<1, 1=PlI≥1
14	Logarithm of salivary mutans streptococci count
Breast feeding	
15	Breast feeding: 0=no, 1=yes
16	Daily breast-feeding frequency
17	Breast-feeding duration: from birth to weaning, in months
Baby bottle use	
18	Past/present baby bottle use: 0=irregular, 1=regular
19	Months of regular baby bottle use
20	Daily baby bottle use, in minutes
21	Nocturnal baby bottle use: 0=no, 1=yes
22	Baby bottle filled with sweetened beverages: 0=no, 1=yes
23	Nocturnal use of baby bottle filled with sweetened beverages: 0=no, 1=yes
Pacifier	
24	Past/present pacifier use: 0=irregular, 1=regular
25	Months of regular pacifier use
26	Daily pacifier use, in minutes
27	Nocturnal pacifier use: 0=no, 1=yes
28	Pacifier dipped in sweetened solution: 0=no, 1=yes
29	Nocturnal sweetened pacifier use: 0=no, 1=yes
30	Malnourished child: 0=no, 1=yes
31	Obese child: 0=no, 1=yes

Clinical Examination. Parents who provided informed consent received a questionnaire that was to be returned the day of the examination. They also received a cover letter notifying them of the day that their children were to be examined, inviting their children to have breakfast after the examination, and asking them to advise teachers whether their children had used antibiotics or mouthrinses with antibacterial properties the week before the examination was to take place. Children who had used antibiotics or antibacterial mouthrinses, or those who were not present on the day of the examinations were scheduled for follow-up examinations. The study was conducted during 1997 and 1998.

Children were examined in the classrooms by three dentists. Diagnostic criteria recommended by the World Health Organization were used to score decayed (d) and filled (f) teeth (17). The status of teeth rather than surfaces was scored to increase consistency in clinical judgments made by the three dentists.

A universally accepted definition for severe ECC does not exist (1). For our study, we consider children who had at least two affected primary maxillary incisors to have severe ECC. This case definition was chosen for various reasons. The use of a simple case definition should increase the consistency of clinical judgments among the three participating dentists. Moreover, this definition, which also was used by other authors investigating rampant caries in Western countries (13-16), allowed us to compare results of our study to others reported in the literature. Finally, a case definition based on the status of only anterior teeth might help overcome the problem that unmanageable children can present during an oral examination. However, a major limitation of this case definition is that children with two or more lesions on posterior teeth but with either all or only 1 of the anterior teeth unaffected with caries were misclassified as unaffected by rampant caries.

Plaque levels on the primary second molars and central incisors were assessed using the methods of Silness and Löe (18). Mean scores were used as an estimate of oral hygiene level (19).

Examiner training for assessments of early childhood caries was held at the G. Sanarelli Hygiene Institute. Examiner reliability for the presence or absence of RECDD was assessed using Cohen's kappa statistic and replicate examination results on 20 patients (20).

Questionnaire. The questionnaire was completed at home by parents. Variables for six major categories were created from the available questionnaire data (Table 1). Six background variables were created (variables 1–6). A score ranging from 1 to 3 was assigned to both occupational and educational levels of each parent. In children with only one parent, scores of that parent were doubled (19). An overall score for each child consisted of the sum of parent scores, and ranged from 4 to 12. Children were divided into low (scores 4–6), medium (scores 7–9), high (scores 10–12) social classes. Other variable categories related to diet (variables 7–9), fluoride use and oral hygiene (variables 10–12), breastfeeding habits (variables 15–17), use of the baby bottle (variables 18–23), and dummy (pacifier) use (variables 24–29).

Microbiological Procedures. On the morning of the dental examination and before children ate their breakfasts or brushed their teeth, unstimulated saliva was collected by one of the examiners. A wooden tongue depressor with an enlarged extremity, which allowed the collection of 0.1 μl of saliva, was pressed on the tongue of the child and then on Rodac plates containing Mitis Salivarius Agar with bacitracin (0.2 U/ml) and sucrose (200 g/l), a medium selective for mutans streptococci (21). After incubation (48 hours in anaerobiosis and 24 hours in aerobiosis), colonies with the morphology of mutans streptococci (22), i.e., *Streptococcus mutans* and *Streptococcus sobrinus*, were counted. Counts were logarithmically transformed to normalize data. Counts of 0 (corresponding to <10,000 mutans streptococci colony-forming units, i.e., cfu, per ml of saliva) were treated as 0.5, and counts higher than 300 (corresponding to the highest limit of detection, i.e., >3,000,000 cfu/ml) were treated as 300 (23) (variable 14, Table 1).

Nutritional Status. Children's weights and heights were measured at the dental examinations and the body mass index (BMI) calculated using the formula (weight in kg)/(height in m)^2. BMI values were compared to age- and sex-specific BMI percentile distributions of French children (24) because no data are available for Italian children. Subjects with a BMI higher than the 95th percentile were considered obese and those with values lower than the fifth percentile were considered malnourished (variables 30 and 31, Table 1).

Statistical Analysis. Prevalences and 95 percent confidence intervals for any caries and RECDD were calculated for the entire sample and by age. For calculation of standard errors the formula $\sqrt{p(1-p)/n}$ was used, and any effects of clustering within kindergartens were not taken into account.

Percent of children with at least 1 df tooth (i.e., caries prevalence), mean df teeth, percent of children with at least one d tooth, mean d teeth, and mean df and d anterior teeth were compared between children with RECDD (RECDD group) and those with caries other than RECDD ("other caries" group), and between the RECDD group and all other children using Student's *T*-test for unpaired samples (means), and the chi-square test with Yates correction for continuity (proportions). The percentages of all df and d teeth found in those children with one or more df and d teeth, respectively, also were calculated for the RECDD and "other caries" groups.

Differences in proportions or means of the independent variables among the three subgroups of the sample defined by caries status (RECDD, caries other than RECDD, and caries free) were tested using the chi-square test (proportions) or analysis of variance (means) as appropriate. Variables significantly associated with RECDD and other caries were considered for multivariate analysis. To reduce the degree of multicollinearity between regressors, a series of single and multiple linear and logistic regression analyses using variables of the same category were performed. When two or more variables were correlated, only one of them was used in the final model. This approach, together with the retrospective design of the study, led us to make cautious interpretations of the results of the analysis concerning RECDD predisposing/preventing behaviors.

Because some variables were eliminated from our regression models on statistical grounds alone, it was difficult to know if we retained the most important variables for the analysis. The effect of the final set of variables on the probability of RECDD and of caries other than RECDD was assessed by ordinal logistic regression analysis using Limdep 6.0 econometric software. The dependent variable had three possible outcomes: 0=caries free group, 1=other caries group, and 2=RECDD group.

Finally, to assess the predictive power of the set of variables used for the multivariate analysis, another logistic regression analysis was performed. In this case, the dependent variable was presence or absence of RECDD. The logistic regression produced an individual RECDD probability, using the formula: probability$=1/(1+e^{-z})$, where z is the linear combination $z=b_0+b_1x_1+b_2x_2+\ldots$; b_0, b_1, b_2 ... are the estimated coefficients from the regression model, and x_1, x_2 ... are the values of the explanatory variables for each individual. On the basis of the frequency distribution of the estimated individual RECDD probabilities, three threshold levels were chosen arbitrarily. Subjects whose probability was higher than the threshold level were considered at high RECDD risk, while the remaining subjects were considered at low risk. Then, sensitivity, specificity, and Youden's Index [(true positive rate)+(true negative rate)–1] were calculated for each threshold level (25).

Results

Consent for the examination was obtained for 1,494 children (participation rate=73.8%). This response rate caused the sampling error to increase from 1 percent to 1.13 percent. No differences between the study population and the final sample were observed with respect to distributions of children according to age, sex, or immigration status from developing countries (Table 2).

Cohen's kappa for the presence or absence of RECDD was calculated for replicate examinations completed on 20 patients during the training sessions. The values obtained—1.00 (examiner 1 vs examiner 2), 0.83 (examiner 1 vs examiner 3) and 0.83 (examiner 2 vs examiner 3)—suggest good interexaminer agreement (20).

The percentage of children with at least one df tooth in the overall sample—i.e., caries prevalence—was 27.3 percent (Table 3). RECDD prevalence was 7.6 percent. At 3 years of age, 6.2 percent of children already were af-

TABLE 2
Percent Distribution of Study Population and Sample According to Age, Sex, and Immigrant Status

	Age (Years)			Sex		Immigrant Status*	
	3	4	5	Male	Female	Yes	No
Population	34.4	33.1	32.7	51.4	48.6	2.0	98.0
Sample	35.3	32.1	32.5	54.6	45.4	3.6	95.4

*Developing country.

TABLE 3
Percent of Children with at Least One df Tooth and RECDD, by Age

	Overall Caries (95% CI)	RECDD (95% CI)
Total	27.3 (25.0, 29.6)	7.6 (6.3, 9.0)
3-year-olds	26.5 (22.7, 30.3)	6.2 (4.0, 8.5)
4-year-olds	27.1 (23.0, 31.2)	7.4 (5.0, 9.8)
5-year-olds	29.3 (25.2, 33.4)	9.1 (6.5, 11.7)

Note: The effects of clustering on estimates are not taken into account.

TABLE 4
Prevalence and Severity of df and d Teeth by Caries Status Group

					Anterior Teeth	
Caries Group	% dft>0	Mean dft (SD)	% dt>0	Mean dt (SD)	Mean df (SD)	Mean d (SD)
RECDD	100.0	6.9	94.8	6.7	3.2	3.0
	(115/115)	(4.2)	(109/115)	(4.3)	(1.1)	(1.4)
Other	100.0	2.7	83.9	2.0	0.2	0.2
caries	(293/293)	(1.8)	(47/293)	(1.7)	(0.4)	(0.4)
RECDD	21.2	0.6	17.8	0.4	0.05	0.04
unaffected	(293/1,379)	(1.4)	(246/1,379)	(1.2)	(0.2)	(0.2)
Total	27.3	1.1	23.8	0.9	0.3	0.3
	(408/1,494)	(2.4)	(355/1,494)	(2.3)	(0.9)	(0.9)
	RECDD vs Other Caries*					
	χ^2=0	T=14.1	χ^2=14.3	T=15.8	T=40.0	T=31.2
	P=1	P<.001	P<.001	P<.001	P<.001	P<.001
	RECDD vs RECDD Unaffected					
	χ^2=337.7	T=16.0	χ^2=362.6	T=15.7	T=30.9	T=22.7
	P<.001	P<.001	P<.001	P<.001	P<.001	P<.001

Note: Statistical analysis of differences (Student's T-test for unpaired samples for means, chi-square with Yates correction for continuity for proportions).

TABLE 5
Percent Distribution of Children with at Least One df or d Tooth and Teeth that Are df or d, by Caries Status Group

	dft>0		dt>0		% Anterior Teeth	
Caries Group	% Children (SD)	% Teeth (SD)	% Children (SD)	% Teeth (SD)	dft>0 (SD)	dt>0 (SD)
RECDD	28.2	49.8	30.7	56.0	84.5	86.3
	(115/408)	(795/1,596)	(109/355)	(769/1,374)	(364/431)	(346/401)
Other	71.8	50.2	69.3	44.0	15.5	13.7
caries	(293/408)	(801/1,596)	(246/355)	(605/1,374)	(67/431)	(55/401)

fected by this disease. Differences in prevalence between males and females were small (data not shown).

Mean dft scores for the RECDD group were more than double that of the other caries group, and 10 times that of all RECDD-unaffected children (6.9 vs 2.7 and 0.6, respectively) (Table 4). Mean dt scores for the RECDD group were more than three times greater than dt scores for the other caries group and 15 times greater than that of all children unaffected by RECDD (6.7 vs 2.0 and 0.4, respectively). Almost 95 percent of the RECDD group had at least one decayed tooth, while 84 percent of the other caries group and 18 percent of the RECDD unaffected children had at least one decayed tooth.

RECDD children represented only 28.2 percent of all children with caries, yet they had one-half of all df teeth (Table 5). RECDD children represented 30.7 percent of all children in the sample who had one or more decayed teeth, but they had a disproportionate number of decayed teeth (56% of all decayed teeth).

Variables found in the bivariate analyses to be associated with the presence of RECDD and with caries other than RECDD at a statistically significant level are displayed in Table 6. Differences between the RECDD and other caries groups and between the RECDD and caries-free groups were found for many of the variables in the clinical, microbiological, nutritional, behavioral, and familial categories.

However, no significant differences were found between the caries free and other caries groups with respect to cariogenic diet, toothbrushing frequency, malnutrition, and some of the improper feeding habits assessed.

Results of the ordinal logistic regression analysis are displayed in Table 7. Low and medium social classes, use of a baby bottle filled with sweetened beverages, high salivary mutans level, and malnutrition significantly increased RECDD probability, whereas milk and yogurt consumption and a low Plaque Index significantly decreased RECDD probability. On the other hand, the variables significantly affecting non-RECDD caries probability were low social class, high salivary mutans levels, and milk and yogurt consumption. Due to strong correlation coefficients among low socioeconomic status, immigrant background and DMFT of mothers, as well as among toothbrushing frequency, use of fluoridated toothpaste, and Plaque Index (data not shown), only one of these variables was used.

Results of the logistic regression model with RECDD presence or absence as the dependent variable are given in Table 8. On the basis of their estimated RECDD probability, chil-

TABLE 6
Differences Between RECDD, Other Caries, and Caries-free Groups with Respect to Explanatory Variables

Explanatory Variables	RECDD % or Mean (SD)	Other Caries % or Mean (SD)	Caries Free % or Mean (SD)
Social class *,†,‡			
Low	63.5 (73/115)	42.0 (123/293)	48.3 (525/1,086)
Medium	36.5 (42/115)	44.4 (130/293)	36.0 (391/1,086)
High	0.0 (0/115)	13.6 (40)	15.7 (170/1,086)
DMFT of mother*,†,‡	9.8 (8.8)	8.1 (5.4)	6.7 (5.4)
Milk*,†,‡	0.12 (0.08)	0.15 (0.10)	0.19 (0.10)
Yogurt*,†,‡	0.1 (0.3)	0.2 (0.4)	0.3 (0.5)
Cariogenic diet*,†	84.3 (97/115)	67.2 (197/293)	66.4 (720/1,086)
Toothbrushing freq. *,†			
irregular	47.8 (55/115)	24.6 (72/293)	21.5 (233/1,086)
1	26.1 (30/115)	28.0 (82/293)	28.4 (308/1,086)
2	26.1 (30/115)	37.6 (110/293)	41.8 (454/1,086)
3	0.0 (0/115)	9.9 (29/293)	8.4 (91/1,086)
Fluoridated toothpaste*,†,‡	72.2 (83/115)	95.9 (281/293)	88.4 (960/1,086)
PlI lower than 1*,†,‡	26.1 (30/115)	40.6 (119/1,086)	53.7 (583/1,086)
Log mutans count*,†,‡	2.0 (0.9)	1.3 (1.0)	0.4 (0.8)
Breastfeeding duration*,†,‡	5.9 (3.2)	8.3 (6.9)	6.8 (4.8)
Daily bb use*,†	81.3 (85.7)	58.3 (49.0)	41.3 (64.2)
Nocturnal bb use *	41.7 (48/115)	32.4 (95/293)	26.5 (288/1,086)
bb with sweetened beverage*,†‡	10.4 (12/115)	5.8 (17/293)	2.2 (24/1,086)
Daily pacifier use*,†	234.9 (399.0)	138.6 (204.0)	154.3 (253.9)
Sweetened pacifier*,†,‡	20.9 (24/225)	4.1 (13/293)	7.8 (84/1,086)
Noct. sweet. pacifier*,†	15.7 (18/115)	3.7 (11/293)	4.4 (48/1,086)
Malnourished child*,†	20.9 (24/115)	6.1 (18/293)	7.3 (79/1,086)
Obese child*,†‡	20.9 (24/115)	20.1 (60/293)	11.0 (120/1,086)

All differences are significant at 99.9% level, excluding cariogenic diet (99.95%) and daily pacifier use (99.80%). 95% level statistically significant differences between pairs of groups: *RECDD vs caries free, †RECDD vs other caries, ‡other caries vs caries free.

TABLE 7
Results of Ordinal Logistic Regression Analysis of the Effect of the Final Set of Variables on Risks for RECDD and for Caries Other than RECDD

	RECDD			Other Caries		
	OR	95% CI	*P*-value	OR	95% CI	*P*-value
Low socioecon. class	3.9	1.0, 15.0	.05	2.5	1.1, 5.9	.03
Med. socioecon. class	4.2	1.0, 17.1	.04	1.5	0.7, 3.4	.33
Milk	10^{-7}	10^{-9}, 10^{-4}	<.01	10^{-3}	10^{-4}, 0.06	<.01
Yogurt	0.1	0.02, 0.7	.01	0.4	0.2, 0.97	.03
Plaque Index<1	0.2	0.05, 0.7	.01	0.6	0.3, 1.2	.13
Log mutans count	4.5	2.4, 8.3	<.01	2.7	1.8, 3.9	<.01
Noct. bb use	1.7	0.5, 5.5	.40	1.0	0.5, 2.2	.93
bb w/sweet. beverage	4.7	1.4, 15.2	.009	2.2	0.9, 5.5	.09
Sweetened pacifier	0.4	0.06, 2.6	.32	0.5	0.1, 1.9	.27
Malnourished child	11.6	1.9, 70.1	.006	1.5	0.3, 7.0	.58

χ^2_{18df}=87.2; *P*<.001; logarithm of likelihood=−144.0.

dren were considered at low or high risk according to three different threshold levels (10%, 25%, 50%). The threshold level of 10 percent gave the highest predictive power, with sensitivity, specificity, and Youden's index values of 89.5 percent, 77.8 percent, and 0.67, respectively.

Discussion

Why RECDD Monitoring? Determining the prevalence of RECDD is not easy because a universally accepted epidemiologic index does not exist (1). When infants and toddlers are being studied, terms like ECC are suitable and a case definition can be based on the presence of at least one lesion on any tooth (26). When the severity of the disease is to be taken into account, terms like Rampant Infant and Early Childhood Dental Decay (RIECDD) can be used and a case can be characterized by a pattern of attack in which lesions affect primary upper incisors first and then rapidly involving molars and other teeth. Knowledge of the prevalence of both ECC and RIECDD is important for programming adequate oral health strategies and the estimation of resources and funds. Study of ECC prevalence also is essential for monitoring the effectiveness of population-based preventive programs aimed at controlling any type of caries, not just rampant caries (27).

The prevalence of RIECDD should be controlled because of its high treatment costs, particularly among children from low social classes who usually get their dental care in the public sector (1,2,8,9). The importance of monitoring of rampant caries for public health dental officers also is confirmed by the results of the present study. Children with this disease, who accounted for less than 8 percent of the entire sample, had 56 percent of all decayed teeth and two-thirds of these children were from low social classes. Low social class children with RECDD had a mean dt score of 8.2 (SD=3.8) per person, and 42.8 percent of all decayed teeth (data not in table).

RECDD Prevalence. The primary limitation of the case definition we used—i.e., two or more df maxillary primary teeth—is the possibility of misclassifying children as unaffected by RECDD who have affected posterior teeth and only one or no affected anterior teeth. The percentage of chil-

TABLE 8
Predictive Power and Percent of Children at High RECDD Risk, by Threshold Level

Threshold Level (%)	Sensitivity (%)	Specificity (%)	Youden's Index*	% at Risk
10	89.5	77.8	0.67	27.3
25	63.2	91.3	0.54	12.9
50	31.6	96.9	0.28	5.2

*Youden's index=(true positive rate)+(true negative rate)–1.

dren in the present study who potentially were misclassified was 14.4 percent (n=215). Their mean dft and dt scores were 3.3 (SD=1.7) and 2.5 (SD=1.8) per person, respectively. They had 44.9 percent of all df teeth (716 of 1,596), and 39.7 percent of all d teeth (546 of 1,374) (data not shown). If we classified them as having RECDD, overall prevalence would rise to 22.1 percent, and these children would have 94.7 percent of all df teeth (1,511 of 1,596) and 95.7 percent of all d teeth (1,315 of 1,374). The dental status of subjects who did not meet our case definition of RECDD can be considered a serious problem, but not as serious as those who were classified as having RECDD. Only 11.1 percent (24 of 215) of children without RECDD had dft scores equal to or greater than 6, but 53.0 percent (61 of 115) of those who were so classified had this number.

We compared the prevalence of RECDD found in the present study to surveys from other Western countries. Only studies using a case definition similar to ours and with few immigrants were considered in this comparison. This last criterion was important because only 3.6 percent of the children in our sample had immigrant backgrounds, a characteristic that is strongly associated with a high prevalence of this disease (8,16,28).

The prevalence of caries on primary maxillary incisors (at least two teeth involved) in 1- to 4-year-old urban white children from the United Kingdom as reported by Holt et al. (16) was 6.6 percent. Silver (15) found 4 percent of 230 3-year-old English children affected by this disease. Wendt and Jonsell (8) reported 4.7 percent prevalence in a sample of 3-year-old Swedish children. Paunio et al. (14) found that 5.7 percent of 1,018 3-year-old Finnish children had caries on primary maxillary incisors. Kamp (29) reported that 5.3 percent of the 379, six-month-old to 4.5-year-old children on a US military base in Japan had caries affecting at least one primary incisor. Prevalence reported by Wyne et al. (30) in 160 2- to 3-year-old children from Australia was only 2.6 percent. The value found in the present sample (7.6%) is higher than those reported in these other studies. This finding might be explained in part by the average age of the children in our study, which is older than in these other studies.

No widespread caries-preventive programs are available for children living in Rome. A recent large reduction in caries that has been observed in Roman schoolchildren is attributable to the increased use of fluoridated toothpastes, which rose from 230 ml per capita per year in 1990 to 270 ml in 1996 (personal communication, Unilever Italia, 1977). No changes in toothbrushing practices or in type of diet have been reported (31). According to Konig, current changes in human behavior in Western countries have made good oral hygiene socially desirable. This norm helps explain the increased sales of toothpastes. Television commercials, with their positive emphasis on toothbrushing—described by Konig (32) as "very helpful boosters for oral health education messages"—are the only widespread oral health education messages available in Italy.

RECDD-related Factors. The results of the present study do not permit us to make inferences about the variables causally related to RECDD because of its retrospective design. Even assuming that a certain factor preceded the development of caries, we have no information on how the child's response to that factor may have varied during the disease process (33). Moreover, the validity of the behavioral data is debatable because they were obtained by questionnaire and the presence of information bias cannot be excluded (34, 35).

Inappropriate feeding behaviors, such as nocturnal and prolonged use of a baby bottle filled with sweetened solutions and use of sweetened pacifiers during naptime and nighttime were found to be associated with RECDD, but not with non-RECDD caries, findings that are consistent with other studies (13,15,16,36-40). However, the association between RECDD and baby bottle use or breastfeeding is not observed in all studies (41). This observation has encouraged the use of terms other than nursing caries or baby bottle tooth decay.

Improper feeding behavior is responsible for an increase in the exposure of primary teeth to fermentable carbohydrates. This increase is likely to promote both an early colonization by oral mutans streptococci (42) and an increase in the number of these microorganisms in dental plaque and saliva (4,43). We found an association between high levels of mutans streptococci infection and an increased prevalence of RECDD (13,44).

The protective effect of milk and yogurt consumption in our study, also reported by Juambeltz et al. (38), may be attributed to different milk components, such as calcium, phosphates, casein, whey proteins, and lipids (19). This protective effect suggests that RECDD might not be promoted by milk consumption per se, but by the excessive use of sweetened milk during naptime and at night when salivary flow is reduced. This association also was found by other investigators (42,43).

The high prevalence of RECDD in malnourished children found in the present study is in agreement with the study of Alvarez et al. (6). This finding can be explained by the presence of developmental enamel defects (45) and a reduction in salivary secretion rate (46), both frequently found among malnourished children and that tend to increase their risk for caries.

In contrast to universally accepted findings (27), the caries-preventive effect of fluoride was not statistically significant in the present study, probably because fluoride was seldom used by the children in our sample. Few children regularly underwent professional fluoride applications (0.3%), or regularly took fluoride tablets and/or used fluoride mouthrinses for at least two years prior to the study (10.4%, data not shown). Moreover, 94 percent of Rome is supplied by drinking water containing less than 0.3 mg/L of fluoride (47), which might also explain the relatively high caries prevalence reported.

RECDD Prevention. The results of this study can help inform decisions about the most appropriate RECDD preventive strategies for children in Rome. Because the disease affects only a small part of the population, application of the "high-risk strategy" is very attractive (48). However, for a correct application of this strategy, methods for identifying subjects at greatest risk and for preventing the disease in those subjects identified must be acceptable and feasible. In this study, the best model for predicting RECDD gave a Youden Index value of 0.67, with 78.7 percent of cases correctly predicted (data not shown). The predictive power obtained by prospective studies, which are more appropriate for this type of analysis than our cross-sectional one, should be lower. However, even assuming that the predictive value we obtained is valid and satisfactory, the expense of screening large numbers of children and problems with implementation of preventive measures on subjects spread throughout a large population remain.

An alternative approach to the high-risk strategy could be to identify communities at greatest risk for RECDD, an approach proposed by Amstutz and Rozier (49). Intensified preventive measures could be targeted to communities believed to be at greatest risk. Using an approach similar to that proposed by the aforesaid authors, analysis of community risk could use kindergartens as the unit of analysis, while aggregating predictors at the kindergarten level. By using this analysis and intervention strategy, the number of individuals who are the target of the preventive programs would be reduced and concentrated in small geographic areas. However, problems associated with the implementation of interventions in communities that are at high risk for RECDD still exist. Because of the high prevalence of RECDD among 3-year-old children, kindergartens could be used principally for the assessment of community risk, and for the monitoring of disease prevalence. Preventive dentistry programs targeted to pregnant women and toddlers also should be developed and tested for their effectiveness. The places to implement primary preventive interventions may be the offices of pediatricians and gynecologists in those communities at highest risk for caries.

Acknowledgments

The authors wish to thank Drs. Tatiana Fabbri, Cristina Bossa, and Enrico Lorenzi for their valid help in clinical examinations and microbiological procedures.

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