Early Childhood Caries: Prevalence and Risk Factors in Seoul, Korea

Bo-Hyoung Jin, DDS, PhD; Deuk-Sang Ma, DDS, PhD; Hyock-Soo Moon, DDS, PhD; Dai-Il Paik, DDS, PhD; Se-Hyun Hahn, DDS, PhD; Alice M. Horowitz, PhD

Abstract

Objective: *The purpose of this study was to determine the prevalence of early childhood caries (ECC), including noncavitated lesions (d_1), in children 6–59 months of age in relation to socioeconomic factors, feeding practices, and oral health behaviors in Seoul, Korea.* ***Methods:*** *The children attended child care facilities and were selected from 32 primary sampling units. Two dentists examined 470 children. Parents of 383 of the subjects were interviewed by phone regarding caries risk factors.* ***Results:*** *For children 6–59 months of age, the prevalence of ECC and severe ECC were 56.5 percent and 47.0 percent respectively. In bivariate analysis, the children whose nursing bottle contained sweetened solution had higher severe ECC prevalence (P=.035), and children whose parents reported a lower frequency of between-meal snacks showed lower ECC prevalence (P=.046). By logistic regression analysis, age and frequency of between-meal snacks were associated with the prevalence of ECC (P<.05).* ***Conclusion:*** *This study demonstrates that the prevalence of ECC was high among children in Seoul. Early educational intervention programs for pregnant women and mothers of young children should be developed based on the risk factors identified in this study. [J Public Health Dent 2003;63(3):183-88]*

Key Words: early childhood caries, noncavitated lesion, caries risk factors.

Children who have caries in their primary teeth in infancy or as toddlers tend to develop additional dental decay in their primary teeth (1,2) and are more likely to experience caries in their permanent teeth (3-5). Dental caries in primary teeth is a major health problem in Korea. According to the 2000 National Oral Health Survey, 83.3 percent of 5-year-old Korean children experienced dental caries in their primary teeth (6).

Many terms have been used to describe dental caries in young children. These include "baby bottle tooth decay," "nursing caries," and "bottle mouth," which tend to identify caries in the labial surfaces of upper anterior primary teeth. In contrast, early childhood caries (ECC) is a term that encompasses all dental caries occurring in the primary dentition of young children and ECC includes noncavitated lesions (d_1) as well as cavitated lesions. This definition was recommended by workshop participants in 1999 in an effort to better evaluate evidence from different studies bearing on the relative frequency, etiology, clinical course, and impact of ECC (7,8).

Studies on ECC have been conducted to identify the etiology, prevalence, and treatment of this disease over the past 40 years. A higher prevalence of ECC in lower socioeconomic groups has been reported (9-11). Information and education about child oral care, and the level of education of primary caregivers and family income were negatively associated with caries levels in children (12). ECC is commonly associated with incorrect feeding habits such as putting a child to bed with a bottle, bottle feeding with sweetened beverages, and prolonged breastfeeding (13,14). Even though prolonged baby bottle use seems to be a rather widely used practice among infants and young children, not all children with the nursing bottle habit develop ECC (15). It also has been demonstrated that oral health behaviors are associated with the prevalence of ECC (16). Some researchers have recognized that infant feeding practices are influenced by cultural, ethnic, and socioeconomic factors (17,18). Thus, to develop and implement ECC interventions in Korea, it is necessary to identify risk factors for this country.

Seoul is the capital city of South Korea and accounts for about 20 percent of the total population. The water supplies are not fluoridated and neither professional fluoride application nor fluoride supplements are widely used. There are no organized public health programs for early childhood such as fluoride mouthrinse regimens, but most toothpaste for children contains fluoride in South Korea. The purpose of this study was to determine the prevalence of ECC, including d_1, in children 6–59 months of age in relation to socioeconomic factors, feeding practices, and oral health behaviors in Seoul, Korea.

Methods

Subject Selection. To identify children for the study, Seoul was divided into four strata by administrative boundaries. Subsequently, eight child care facilities were selected in each stratum as primary sampling units and 15 subjects were selected randomly in each primary sampling unit. A total of 480 children aged 6–59 months were selected from 32 child care facilities. The study was conducted during January through March 2000.

Send correspondence and reprint requests to Dr. Ma, College of Dentistry, Kangnung National University, 123 Chibyundong, Kangnungshi, Kangwondo, South Korea, 210 702. E-mail: mads@kangnung.ac.kr. Dr. Jin is with the Department of Dental Hygiene, Shingu College, Sungnam Kyunggi, South Korea. Drs. Moon, Paik, and Hahn are all at the College of Dentistry, Seoul National University. Dr. Horowitz is with the National Institute of Dental and Craniofacial Research, National Institutes of Health, Bethesda, MD. This research was supported by grant #1999(HC-08-07) of the Korea Health Promotion Research Program, Ministry of Health and Welfare, R.O.K. This paper was presented as an oral presentation April 30, 2002, at the annual session of the American Association of Public Health Dentistry, Danvers, MA. Manuscript received: 2/18/02; returned to authors for revision: 4/12/02; final version accepted for publication: 12/20/02.

Oral Examination. Two dentists using natural light, a small auxiliary light, standard mouth mirrors and explorers, and gauze wipes conducted the oral examinations. A small auxiliary pen-type light was used to examine proximal and lingual surfaces. An explorer was used only to remove plaque or to detect any loss of tooth substance when this condition was suspected. All children had parental consent. Children were examined in a supine position on tables except for infants who were held in the lap of their caregiver. The criteria for dental caries diagnosis were based on National Institute of Dental and Craniofacial Research (NIDCR) standard examination method (19). Noncavitated caries lesions and cavitated lesions were examined separately. Cavitated lesions included lesions penetrating the pulp as well as cavitated enamel or dentine lesions (7,8). Only deciduous teeth were examined and caries was recorded for all tooth surfaces.

Calibration of the two dentists was accomplished by first practicing on extracted primary teeth. Subsequently, both examiners examined 45 children as a pilot study for calibration purposes. During the main survey, 25 children were reexamined. The kappa statistic was used for calculating agreement of the two examiners based on tooth level (dmf). The interexaminer kappa value was 0.71 and intraexaminer kappa values for examiners I

TABLE 1
Case Definitions of Early Childhood Caries and Severe Early Childhood Caries (8)

Age (Months)	Early Childhood Caries	Severe Early Childhood Caries
<12	1 or more dmf surfaces*	1 or more smooth dmf surfaces*
12–23	1 or more dmf surfaces*	1 or more smooth dmf surfaces*
24–35	1 or more dmf surfaces*	1 or more smooth dmf surfaces*
36–47	1 or more dmf surfaces*	1 or more cavitated, filled, or missing (due to caries) smooth surfaces in primary maxillary anterior teeth OR dmfs score ≥ 4
48–59	1 or more dmf surfaces*	1 or more cavitated, filled, or missing (due to caries) smooth surfaces in primary maxillary anterior teeth OR dmfs score ≥ 5
60–71	1 or more dmf surfaces*	1 or more cavitated, filled, or missing (due to caries) smooth surfaces in primary maxillary anterior teeth OR dmfs score ≥ 6

*Any carious lesion, noncavitated or cavitated, missing tooth due to caries, or filled surfaces. Includes primary teeth only.

TABLE 2
List of Independent Variables Investigated

Independent Variables	Time	Subjects for Analysis	Logistic Regression Model
Socioeconomic factors			
Age (months)	Present	All ages	Included
Father's level of education: 0=college or above; 1=middle, high school, or below	Present	All ages	Included
Mother's level of education: 0=college or above; 1=middle, high school, or below	Present	All ages	Included
Mother's employment status: 0=not employed; 1=employed full or part time	Present	All ages	Included
Family income level: 0=high (>$2,400/m); medium ($800/m to $2,400/m); 1=low (<$800/m)	Present	All ages	Included
Feeding practices			
Feeding practice: 0=breast milk; 1=bovine milk, powdered milk, others	Past/present	All ages	Excluded
Content of bottle: 0=milk, 1=juice, soda, and other sweetened solution	Past/present	Bottle users only	Included
Bedtime bottle use: 0=no; 1=yes	Past/present	Bottle users only	Included
Bottle feeding duration: 0=<12 months; 1=12 months or more	Past	Bottle users only	Excluded
Oral health behavior			
Person responsible for child's oral hygiene: 0=adult, adult+child; 1=child	Present	36–59 months	Included
Between-meal snacks/day: 0=1 or fewer; 1=2 or more	Present	36–59 months	Included
Routine dental checkups: 0=yes; 1=no	Present	36–59 months	Included

TABLE 3
Dental Caries Experience by Age

Age (Months)	n	dmft Index (Mean ± SE) Excluding d_1*	dmft Index (Mean ± SE) Including d_1	ft (Mean ± SE)	ECC (%)† Excluding d_1	ECC (%)† Including d_1	Severe ECC (%)‡ Excluding d_1	Severe ECC (%)‡ Including d_1
6–59	383	1.93 ± 0.27	3.67 ± 0.47	0.46 ± 0.10	40.3	56.5	24.4	47.0
6–11	25	0.00 ± 0.00	0.03 ± 0.03	0.00 ± 0.00	0.0	3.2	0.0	3.2
12–23	54	0.47± 0.09	1.85 ± 0.48	0.00 ± 0.00	16.3	44.0	6.5	36.4
24–35	80	1.08 ± 0.23	4.00 ± 0.70	0.10 ± 0.08	36.1	63.6	28.1	62.6
36–47	129	2.87 ± 0.30	5.37 ± 0.51	0.46 ± 0.12	63.5	79.3	35.9	61.5
48–59	59	5.06 ± 0.38	6.92 ± 0.38	1.70 ± 0.26	83.0	90.8	50.2	70.3

*Noncavitated carious lesion.
†Percent of children with ECC.
‡Percent of children with severe ECC.

and II were 0.78 and 0.81, respectively, for tooth level including d_1. The interexaminer kappa value was 0.71 and intraexaminer kappa values for examiner I and II were 0.84 and 0.80, respectively, for tooth level excluding d_1.

Definitions of Early Childhood Caries and Severe Early Childhood Caries. Case definitions of ECC and severe ECC in this study followed the recommendation of a report from a 1999 workshop sponsored by the NIDCR, the Health Resources and Services Administration, and the Health Care Financing Administration (Table 1) (8).

Survey Questionnaire. The questionnaire included information regarding socioeconomic factors, feeding practices, and oral health behaviors (Table 2). The survey instrument was pretested twice with mothers of infants or small children, once with 20 mothers, and once with 10 mothers. During the pretest, some questions were found to be confusing, which were then revised. A trained interviewer interviewed the parents of all subjects by phone within two weeks after the oral examinations.

Data Analysis. Descriptive and analytical techniques were conducted using SUDAAN Version 8.0.0 (Research Triangle Institute, Research Triangle Park, NC). After data collection, poststratified adjustment was done for children's age and sex using the 2000 Nationwide Health and Welfare Indicators in Korea. The chi-square test for categorical variables was used for comparisons of proportions. A logistic regression model was used to identify risk factors for caries development among children older than 35 months by considering independent variables simultaneously (Table 2). The Wald test was done and a *P*-value <.05 was considered statistically significant.

TABLE 4
Socioeconomic Factors and Caries Prevalence Among Children Aged 6–59 Months

Variables	Status	n	Caries Prevalence (%) ECC	P	S-ECC*	P
Father's education	College	311	56.1	.871	46.2	.682
	High school	72	57.8		50.2	
Mother's education	College	271	53.6	.298	43.6	.172
	High school	112	63.5		55.4	
Mother's employment	Not employed	180	53.1	.318	44.6	.357
	Employed	203	59.8		49.6	
Family income	High	343	55.6	.109	45.4	.050
	Low	40	71.4		63.2	

*S-ECC=severe early childhood caries.

Results

Table 3 shows the prevalence of ECC and severe ECC. Although 470 children were examined clinically, 87 children were lost in the survey because their parents did not participate in the interview. Thus, a total of 383 children 6–59 months of age with a mean age of 36.5 months were interviewed (200 boys and 183 girls). The response rate for the questionnaire was 79.8 percent. In each classification scheme, there were no statistically significant differences between the age and the sex for the nonresponse rates. The prevalence of ECC including d_1 in children 6–59 months of age was 56.5 percent, and severe ECC was 47.0 percent.

The relationship between socioeconomic factors and caries status is shown in Table 4. Father's education level, mother's education level, mother's employment, and family income were examined. But there were no statistically significant differences between these risk factors and caries prevalence ($P \geq .05$).

The relationship between infant feeding practices and caries status is shown in Table 5. The children whose nursing bottle contained sweetened solution had higher severe ECC prevalence ($P = .035$). But type of feeding practice, bedtime bottle, and age of weaning from nursing bottle feeding were not statistically significant variables ($P > .05$).

The relationship between oral health behaviors and caries status is

TABLE 5
Feeding Practices and Caries Prevalence Among Children Aged 6–59 Months

Variables	Status	*n*	Caries Prevalence (%) ECC	*P*	S-ECC*	*P*
Feeding practice	Breast milk	28	51.6	.752	43.0	.769
	Other	355	56.9		47.3	
Content of bottle†	Milk	187	50.6	.078	39.7	.035
	Sweetened solution	168	62.8		54.5	
Bedtime bottle†	Yes	216	57.8	.925	47.0	.584
	No	139	58.5		50.5	
Age at weaning from bottle feeding‡	<12 months	27	78.5	.902	71.0	.431
	≥12 months	239	77.5		63.4	

*S-ECC=Severe early childhood caries.
†Bottle users only.
‡Children who have weaned bottle feeding.

TABLE 6
Oral Health Behaviors and Caries Prevalence Among Children Aged 36–59 Months

Variables	Status	*n*	Caries Prevalence (%) ECC	*P*	S-ECC*	*P*
Person responsible for child's oral hygiene	Adults	57	80.9	.503	63.0	.692
	Child	167	86.4		66.8	
Between-meal snacks/ day	1 or fewer	59	76.7	.046	57.2	.152
	2 or more	165	87.9		68.8	
Routine dental checkups	Yes	38	83.0	.743	66.3	.953
	No	186	85.5		65.8	

*S-ECC=severe early childhood caries.

shown in Table 6. The children whose parents reported a lower frequency of between-meal snacks showed statistically lower ECC prevalence (P=.046).

The results of logistic regression analysis are shown in Table 7. As a result of considering 10 independent variables simultaneously (Table 2), age and frequency of between-meal snacks were statistically significant among independent variables (P<.05).

Discussion

South Korea is basically a single racial ethnic country and its capital city, Seoul, enjoys a relatively high economic status compared with other regional cities. While rice remains the nation's staple food, the consumption of fast foods, between-meal snacks, and sugar has markedly increased during the fast economic development. Almost all the people benefit from the national health insurance scheme, yet caries-prevention regimens such as pit and fissure sealants and professional fluoride applications are not covered by this insurance. The water supplies of Seoul are not fluoridated, and the use of professional fluoride application or fluoride supplements is rare. Although most kinds of toothpaste for children contain fluoride, no data are available regarding the percent of parents who purchase this toothpaste for their children. According to the National Oral Health Survey in 2000, levels of caries found among 5-year-olds were a mean dft of 5.47 and a mean dfs of 11.16 in metropolitan areas. There was no significant difference in caries prevalence by area of residence, although those living in rural areas were found to experience a slightly higher caries prevalence.

Data from this study confirmed a significant amount of dental caries was evident at an early age (Table 3). The prevalence of ECC and severe ECC increased with age. Mean dmft excluding noncavitated lesions was 1.93, but mean dmft including noncavitated lesions was 3.67 at the age of 6–59 months. These findings indicate that it is important to evaluate noncavitated lesions for early intervention. Given the possible rapid progression of dental caries in primary teeth of susceptible children as well as the need to reduce the probability of a false negative diagnosis, both noncavitated and cavitated carious lesions should be included in the research diagnostic criteria for dental caries in primary teeth. Diagnosis of noncavitated carious lesion will provide more useful data on the caries process in primary teeth and may aid in understanding the progression of dental caries during early childhood (8). Over 90 percent of the children aged 48–59 months had ECC. Furthermore, only 8.0 percent of the subjects had pit and fissure sealants in their teeth at age 36–59 months (data not shown). In the National Oral Health Survey in 2000, the prevalence of dental caries in primary teeth also was very high and this national survey did not include noncavitated lesions (6). Considering this severe caries status, early dental interventions are necessary to reduce ECC.

In general, socioeconomic status has been considered an indicator in caries risk assessment studies and lower socioeconomic status has frequently been associated with higher levels of caries, although few contemporary reports address this issue for preschool aged children (10,20). Parents' level of education, mother's employment, and family income were examined in this study. Family income can affect food selection and nutrient intake for mothers and also for infants during the tooth development period. Family income also can affect health values, lifestyle, and access to health care information. As a consequence, lower family income can be an indirect risk factor for caries, and higher income is associated with better access to care (12,21). In this study, however, the proportion of children from families with higher family income who had ECC was not

TABLE 7
Results of Logistic Regression Analysis of Effect of Variables for Early Childhood Caries (ECC) and Severe ECC Among Children 36–59 Aged Months

	ECC			Severe ECC		
	Odds Ratio	95% CI	*P*	Odds Ratio	95% CI	*P*
Age (months)	1.090	1.009, 1.177	.030	1.042	1.006, 1.079	.024
Father's level of education	1.982	0.265, 14.814	.640	0.852	0.226, 3.207	.805
Mother's level of education	1.858	0.246, 14.024	.532	1.375	0.627, 3.016	.411
Mother's employment	1.142	0.461, 2.829	.765	1.381	0.580, 3.289	.449
Content of bottle	1.422	0.648, 3.121	.364	0.887	0.424, 1.857	.740
Bedtime bottle	1.056	0.435, 2.564	.900	1.349	0.700, 2.597	.355
Person responsible for child's oral hygiene	1.069	0.358, 3.194	.901	0.924	0.368,2.324	.861
Frequency of between-meal snacks	2.377	1.047, 5.395	.039	1.670	0.789, 3.536	.171
Routine dental checkup	1.343	0.429, 4.201	.598	1.166	0.517, 2.630	.700

statistically different compared to those with lower family income, although children with higher family income tended to have a lower prevalence of severe ECC (Table 4). The proposed criterion for low family income was about US $800 monthly, which is the level of lower family income in Korea. Although attempts were made to adjust the cut-off point to several different criteria, there were still no significant differences. But when children younger than 12 months or 24 months of age were excluded, lower family income was associated with higher ECC or SECC prevalence significantly (data not shown). This finding may reflect the need for further study especially in younger children because there are relatively few studies of caries prevalence in children younger than 24 months of age. Furthermore, the data that are available often are grouped into broad age categories, and the definitions of ECC are different. Although a low level of parental education does contribute to lack of information and education about children's oral health care (22-24), there was no difference in this study.

Bottle feeding has increased considerably in recent years. ECC has been related to prolonged feeding beyond 1 year of age (25,26), but there was no difference in this study (Table 5). Roberts et al. (27) also reported that they were unable to relate dental caries to length of time of breast- or bottle feeding. But in the current study, it was noted that the prevalence of ECC and severe ECC was slightly higher in children who were weaned early from the nursing bottle, although there was no statistical difference. Caries may be related to the kinds of foods consumed or oral hygiene behaviors after weaning from the nursing bottle. Further study is needed concerning these factors. In this study, the contents of nursing bottles were usually milk, fruit juice, or yogurt. All liquids except bovine milk were categorized as sweetened liquids and the children whose nursing bottle contained sweetened solution had higher severe ECC prevalence (Table 5). Many caregivers seem to ignore or do not understand the relationship between the contents of the nursing bottle and dental caries. In this study, 47.3 percent of the nursing bottles contained sweetened solutions.

Children who consumed more between-meal snacks had a higher ECC prevalence (Table 6), and odds ratio was 2.377 (Table 7). Many studies found an association between the frequency of intake and caries (16,28). Because mothers are usually responsible for establishing and regulating dietary habits of their children (29), and children tend to adopt individual dietary patterns and feeding preferences from their mothers during early childhood (30,31), this factor also should be included in the educational intervention.

Unfortunately, there is no specific policy on ECC prevention and early dental examinations or routine dental checkups are not widely practiced in the country at the present time. The nation's 2000 National Oral Health Survey reported that the percentage of people who had not visited a dentist during the past two years was over 50 percent (6). In this study, the proportion of children who had routine dental checkups was only 14.1 percent (Table 6). Yet all Koreans have National Health Insurance and dental checkups are covered by this insurance program. The American Academy of Pediatric Dentistry recommends that all infants receive a dental examination at or before the age of 1 year (32); however, many other agencies recommend a preferred age of 2 or 3 for the initial dental referral (33). Thus, consensus on establishing an age at which a child should first go to the dentist needs to be established. Nevertheless, a routine dental checkup and early screening could help in the early identification of incipient carious lesions and provide an opportunity for treatment with fluoride to remineralize these lesions. Additionally, these visits provide an opportunity to obtain information on a child's feeding and oral hygiene practices and a time to reinforce healthy practices.

In this study, subjects were selected only in child care facilities. Thus, generalizability is limited to children who go to these facilities, even with post-stratified adjustment to the national population distribution. Because of the financial and personnel resources involved, we did not consider power of test at sample size decision, but we did post hoc power analysis in the

process of analysis.

In the data analyses procedures, we considered interactions between covariates that provide a better description of the risk relationships, but there was no statistical significance at $P<.05$ levels. For this reason, we considered the main effects only.

Conclusions

This study demonstrates high prevalence of ECC among children in Seoul. Early educational intervention programs for pregnant women and mothers of young children should be developed based on the risk factors identified in this study.

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