Dental Caries in African Preschool Children: Social Factors as Disease Markers

Mehroon N. Khan, BDS, MSc(Dent); Peter E. Cleaton-Jones, BDS, MBBCh, PhD, DSc(Dent)

Abstract

Objective: *This study investigated the associations between dental caries prevalence and severity and social factors in 3- to 5-year-old African children.* ***Methods:*** *Dental caries was diagnosed in natural light using WHO criteria, mirrors, and explorers. Socioeconomic information was obtained by questionnaire.* ***Results:*** *The percentages of 3-, 4-, and 5-year-olds with any caries experience were 47 percent, 58 percent, and 63 percent, respectively. Mean dmfs scores (SD) were 2.2(3.6), 3.0(3.8), and 3.7(4.1), respectively. Family education was associated with caries prevalence (P=.03) and severity (P=.008) in a multivariable regression model.* ***Conclusion:*** *In the indigenous African group studied, family education is a disease marker to target in future caries risk evaluations. [J Public Health Dent 1998;58(1):7-11]*

Key Words: dental caries, epidemiology, Africa, social factors, disease markers.

South Africa has undergone a social revolution in the 1990s. Both racial segregation and a low-level civil war ended, and the first democratically elected government in the country's history took office. To make up for past inequities and to allow for future developments, many more demands are being placed on the national health care budget than can be satisfied (1). In such circumstances common sense suggests that those most at risk to disease be targeted to make best use of available resources. One way to target individuals at high risk to dental caries is to use social factors as caries predictors (2).

Social gradients have been observed for a wide range of health measures. Whatever measures are used, be they objective clinical indicators or self-reported indicators, lower social classes are disadvantaged compared to those at the higher end of the social scale (3). Social factors reported to be indicators of risk for dental caries in children include parental education (4,5), social class (6), and the number of children per family (7).

Contemporary evidence from Africa generally has shown a higher prevalence and severity of caries among children from upper socioeconomic backgrounds (8-12), a relationship opposite to that in Europe. In South Africa, two studies found an inverse relationship between dental caries, parental education, and social class in white children; however, similar information for black children is not available (13,14).

The purpose of this study was to look for associations between dental caries and some social factors in a typical South African urban black community. A long-term goal of this work is to enable resources to be concentrated on those most at risk to caries in South Africa.

Methods

Subjects. The study protocol was approved by the University of Witwatersrand's Committee for Research on Human Subjects. Permission also was obtained from the Central Creche Committee of Katlehong to conduct the study, and from parents to examine their children on the understanding that no child would be examined against his or her will.

The large cities of the province of Gauteng (the most densely populated region of South Africa), which are almost contiguous, are bounded by so-called black townships originally established to house labor for the cities. The townships, while differing in size, are all similar in broad design and contain the same standardized mass-produced houses and hostels (single-sex dormitory accommodations). Squatters, or individuals living in self-made shacks, are found in all townships. The townships share the same suboptimal fluoride water supply (0.33 ppm F). The Gauteng townships are typical of urban black townships throughout the country.

The study was carried out in the black township of Katlehong, situated 27 km east of Johannesburg, 10 km south of Germiston, and 8 km east of Alberton, three of the largest cities in South Africa. The official township population is 500,000, although an unofficial estimate is double that number (15). There are 23,309 known housing units subclassified into standard two-room houses (40%), informal backyard tenants (30%), squatters (20%), hostels (7%), and elite homes (3%). Electricity is supplied to 60 percent of homes. Piped water goes to 85 percent of homes, while 15 percent have communal taps.

All children attending the seven municipal creches (day nurseries) throughout Katlehong were chosen for study. A minimum required sample size of 384 was calculated based on an estimated caries prevalence of 50 percent, a beta error of 0.05, and an alpha error of 0.05.

Dental Caries. The single examiner (MNK) was calibrated for dental caries diagnosis before the survey to a kappa score for surface to surface comparisons of 0.90 (16). During the field study, 10 percent of the sample was

Send correspondence to Dr. Cleaton-Jones, Dental Research Institute, Private Bag 3, WITS 2050, South Africa. E-mail: 078pec@cosmos.wits.ac.za. Professors Cleaton-Jones and Khan are both at the University of the Witwatersrand, Dental Research Institute, Johannesburg. Reprints will not be available from the authors. This study was supported by grants from the South African Medical Research Council and the South African Sugar Association. The study was presented at the Annual Scientific Meeting, South African Division of the International Association for Dental Research, September 7-9, 1994. Manuscript received: 6/3/96; returned to authors for revision: 7/31/96; accepted for publication: 4/18/97.

reexamined and the reliability of the examiner was found to have been maintained. The children's primary teeth were examined in good natural light outside the school using sterile plain mirrors and explorers and WHO caries diagnostic criteria (17). Only teeth extracted for dental caries were recorded as missing. Caries prevalence was defined as the percent of the sample with a dmfs score of 1 or more, while caries severity was indicated by mean dmfs scores.

Social Factors. A pretested anonymous questionnaire coded to link with the dental caries data was sent home with each child. The responses were used to define nine variables. Each child's age was recorded in whole years. A social class variable was derived from the occupation of the father (or mother if the father was unemployed or no longer in the family) using the six British social classes (18) and South African occupation descriptions (19). These six classes are I (independent and high professional), II (salaried professional and equivalent), IIIN (owners and executives in small commerce and services), IIIM (working owner in small commerce/service), IV (routine nonmanual), and V (unskilled manual). The six classes were then condensed into upper (I, II, IIIN) and lower (IIIM, IV, V). The occupational classification was based on the usual occupation of a parent irrespective of whether the parent was employed or not at the time of the survey. The employment status of parents at the time of the study was used to designate both parents, one parent, or no parents employed.

In South Africa seven years of primary school are followed by five years of secondary school, culminating in matriculation (high school diploma). Tertiary education can be at a university, technical college, or commercial college. Three family education groups were defined according to combinations of the years of schooling completed by the parents. In the low group both parents had completed less than 10 years of schooling. The middle group contained one parent who had completed 10 to 12 years of school and the other seven to 12 years. The high group had one parent with 12 years of completed schooling plus tertiary education, the other with at least 10 to 12 years of school. In single-parent households the education level of that parent was used.

Total family income per month was recorded in 13 categories similar to those used in the South African National Census. These categories were condensed into three groups for analysis: a low group of ≤US$285, a middle group of US$286 to US$999, and a high group of ≥US$1,000. (The exchange rate for the South African rand at the time of the study was ZAR3.5=US$1.)

The number of families and individuals per land unit was recorded. Family crowding was determined by dividing the number of rooms per dwelling (excluding toilet) by the number of inhabitants in that dwelling. A ratio of less than 1.0 was termed crowded; a ratio of 1.0 or more, not crowded. The availability of piped drinking water, electricity, and garbage collection was recorded as present or absent.

Data Management and Analysis. All the data were transferred to a Sun SPARCcenter 2000 computer and analyzed on a university network using SAS (20). Pearson correlations were calculated between each of the social variables used to see if similar aspects were captured in more than one variable. For the analysis of discrete caries data (prevalence), a logistic regression analysis was used. The distribution of dmfs scores (caries severity) was highly skewed. Transformation to exact normality of such ordinal data is not possible; however, it is possible to achieve a key feature of normality — namely, zero skewness — by a systematic search among transformations of the form log(dmfs+k). The k achieving zero skewness was 0.15. In this family of so-called Box-Cox transformations with shift, the selection is restricted to a small subfamily and is done by eye (21). The log(dmfs+0.15) was evaluated with a general linear model analysis. For both multivariable analyses the independent variables were entered simultaneously. The critical level for statistical significant was set at $P<.05$.

Results

Of the 668 children attending the nursery schools, 464 (69%) returned questionnaires completed by their parents. Six of these had so much information missing that they were discarded. The age of children with completed questionnaires ranged from 2 to 6 years. A minimum of 30 per age group was necessary for statistical reasons; thus, children aged 2 years (n=12) and 6 years (n=20) were excluded. The final sample reported in this paper is 426, 64 percent of all children attending the schools.

No significant differences in dental caries prevalence were found among the creches (χ^2=6.78; df=6; P=.34) or between sexes (χ^2=0.31; df=1; P=.58). Also, no significant relationships between creche or sex and any of the social factors were found. The data were therefore pooled.

At 3 years of age, 47.3 percent had

TABLE 1
Frequency Distribution of Children by Age and dmfs Levels

Age (Years)	dmfs								Total
	0		1–5		6–10		11–20		
	n	%	*n*	%	*n*	%	*n*	%	*n*
3	48	26	30	20	8	11	5	21	91
4	80	44	67	46	33	45	9	38	189
5	54	30	50	34	32	44	10	42	146
Total	182	43	147	35	73	17	24	5	426

caries; at 4 years, 57.7 percent had caries; and at 5 years, 63.0 percent had caries. Mean dmfs scores (SD) were 2.2 (3.6), 3.0 (3.8), and 3.7 (4.1) at 3, 4, and 5 years of age, respectively. The dmfs scores were grouped into four levels of increasing severity (Table 1) to look at the change in prevalence with increasing age. A chi-square for trend test showed a statistically significant increase in dmfs scores with age (χ^2=6.95; df=6; P= .008).

Family characteristics, caries prevalence, and caries severity are presented in Table 2. Most families were in the lower social class, indicating the unskilled nature of work done by most family breadwinners. The prevalence of caries was greater in the higher social class; however, mean dmfs scores were identical in the two groupings. Only 10 percent of families had no one employed. Caries prevalence and mean dmfs were similar in all the employment groupings. Almost two-thirds of the families were in the low-income bracket, which was below the unofficial national minimal subsistence level of US$343 at the time of the study. Caries prevalence and severity were highest in the low-income group.

Regarding education, most families were in the middle group, over one-third of whom had high school graduates. In general, mothers had higher education levels than fathers. Both prevalence and dmfs scores were inversely associated with education.

The sample was evenly distributed between crowded and not crowded homes, and caries prevalence and experience were similar in the two groups. Homes had from 1 to 11 rooms (mean=4.5, SD=1.8). The number of persons per family ranged from 3 to 14 (mean=5.5, SD=2.2). The mean number of rooms per inhabitant was 0.9 (SD=0.5). The number of families per land unit ranged from 1 to 24 (mean=2.3, SD=3.0). While most homes had piped water and electricity, garbage collection was not common. No clear associations between caries and household variables (home crowding, piped water, electricity, and garbage collection) were evident.

The correlation coefficients for the nine social variables ranged from a low of r=0.02 (employment) to a high of r=0.41 (electricity and water). Of the nine variables, only family education was associated with dental caries prevalence and log(dmfs+0.15) (Table 3) in multivariable analyses.

TABLE 2
Frequency Distribution of Families, and Caries Prevalence and Mean dmfs Scores of Children, by Social Variables

	Family		Children			
			With Caries		dmfs†	
Variable	*n**	%	n	%	Mean	SD
Age (years)						
3	91	21	43	53	2.2	3.6
4	189	44	109	58	3.0	3.8
5	146	35	92	63	3.7	4.1
Social class						
Lower	256	72	139	54	3.3	3.8
Higher	102	28	64	63	3.3	3.8
Employment of parents						
Both unemployed	43	10	25	58	3.0	3.4
Both employed	155	37	89	57	3.0	3.9
One employed	226	53	129	57	3.0	4.0
Income group						
Low	263	62	155	59	3.1	3.8
Middle	144	34	81	56	3.0	4.0
High	19	3	8	42	2.3	4.1
Education group						
Low	100	28	61	61‡	3.6	4.1‡
Middle	170	48	102	60	3.3	3.6
High	87	24	41	47	2.7	3.6
Home crowded						
Crowded	203	52	110	54	3.3	3.7
Not crowded	186	48	106	57	3.3	4.0
Piped water						
Absent	39	9	23	59	2.5	3.1
Present	387	91	221	57	3.3	3.8
Electricity						
Absent	51	12	26	51	2.4	3.1
Present	375	88	218	58	3.4	3.8
Garbage collection						
Absent	276	65	157	57	3.2	3.8
Present	146	35	84	57	3.3	3.6

*Sample sizes vary because of nonresponse to some questionnaire items.
†Whole sample.
‡Statistically significant at P<.05

Discussion

The essence of any epidemiologic study is whether or not the sample examined is suitably representative for a particular study. The township investigated is typical of a South African urban black community. Since attendance at municipal creches is voluntary and subject to affordability, the study sample might not be representative of the general population. The realities of life in South Africa, however, are that general population surveys of young children are almost impossible to do. Even the National Oral Health Survey of the Department of Health (22) was limited to children attending schools in metropolitan areas. The children aged 2 or 6 years excluded from this study were few because parents tend to keep 2-year-olds at home and most children already have started primary school at 6 years of age.

A heartening factor in this study was the high questionnaire response

TABLE 3
Results of Multivariable Analyses of Caries Prevalence and Severity (n=277)

	Logistic Regression [for Caries Prevalence]			General Linear Models Analysis [for log(dmfs+0.15)]	
Variable	Beta Coefficient	Standard Error	*P*-value	F Ratio	*P*-value
Child age	–0.19	0.17	.26	1.86	.16
Social class	0.55	0.31	.07	0.40	.53
Employment	–0.10	0.23	.67	0.10	.90
Family income	0.38	0.24	.12	1.50	.23
Education group	0.47	0.21	.03*	4.96	.008*
Home crowding	0.45	0.27	.09	1.21	.27
Piped water	–0.08	0.54	.89	1.02	.31
Electricity	–0.69	0.45	.13	1.65	.20
Garbage collection	–0.09	0.26	.73	0.03	.86

*Statistically significant at $P<.05$.

rate of 69.5 percent, which is higher than our institute has experienced in other recent surveys — a typical figure being 40 to 50 percent. This high response rate could have been because the field examiner (MHK) is well known in the area.

With all questionnaire studies, response accuracy is an essential component. We have no data to confirm the validity of our questionnaire other than that it was based on a similar one successfully used in an earlier study in older children of other communities (14). Individuals completing a questionnaire must be literate enough to understand what is being asked. Approximately 48 percent of the indigenous African population in South Africa (rural plus urban) is illiterate or semiliterate, as indicated by less than seven years of formal schooling (23). No rates are available for the urban population; however, local researchers in this field estimate the rate at about 40 percent. In our sample only 6 percent of families who completed the questionnaire had both parents with less than seven years of schooling. Anecdotal evidence from discussions with teachers at schools in the present study suggests that neighbors, friends, or relatives who were literate helped these low-education families to complete their questionnaires. In our experience, reporting of family income is a problem because of the natural desire for privacy. To help overcome this problem, we used broad income ranges, made the questionnaire anonymous, and provided an envelope in which to seal the questionnaire.

The fairly high caries prevalence but low mean dmfs scores seen in this study are similar to trends reported elsewhere in Africa (9,10,25). Our study differs from most African investigations in that our observed caries rates decreased as family education increased, a typical western pattern.

The spectrum of social factors in the study sample shows the characteristics of disadvantaged people who have been collectively termed an underclass community by Kliegman (24), a relic of a previous political system. This system, "apartheid" (apartness), used a separate, inferior education system and restrictions on where to live as core policy.

The multivariable analyses in our study showed only one of the nine variables — family education — to have a statistically significant relationship to caries prevalence and severity. Social class, mostly based on the occupation of a parent, has been examined for its effects on caries in several studies in Africa, with inconsistent findings. Caries was found to be significantly worse in higher social classes in Nigeria (8,11) and Sierra Leone (12). In the current study, no statistically significant effect was seen, an assessment shared by researchers in Kenya (25), Sudan (26), and Tanzania (27-29).

The way in which individuals with different educational levels are grouped influences the statistical analysis. In an initial analysis of these same data, a six-category education variable suggested by Holan et al. (5) was used for each parent separately. No statistically significant associations between caries rates and parental education were found (30). Subsequent reflection led us to believe that the general milieu of the family in South Africa is probably more important than the education level of one parent; hence, the system reported in this paper was devised. A feature of families in developing communities in South Africa is that the father, regarded as the head of the household, frequently has less education than the mother. Due to pressure to earn money early in life, males leave school earlier than females. Currently, females constitute 57 percent of the school and university population, compared to 52 percent of the general population (31). The combined parental education level at home thus seems a more appropriate measure. The reasons for the significant relationship between education and caries are not known.

Clearly, different ethnic groups living in the same country can have different social markers for the same disease. This possibility was shown recently when 12-year-old South African Indian and white groups were compared for dental caries using the same social markers. In the Indian community, no statistically significant social markers were seen, in contrast to three in the white group — namely, social class, family income, and crowding (14). One reason for a lack of identified social markers in Africans could be that the wrong markers or methods have been used up to now because investigations apply factors or classifications applicable to Europe

and other western countries. No assessments appropriate for African populations have been defined and are needed. An advantage of the current study is that clearly defined classifications were used. In studies elsewhere in Africa, classifications either have not been described or have been vague (8,11,12), so that conclusions may not be accurate.

A final complicating factor in our study of the relationship between social factors and dental caries is the relatively low caries level in the Katlehong community. Dental caries was diagnosed in natural light in this study. In our experience, this technique yields results comparable to the operatory light. Studies to identify risk markers in populations with high rates of disease may show different statistical effects than in communities with low disease. The d, m, and f components have not been reported separately in this article because no children had filled teeth and very few had missing teeth. Almost all caries recorded was untreated, the d component indicating a lack of access to dental treatment.

What has emerged from this study is that family education grouping should be used in prospective studies of dental caries risk groups in South African children.

Acknowledgments

We are indebted to Canicia Chobisa, chairside assistant, for arranging the interviews and being the interpreter; the principals, teachers, parents, and children who participated in the research; and the Central Creche Committee of Katlehong and the staff of Katlehong City Council.

References

1. Sinclair MR, Place JL, eds. Changing health in South Africa: toward new perspectives in research. Menlo Park, CA: Henry J. Kaiser Family Foundation, 1991.
2. Graves RC, Abernathy JR, Disney JA, Stamm JW, Bohannan HM. University of North Carolina caries risk assessment study. III. Multiple factors in caries prevalence. J Public Health Dent 1991;51: 134-43.
3. Locker D. An introduction to behavioral science and dentistry. London: Tavistock Routledge, 1989.
4. Verrips GH, Frencken JE, Kalsbeek H, ter Horst G, Filedt Kok-Weimar TL. Risk indicators and potential risk factors for caries in 5-year-olds of different ethnic groups in Amsterdam. Community Dent Oral Epidemiol 1992;20:256-60.
5. Holan G, Iyad N, Chosack A. Dental caries experience of 5-year-olds related to their parents' education levels: a study in an Arab community in Israel. Int J Pediatr Dent 1991;2:81-5.
6. Milen A, Hausen H, Heinonen OP, Paunio I. Caries in primary dentition related to age, sex, social status and county of residence in Finland. Community Dent Oral Epidemiol 1981;9:83-6.
7. Zadick D. Epidemiology of dental caries in 5-year-old children in Israel. Community Dent Oral Epidemiol 1978;6:91-6.
8. Enwonwu CO. Socioeconomic factors in dental caries prevalence and frequency in Nigerians. Caries Res 1974;8:155-71.
9. Manji F. The prevalence of caries in children of African and Asian origin in Nairobi, Kenya. Odontostomatol Trop 1983; 6:27-33.
10. Manji F. Dental caries and socioeconomic factors amongst Nairobi schoolchildren. Odontostomatol Trop 1986;9:141-4.
11. Olojugba OO, Lennon MA. Dental caries experience in 5- and 12-year-old school children in Ondo State, Nigeria, in 1977 and 1983. Community Dent Health 1987; 4:129-35.
12. Normark S. Social indicators of dental caries among Sierra Leonean schoolchildren. Scand J Dent Res 1993;101:121-9.
13. Chosack A, Cleaton-Jones P, Matejka J, Fatti P. Social class, parent's education and dental caries in 3- to 5-year-old children. J Dent Assoc S Afr 1990;44:4-7.
14. Cleaton-Jones P, Chosack A, Hargreaves JA, Fatti LP. Dental caries and social factors in 12-year-old South African children. Community Dent Oral Epidemiol 1994;22:25-9.
15. Katlehong Town Council Department of Statistics. 1991.
16. Cleaton-Jones P, Hargreaves JA, Fatti LP, Chandler HD, Grossman ES. Dental caries diagnostic calibration for clinical field surveys. Caries Res 1989;23:195-9.
17. World Health Organization. Oral health surveys, basic methods. 3rd ed. Geneva: WHO, 1980.
18. Office of Population Censuses and Surveys. Classification of Occupations. London: Her Majesty's Stationery Office, 1980.
19. Schlemmer L, Stopforth P. A guide to the coding of occupations in South Africa. Fact paper no 4. University of Natal: Centre for Applied Social Sciences, 1979.
20. SAS Institute Inc. SAS-STAT user's guide. Version 6. 5th ed. Vols 1 and 2. Cary, NC: SAS Institute Inc., 1989.
21. Rice J. Mathematical statistics and data analysis. 2nd ed. Belmont, CA: Duxbury Press, 1995.
22. Van Wyk PJ, ed. National Oral Health Survey. Pretoria: Department of Health, 1994.
23. Tuchton GM. Adult basic education in South African. In: McKay V, ed. A sociology of education. Johannsburg: Lexicon, 1995:230-50.
24. Kliegman RM. Perpetual poverty: child health and the underclass. Pediatrics 1992:710-13.
25. Masiga MA, Holt RD. The prevalence of dental caries and gingivitis and their relationship to social class amongst nursery-school children in Nairobi, Kenya. Int J Paediatr Dent 1993;3:135-40.
26. Raadal M, Elhassan FE, Rasmussen P. The prevalence of caries in groups of children aged 4-5 and 7-8 years in Khartoum, Sudan. Int J Paediatr Dent 1993;3:9-15.
27. Kerosuo H, Honkala E. Caries experience in the primary dentition of Tanzania and Finnish 3–7-year-old children. Community Dent Oral Epidemiol 1991;19:272-6.
28. Kerosuo H, Ngassapa D, Kerosuo E, Ranta K. Caries experience in the primary dentition of nursery-school children in Dar-es-Salaam, Tanzania. Caries Res 1988;22:50-4.
29. Frenken JE, Truin GJ, Sarita P, Van 't Hof MA, Knig KG. Caries prevalence in the deciduous dentition of a Tanzanian urban and rural child population in relation to levels of fluoride in drinking water in 1984, 1986 and 1988. East Afr Med J 1990; 67:237-45.
30. Khan MN. Caries and social factors in African preschool children in Katlehong. MSc(Dent) research report. Johannesburg: University of the Witwatersrand, 1996:1-69.
31. Strauss JP, Van der Linde HJ, Plekker SJ, Strauss JWW. Education and manpower development 1995. No 16. Bloemfontein: Research Institute for Education Planning, University of Orange Free State, 1996.