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Prevalence of dental caries in Indiana school children: results of 1982 survey

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Abstract

During the 1981-82 school year, 6,363 Indiana school children in grades 1-12 were examined to determine caries prevalence and its relationship to geographic area, type of residence, water fluoride history, age, and sex. The results compare favorably with those observed in Region III of the NIDR national caries survey. When compared to a similar survey conducted in Indiana 10 years earlier, the present data reflect a decreased caries prevalence in both the permanent and primary dentitions. During the past 23 years caries prevalence in Indiana has declined nearly 70%.

Since 1958, statewide surveys of the prevalence of dental caries in Indiana school children have been performed at 10- to 13-year intervals. The most recent survey was conducted during the first half of 1982. Its primary objective was to determine caries prevalence on the basis of geographic area, type of residence, water fluoride history, age, and sex. This article summarizes the observations obtained from the latest survey.

Methods and Materials

School Selection

During the 1981-82 school year, 6,363 children in 134 schools, grades 1-12 were examined to determine dental caries prevalence. The schools and grade levels examined were chosen randomly using a weighted sampling procedure based on a stratified listing of all public and parochial schools.[2-6] The schools were stratified into various categories to reflect their geographic location (northern, central, or southern), type of residence (urban or rural), and water fluoride content (fluoridated or nonfluoridated).

Geographic location was based on the boundaries used by the Health Service Agency (HSA). Urban areas were defined arbitrarily as those cities with a population of 10,000 or greater based on the 1980 census.[7] Information regarding water fluoride content was derived from various lists and maps provided by the Dental Division of the Indiana State Board of Health.[8-12] Fluoridated water was defined as having at least 0.8 ppm fluoride. Lifetime exposure to fluoridated water was considered to be exposure (residence) for at least 92% of the participant's life. Age was defined as the child's age at the time of examination and sex was obtained from the health history questionnaire.

Participant Selection

Once initial approval was obtained from the superintendants and principals of the selected schools, arrangements were made to conduct the examinations. A consent letter/health history was provided to each student in the chosen grade levels. Examinations were performed only on those students who returned a completed health history/consent form and who had a negative health history.

Examination Team and Equipment

The examining team consisted of a single examiner and a recorder. Examiner calibration with an experienced clinical examiner was conducted to establish diagnostic consistency before the survey was begun. Diagnostic criteria were those described by Radike in 1968.[13]

The field equipment included a portable dental light,

dental chair, plane surface mirrors, double-ended explorers, and compressed air. The caries examinations were performed without radiographs and each student's teeth were brushed with a dentifrice prior to examination to remove oral debris.

Findings were recorded in terms of DMF and def teeth and surfaces. The data then were transferred to punch cards for cybernetic analysis and tabulated according to age, sex, type of residence, and water fluoride history.

Results

The prevalence of dental caries as a function of age is presented in Table 1. These data indicate that at age 7 the average DMF teeth and surface values were 0.18 and 0.23, respectively. As expected, these values consistently increased with increasing age. The typical 11-year-old had 1.19 DMF teeth and 1.65 DMF surfaces; at age 18 these values were 4.61 and 6.94, respectively.

The data shown in Table 2 relate caries experience to sex of the child for the combined ages. It can be seen that boys generally experienced about 18% more carious lesions in the primary dentition and about 10% fewer caries in the permanent teeth than girls. This finding was observed consistently for all ages examined.

Table 3 shows caries prevalence as a function of both urban and rural residencies in the three HSA geographic portions of Indiana. These data indicate that caries prevalence was slightly higher (5%) in northern rural children compared to the average for the state (Table 2), while urban children in the north had the least caries experience. The children residing in rural as well as urban communities of the central and southern regions of the state experienced essentially the same caries levels.

Figure 1 summarizes caries prevalence according to the presence or absence of fluoride in the drinking water. Lifetime exposure to fluoridated water resulted in modest overall decreases in caries prevalence of about 9% in primary teeth and 17% in permanent teeth. Most of these differences were observed in the number of decayed tooth surfaces (41.9% decrease) and missing tooth surfaces (60.0% decrease). In terms of different tooth surfaces, fluoridated water was associated with caries decreases of 13.5, 14.6, and 33.3% on occlusal, buccolingual, and proximal surfaces, respectively.

The level of maternal education appeared to be inversely related to the caries prevalence of the children (Table 4). Although not shown, a similar inverse relationship between caries prevalence and the paternal education level also was observed.

Table 5 summarizes the distribution of DMF surfaces for the entire population surveyed. Only 3.5% of the permanent tooth surfaces were missing, while only 15.0% of the surfaces exhibited frank lesions in need of restoration. The remaining 81.5% of the afflicted surfaces had been restored.

Table 6 and Figure 2 present the data from previous Indiana surveys[14,15] as well as the latest survey and illustrate the declinng caries rate of permanent teeth (DMFT) over the past 23 years. During the 13-year period between 1958-59 and 1971-72 the overall prevalence of caries declined by about 35%. An even greater decline in caries prevalence (about 50%) occurred during the 10-year period between the 1971-72 and 1981-82 surveys. As shown in Table 7 and Figure 3,

Table 1. Prevalence of Dental Caries in Indiana School Children (1982)

Age of Children	*Number of Children Examined*	*Primary Dentition* def Teeth	def Surfaces	*Permanent Dentition* DMF Teeth	DMF Surfaces
7	299	1.86	3.78	0.18	0.23
8	492	2.21	4.60	0.46	0.60
9	534	2.27	4.87	0.67	0.93
10	582	2.26	4.72	0.93	1.28
11	584	1.59	3.37	1.19	1.65
12	583	1.01	2.01	1.48	2.03
13	510	0.43	0.87	1.92	2.70
14	504	0.17	0.37	2.24	3.21
15	489	0.08	0.17	3.02	4.30
16	505	0.05	0.12	3.42	4.97
17	544	0.02	0.05	4.08	5.81
18	498	0.01	0.02	4.61	6.94
19	239	0.01	0.02	4.92	7.84
Total Sample	6363	0.96	2.00	2.17	3.13

Table 2. Caries Prevalence of Entire Survey Population According to Sex

Parameter	*Boys*	*Girls*	*Combined*
deft	1.02	0.89	0.96
defs	2.17	1.84	2.00
DMFT	2.02	2.32	2.17
DMFS	2.96	3.30	3.13

the most dramatic decline in caries prevalence occurred in the primary dentition where an overall decrease of about 62% was observed in the 10-year period from 1971-72 to 1981-82.

In 1979-80 the National Dental Caries Prevalence Survey was conducted in Region III of the United States and Table 8 compares the data from the national and Indiana surveys. Region III is comprised of Minnesota, Iowa, Missouri, Illinois, Indiana, Ohio, Wisconsin, and Michigan. A total of 5,484 children between the ages of 5 and 17 were examined in the NIDR survey. The DMFS in Region III was found to be 4.7, with 16.8% of these surfaces classified as decayed and unfilled, 7.1% extracted due to caries, and 76.1% restored. It can be seen in Table 8 that the data from the Indiana survey compare favorably to that collected in Region III as part of the NIDR survey, although the values from the Indiana survey are consistently lower.

Discussion

As can be seen in the data accumulated from the present and prior dental surveys, caries prevalence has decreased dramatically in Indiana during the past 23 years. This marked decline may be attributed to many factors including: water fluoridation, greater availability of fluoride dentifrices and pediatric fluoride supplements, increased dental manpower, increased availability of dental insurance, increased public awareness, and dental health education.

In 1975 it was determined that roughly 61.2% of Indiana's population was served by community water systems which were fluoridated either naturally or by the addition of fluoride.[16] Indiana schools have conducted supervised fluoride rinsing or brushing programs since the fall of 1967. Using either a 1.23% APF brushing or 0.2% NaF rinsing system, approximately 95,000 school children in grades K-12 were treated during the 1982-83 school year.[17] In 1973 Indiana also began to install fluoridation equipment in selected rural schools. In September of 1982, 99 schools with a combined enrollment of 44,000 children were involved in this program.[18] In addition to these public health programs, it is known that the majority of practicing dentists routinely administer topical fluoride and recommend the regular use of fluoride dentifrices by school children. There can be little doubt that these caries-preventive measures have contributed markedly to the state-wide decline in caries prevalence.

Increased availability of dental services also have had an impact on the improved dental health of Indiana residents as reflected by the high percentage (81.5%) of restored tooth surfaces. In the 1958-59 and 1971-72 surveys only about 43 and 53% of the carious teeth had been restored. In 1983 Indiana had 2,685 practicing dentists, or one dentist per 2,037 residents.[19] Of this number of dentists, 2,407 practitioners were younger than 65 years of age. Using this number of practicing dentists, the dentist-population ratio was 1:2,273 in 1983. Thus, it is quite probable that the relatively large number of dentists in relation to the population has had significant impact upon the increase in the percentage of restored carious surfaces.

Another factor which may have some bearing on

Table 3. Caries Prevalence of Entire Survey Population According to Region and Type of Residence

Section of Indiana	*Type of Area*	*Number of Children*	*Primary Teeth*		*Permanent Teeth*	
			deft	defs	DMFT	DMFS
Northern	Rural	1149	1.00 ± 2.01*	2.09 ± 4.81	2.31 ± 2.88	3.36 ± 4.87
	Urban	1019	0.95 ± 1.93	1.90 ± 4.41	1.91 ± 2.61	2.67 ± 4.04
	Combined	2168	0.98 ± 1.98	2.00 ± 4.62	2.12 ± 2.76	3.04 ± 4.51
Central	Rural	1067	0.90 ± 1.87	1.95 ± 4.71	2.06 ± 2.59	3.00 ± 4.26
	Urban	1012	0.94 ± 1.98	1.85 ± 4.42	2.31 ± 2.41	3.34 ± 5.16
	Combined	2079	0.92 ± 1.92	1.90 ± 4.57	2.18 ± 2.89	3.16 ± 4.72
Southern	Rural	1108	1.00 ± 2.08	2.22 ± 5.40	2.20 ± 2.76	3.15 ± 4.40
	Urban	1040	0.93 ± 1.95	1.95 ± 4.66	2.25 ± 2.85	3.26 ± 4.98
	Combined	2148	0.97 ± 2.02	2.09 ± 5.06	2.22 ± 2.81	3.21 ± 4.69

* Mean ± standard deviation.

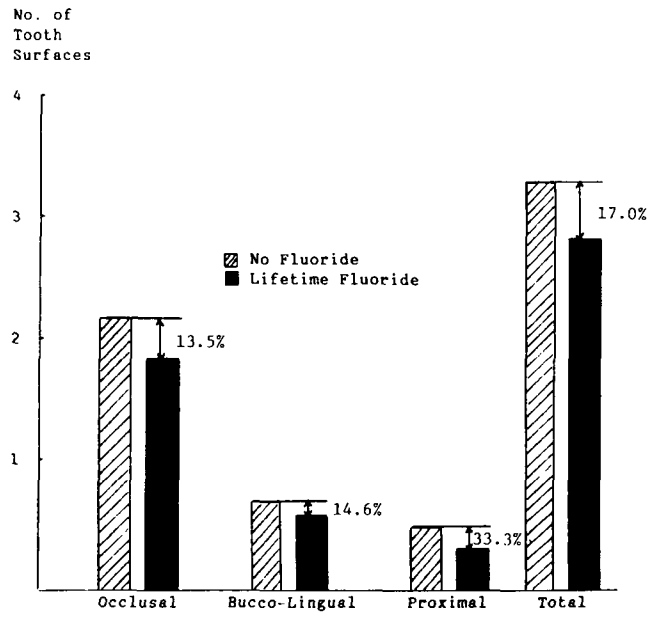

FIG 1. Caries prevalence according to the presence or absence of fluorides in the drinking water.

TABLE 4. Caries Prevalence of Entire Survey Population According to Maternal Education Level

	Caries Prevalence of Children		
Mother's education	defs	DMFS	Total
8th grade or less	2.94	3.81	6.75
Attended high school	2.47	3.25	5.72
High school graduate	2.14	3.18	5.32
Attended college	1.71	2.83	4.54
College graduate	1.21	2.81	4.02

TABLE 5. Status of Afflicted Tooth Surfaces of Survey Participants

Parameter	*Mean*	*Per cent*
Decayed surfaces (DS)	0.47	15.0
Missing surfaces (MS)	0.11	3.5
Filled surfaces (FS)	2.55	81.5
Total DMFS	3.13	100.0

the decreased caries prevalence is the increased availability of dental insurance. Although figures are not available for Indiana, national figures reflect the growing use of dental insurance. In 1965 only 3 million beneficiaries or 1.6% of the population were enrolled in dental plans. By 1970, coverage had been extended to 12 million people and in 1976, 46 million beneficiaries or 22% of the population had some type of coverage.[20] During this same time period, out-of-pocket per capita expenditures for dental services rose from $13.87 to $45.11.[20]

Public awareness and dental health education as well as general education also may have played a role in a declining caries level. According to the Indiana Office of Public Instruction, between 1950 and 1970 the number of children successfully completing high school increased by 15%.[21] This can be related to the data presented in Table 5 which shows that as maternal education level increased, the DMFS of the offspring decreased.

The overall decline in caries observed in this survey is consistent with results reported by other examiners throughout the United States in the past several years. Zacherl and Long[22] first reported a 17% decrease in caries prevalence during a 6-year period in children 6-12 years of age. Glass et al.[23] showed a 50% decrease in caries prevalence in children residing in Boston over a 20-year period. DePaola et al.[24] reported a decrease of 40-50% in a nonfluoridated area over a 30-year period. During the past 2 years a number of reports of similar observations have appeared. The results of the present survey are additional evidence that caries prevalence is continuing to decline at a dramatic rate throughout the United States.

In the present survey boys were found to have about 18% more caries in the primary dentition than girls, while the reverse was true in the permanent dentition (Table 2). Historically, these caries rate differences have been attributed to differences in eruption rates, particularly in the permanent dentition. In girls the increased exposure of the permanent dentition to possible carious attack may explain their greater caries rate. Conversely, the longer retention of the primary dentition in boys may explain the increased caries rate in these teeth.

Prior caries surveys in Indiana[14,15] indicated greater caries prevalence in children residing in rural areas throughout the state. In the present survey this trend was reversed for two-thirds of the state; only in the northern portion were caries prevalence rates greater in children residing in rural areas (Table 3). No explanation of these changes was apparent from this study.

The finding of a modest difference in caries prevalence of about 17% between children residing in fluoridated and nonfluoridated communities was unexpected and is in marked contrast to numerous reports of earlier investigations which noted differences of considerably greater magnitude.[25-28] However, this finding is consistent with observations from two recent surveys in which the magnitude of the benefit from fluoridation was reported to be 18 and 33%.[29,30] One may speculate that the increased use of fluoridated products during the past three decades by res-

TABLE 6. Comparison of Dental Caries Prevalence in 1982 With That Observed in Prior Surveys

Age of Children	1958-59 Survey[14] Children Examined	1958-59 Survey[14] Average DMFT	1971-72 Survey[15] Children Examined	1971-72 Survey[15] Average DMFT	1981-82 Survey Children Examined	1981-82 Survey Average DMFT
7	1709	0.99	833	0.65	299	0.18
8	1779	1.77	952	1.11	492	0.46
9	1550	2.50	944	1.55	534	0.67
10	1494	3.17	1002	1.98	582	0.93
11	1438	3.95	1002	2.51	584	1.19
12	1406	4.05	965	3.16	583	1.48
13	980	6.26	1042	3.96	510	1.92
14	922	7.20	950	4.77	504	2.24
15	861	8.51	767	5.19	489	3.02
16	816	9.16	893	5.96	505	3.42
17	571	10.02	972	6.58	544	4.08
18	215	10.47	714	7.10	498	4.61

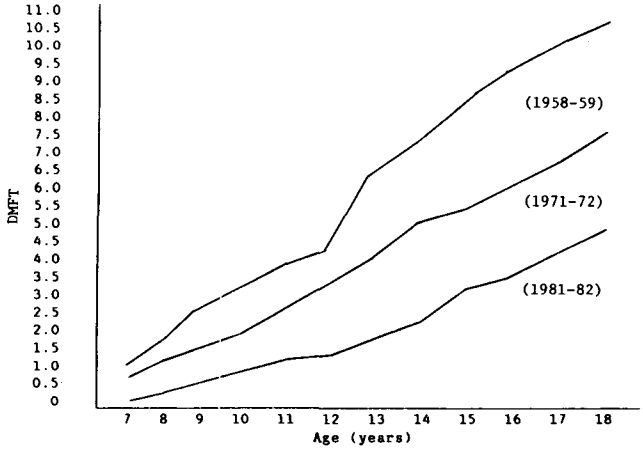

FIG 2. Data from previous Indiana surveys and the latest survey illustrate the declining caries rate of permanent teeth (DMFT).

idents of both fluoridated and nonfluoridated communities lessens the magnitude of the effect which may be attributed solely to communal fluoridation.

Conclusion

During 1981-82 a survey was conducted to determine caries prevalence among Indiana school children. A total of 6,363 school children were examined by a single examining team. It was found that there was a dramatic decrease of about 70% in caries prevalence during the past 23 years and a decline of about 50% during the past 10 years.

Caries prevalence was somewhat greater in the permanent dentition and less in the primary dentition of girls as compared to boys. In the northern third of the state, caries was more prevalent in rural residents than in urban residents while no residential differences were apparent in the remainder of the state. Residents of fluoridated communities had 17% fewer caries than children residing in nonfluoridated areas. Caries prevalence also was found to be inversely related to the eduction level of the parents.

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TABLE 7. Comparison of Caries Prevalence in Primary Dentition Observed in 1971-72 and 1981-82 Surveys

Age of Children	1971-72 Survey Number Examined	1971-72 Survey Average deft	1981-82 Survey Number Examined	1981-82 Survey Average deft	*Per cent Decrease*
7	833	4.72	299	1.86	60.6
8	952	6.66	492	2.21	66.8
9	944	7.29	534	2.27	68.9
10	1002	6.18	582	2.26	63.4
11	1002	3.59	584	1.59	55.7
Age/Sample Adjusted Average deft		5.71		2.15	62.3

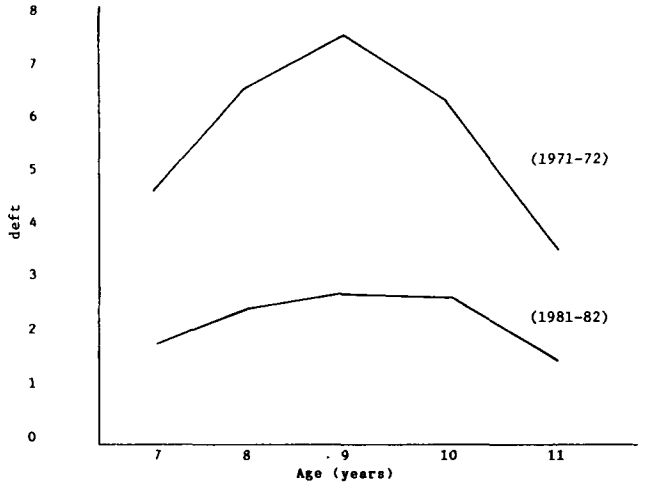

FIG 3. A dramatic decline in caries prevalence occurred in the primary dentition (62%) during a 10-year period.

TABLE 8. Comparison of Results of the Indiana Survey to Region III of the NIDR Survey

Parameter	*Indiana School Children* 6,395; ages 7-19	*Region III* 5,485; ages 5-17
DMFT	2.17	2.95
DMFS	3.13	4.67
deft	0.96	2.68
defs	2.00	5.34

and Victor H. Mercer of the Indiana State Board of Health as well as the numerous school systems and allied agencies in the conduct of this survey.

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1. National Institute of Dental Research: The prevalence of dental caries in the United States children, 1979-1980. The National Dental Caries Prevalence Survey, NIH pub no 82-2245. Bethesda, MD; US National Institutes of Health, 1981.
2. Indiana Department of Public Instruction: Indiana School Directory for 1980-81.
3. Indiana Department of Public Instruction: 1979-80 report of statistical information for Indiana school corporations.
4. Indiana Department of Public Instruction: 1980-81 report of statistical information for Indiana school corporations.
5. Office of the State Superintendent of Public Instruction: A list of open/closed schools (public) 1980-81 vs 1981-82.
6. Office of Catholic Education: Directory of Schools, 1981-82.
7. US Dept of Commerce, Bureau of the Census: Advance reports. *1980 Census of Population and Housing, PHC80-V-16*, Indiana, 1981.
8. Indiana State Board of Health: A list of Indiana communities adjusted to 1 ppm fluoride based on the 1980 census and a telephone survey. September 16, 1981 (amended November, 1981 via telephone).
9. Indiana State Board of Health: A list of Indiana community water systems deficient in fluoride listed by counties as of October 14, 1981.
10. Indiana State Board of Health: A list of Indiana rural schools with fluoridation equipment as of October 14, 1981.
11. *Indiana State Board of Health: A list of schools that no longer* have fluoride equipment as of October 14, 1981.
12. Indiana State Board of Health: A list of schools on private wells deficient in fluoride as of October 14, 1981.
13. Radike AW: Criteria for diagnosis of dental caries, in Proceedings of the Conference on the Clinical Testing of Cariostatic Agents. Chicago; ADA, 1968 pp 87–88.
14. Gish CW: Caries prevalence in Indiana school children during 1958–59. Unpublished report, 1960.
15. Bell CD, Gish CW: 1971–72 survey of caries prevalence in Indiana school children. Unpublished report, 1974.
16. *Center of Disease Control, Bureau of State Services: Fluoridation* Census 1975. Public Health Service, US Dept of Health, Education and Welfare, 1977 p 9.
17. Unpublished data: Supplied by the Oral Health Research Institute, Indiana University from their records of December, 1983.
18. Indiana State Board of Health: A list of Indiana rural schools with fluoridation equipment as of October 14, 1981. (Updated via telephone December, 1983.)
19. Gish CW: Unpublished data, personal communication, 1984.
20. Unpublished data: Supplied by the Health Professions Bureau, Indianapolis, Indiana, July, 1983.
21. Unpublished data: Supplied by the Indiana Office of Public Instruction, July, 1983.
22. Zacherl WA, Long DM: Reduction in caries attack rate in a nonfluoridated community. IADR Program and Abstracts, no 535, 1979.
23. Glass RL, Scheinen A, Barmes DE: Changing caries prevalence in two cultures. IADR Program and Abstracts, no 202, 1981.
24. DePaola PF, Soparkar P, Allukian M, DeVelis R, Resker M: Changes in caries prevalence of Massachusetts children over thirty years. IADR Program and Abstracts, no 200, 1981.
25. Hilleboe HE, Schlesinger ER, Overton DE, Chase HC, Cantwell KT, Hodge HC, Ast DB, Smith DJ, Wachs B: Newburgh-Kingston caries-fluorine study: final report. JADA 52:290–325, 1956.
26. Arnold FA Jr, Likins RC, Russell AL, Scott DB: Fifteenth year of the Grand Rapids fluoridation study. JADA 65:780–85, 1962.
27. Brown HK, Poplove M: Brantford-Sarnia-Stratford fluoridation caries study: final survey, 1963. Can Dent Assoc J 31:505–11, 1965.
28. Blayney JR, Hill IN: Fluorine and dental caries. JADA 74:233–302, 1967.
29. Katz RV, Jensen ME, Meskin LH: Dental caries prevalence in a community of school children: fluoridated vs nonfluoridated. IADR Program and Abstracts, no 296, 1983.
30. Brunelle JA, Miller AJ, Smith JI: DMFS in US children with and without lifelong exposure to water fluoridation. IADR Program and Abstracts, no 302, 1983.