Community Water Fluoridation and Cancer Mortality in Kansas: Is There a Relationship?

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September 1999

KANSAS HEALTH INSTITUTE

Topeka, Kansas

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Background

This study was undertaken to provide input to Kansas communities as they decide whether to fluoridate their drinking water. It has long been recognized that community water fluoridation is a beneficial public health action due to its proven ability to inexpensively prevent many dental problems, particularly for those who do not have access to regular dental care. However, questions have been raised about potential health risks associated with water fluoridation, with increased cancer risk being the most serious potential health concern.

Many scientific studies conducted nationally and internationally strongly indicate the safety of water fluoridation, consistently finding no relationship between water fluoridation and cancer. However, there is concern by some that these findings may not be applicable to Kansas. To address that concern, KHI examined cancer mortality rates in fluoridated and non-fluoridated Kansas communities.

Study Design

This study was conducted using data from 78 Kansas communities with a population of 2,500 or more. The cities were categorized into fluoridated, nonfluoridated, and intermediately fluoridated groups based on 1997 average fluoride levels. For each city, the age-adjusted cancer mortality rate was determined using 1995-1998 state vital statistics for seven groups of cancers: leukemia, brain, breast, gastrointestinal tract, kidney, and reproductive tract cancers as well as all cancers. Three statistical tests (rank correlation, analysis of variance, and regression analysis) were used to examine whether there is a relationship between cancer mortality rates and water fluoridation.

Major Findings

No difference in cancer mortality rates was found between cities with fluoridated water and those with non-fluoridated water, nor was there any significant relationship between the level of fluoride in a community's water and cancer mortality rates.

Conclusion

These findings indicate that in Kansas fluoridation of drinking water does not result in increased cancer mortality rates. This conclusion is consistent with the results of national research strongly supporting the safety of water fluoridation. Community leaders must weigh this and other research indicating that (1) there is a high level of certainty that water fluoridation has significant dental benefits, and (2) that there is a low probability that water fluoridation poses serious health risks.

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Introduction

Community water fluoridation has become a topic of interest and concern in Kansas with several communities facing the decision of whether to fluoridate their drinking water. Wichita (population 316,350), the largest city in Kansas without fluoridated water, and the city of Winfield (population 11,931) are currently discussing this very issue, while Newton, Hesston, and Harper, among other cities in Kansas, have recently decided to implement water fluoridation systems.

Water fluoridation is considered one of the most effective public health measures a community can take because of its wide availability and its inexpensive prevention of tooth decay.[1] Because fluoride is part of the public water supply, the benefits of fluoride are available to everyone, not just those who have regular access to dental care. Studies have shown that fluoridation can reduce cavities in children's primary teeth by as much as 60% and tooth decay in permanent adult teeth by up to 35%.[1] This decrease in turn increases the health of both children and adults while decreasing the overall cost of dental care.

The ability of water fluoridation to effectively prevent dental decay efficiently and inexpensively, as well as the compelling evidence of its safety, have led many health-related organizations and trade associations to support community water fluoridation. Locally, water fluoridation is supported by the Kansas Dental Association and the Kansas Public Health Association. Appendix A lists supporting national agencies.

At the end of 1992, Kansas was ranked thirty-first of the 50 states for the percent of population served with adequate water fluoridation, falling behind Iowa (twelfth), Missouri (twenty-third), and Nebraska (twenty-eighth).[2] About 58% of Kansas residents had the recommended level of fluoride in their water,[2] far short of the *Healthy People 2000* goal of 75% of people served by fluoridated water systems.[3]

The Issues

Despite the almost universal support of water fluoridation for preventing tooth decay, water fluoridation remains a controversial issue due to concerns about possible adverse health effects. These concerns cover a wide variety of health domains, including osteoporosis,[4] osteoporotic hip fractures,[5,6] decreased birth rates, [7] and cancer.[8] One area of active research is fluoride's potential role in osteoporotic hip fractures.

Perhaps the most serious concern cited is the possibility of a relationship between water fluoridation and cancer. While the majority of evidence shows no link between water fluoridation and cancer,[9] Kansas communities debating the relative benefits of water fluoridation may be left with unanswered questions since some feel that national studies may not be applicable to Kansas.

Scope of Study

This study examines community water fluoridation and cancer mortality in Kansas. This analysis was undertaken because cancer mortality is the most serious stated concern and because the analysis was possible using information provided by the Kansas Department of Health and Environment. This study looks at cancer mortality rates at the city rather than county level—an important consideration as fluoridation occurs in the municipal water supply and not at the county level.

A full review of the stated risks of water fluoridation is beyond the scope of this work. Interested readers are referred to *Review of Fluoride: Benefits and Risks*[9] for a more complete summary.

Cancer Mortality and Water Fluoridation

Questions about a potential relationship between cancer and water fluoridation first arose in 1975. Using data from the 20 largest United States cities, a report to the U.S. Congress claimed a link between water fluoridation and increased breast, ovary, urinary, and gastrointestinal cancers.[10] However, subsequent analysis of the same data found no correlation when standard epidemiological research techniques were applied.[11,12] Additional studies from U.S. and international panels further refuted a potential link between cancer and water fluoridation.[13]

A 1990 study sparked controversy again with findings that sodium fluoride absorption in rodents caused osteosarcoma, a form of bone cancer. Bone cancer developed in 4 of 50 male rats exposed to sodium fluoride at levels 37-65 times greater than the highest levels recommended for drinking water.[14] But several subsequent epidemiological studies found no association between water fluoridation and osteosarcoma in humans.[15,16] Data gathered since 1990 have shown no relationship between fluoridation and osteosarcoma.[8]

Despite the concern over fluoride's potential carcinogenicity, the overwhelming majority of evidence supports the safety of water fluoridation. Studies employing standard epidemiological methods have consistently found no association between fluoridation and cancer mortality. Over 50 epidemiological studies evaluating the possibility of an association between cancer and water fluoridation have failed to find any credible link.[9]

Research Question

Is there a relationship between community water fluoridation and cancer mortality rates in Kansas?

Although a preponderance of the national evidence shows that there is no association between fluoridation and adverse health effects, the Kansas Health Institute undertook this study to examine whether there is a relationship between community water fluoridation and cancer mortality rates in Kansas.

Methods

Selection of cities

Since water fluoridation occurs on the municipal level, the Bureau of Water, Kansas Department of Health and Environment served as the source for identifying which cities in Kansas were fluoridated, non-fluoridated, naturally fluoridated, or supplied with fluoridated water from an external source. Cities with a population of 2,500 or more, according to 1990 U.S. Census data,[17] were included in the study. Six city water districts serving populations of 2,500 or more were excluded from the study because vital records for these populations were not available. This study also did not include Kansas residents who live in cities of less than 2,500 people or in un-incorporated areas since fluoridation of water systems serving smaller communities is uncommon.

Classification of water systems

The most recent complete data set of average fluoride levels (taken in 1997) was obtained from the Bureau of Water, Kansas Department of Health and Environment. Fluoride levels in this study were calculated as an average of the fluoride levels reported for a community's water points of entry. Of the cities with a population of 2,500 or greater, those with a 1997 natural or artificial average fluoride level of 0.70 parts per million (ppm) or greater were classified as fluoridated [*n*=34] (see Table 1) (The 0.70 level was chosen because the optimal recommended fluoride level is between 0.70 and 1.20 ppm.[1]) Those cities with a 1997 natural average fluoride level of 0.35 ppm or less were classified as nonfluoridated [*n*=36] (see Table 2). (The fluoride level of 0.35 ppm was selected as the criteria for non-fluoridated cities as it represents half the level of optimal fluoridation.) Cities with a 1997 fluoride reading between 0.35 and 0.70 ppm were classified as intermediately fluoridated [*n*=8] (see Table 3).

Additionally, all cities in this study for which data are available have been fluoridated for a minimum of 30 years.

Cancer Data

Cancer mortality data were obtained from Kansas Vital Statistics Records for 1995, 1996,

1997, and 1998. Cancer mortality rates were adjusted for age using projected population numbers for 1996.

The adjusted cancer mortality rates were obtained for selected cancers as defined by the ninth edition of the *International Classification of Diseases* (ICD-9).[18] Those selected cancers include (1) all cancers [ICD-9 140.0-208.9], (2) cancers of the gastrointestinal tract (including stomach, small intestine, colon, liver) [ICD-9 150.0-159.9], (3) breast cancer (including male breast cancer) [ICD-9 174.0-175.9], (4) cancers of the reproductive and genital organs (including cervix, prostate) [ICD-9 179.0-187.9], (5) kidney cancer [ICD-9 189.0-189.2], (6) brain cancer (including eye, brain, nervous system, glandular system) [ICD-9 190.0-194.9], and (7) leukemia [ICD-9 204.0-208.9].

Disease Model

There is no solid biomedical model of how water fluoridation might cause cancer (either in general or for specific cancer types). The specification and testing of assumptions behind any disease mechanisms are therefore somewhat difficult. This study examines cancer mortality rates over a four-year period (1995-1998) for cities that had begun water fluoridation between 30 and 53 years ago (as of 1999). Thus we assume that any potential relationship between cancer mortality rates and water fluoridation would have appeared during this time frame.

Furthermore while some individuals may have recently moved into or out of a fluoridated or nonfluoridated community, it is assumed that this migration was not related to fluoridation status of the community and hence should not impact our analysis.

Analysis

Three separate types of analyses were conducted to examine for any relationship between water fluoridation and cancer mortality rates: (1) Spearman Rank Correlation test, (2) analysis of variance (ANOVA), and (3) regression analysis.

Spearman Rank Correlation. A correlation is a description of the strength of the association between two data items (e.g., fluoride and cancer). A correlation score can range from 0 to1 (+ or -). A score at or very close to 1—in this case if fluoride levels could totally predict cancer rates in a community—would indicate a perfect relationship. The closer a score is to 0 the more certain we are that there is no relationship between two variables.

The larger the sample size, the more accurately we are able to identify any relationship between two variables. In this study, a correlation (r) of 0.20 would be necessary before we could state that a significant relationship existed between cancer and fluoride.

A procedure for determining the correlation between city water fluoridation and total cancer mortality is the Spearman Rank Correlation. Cities are ranked first according to their total adjusted cancer mortality and then according to their water fluoridation levels. A Spearman Rank Correlation test was performed to determine if there was any relationship between the rankings.

Analysis of variance (ANOVA). An analysis of variance is a common procedure that determines whether groups of individuals differ on some important measurement and, if so, whether that difference is too great to be due to chance. Average cancer death rates for fluoridated and nonfluoridated communities were examined to determine if significant differences existed between them.

A power analysis was conducted to determine whether the sample size would adequately allow for any meaningful ANOVA. Power is the sensitivity of an analysis, its ability to detect differences between groups when those differences are present. This study of fluoridated and nonfluoridated cities in Kansas is sensitive enough to detect a difference of 0.75 standard deviations in the cancer mortality rates 80% of the time (α=0.05, β=0.20).

Seven sets of ANOVAs were conducted for the cancer groups described in the cancer data section. These groups included all cancers deaths combined, as well as death rates for gastrointestinal tract, breast, reproductive tract, kidney, and brain cancers and leukemia.

Regression analysis. The regression technique allows the development of a predictive equation that aids in determining the relative contribution of a constant factor and other specific factors (e.g., water fluoridation levels) to a variable outcome (e.g., cancer death rates).

Table 1. Kansas Cities with Fluoridated Water Systems

City	County	City Population*	Total Age-Adjusted Cancer Death Rate (per 1,000 persons)&	Fluoride (ppm)†	Years of Fluoridation‡
Arkansas City	Cowley	12,762	1.25	1.32	46
Atchison	Atchison	10,656	1.37	0.79	30
Bonner Springs	Wyandotte	6,413	1.40	1.60	40
Chanute	Neosho	9,488	1.39	0.94	43
Coffeyville	Montgomery	12,917	1.34	1.86	47
Colby	Thomas	5,396	0.98	1.91	Natural
Columbus	Cherokee	3,268	1.35	1.49	Natural
Derby	Sedgwick	14,669	1.29	0.74	Natural
Dodge City	Ford	21,294	1.00	1.46	Natural
El Dorado	Butler	11,504	1.18	0.93	47
Eureka	Greenwood	2,974	1.41	0.83	41
Fredonia	Wilson	2,599	1.26	1.33	NA
Gardner	Johnson	3,191	1.61	1.50	33
Garnett	Anderson	3,210	1.67	1.03	47
Girard	Crawford	2,813	1.36	0.78	Natural
Herington	Dickinson	9,942	0.38	1.57	38
Independence	Montgomery	9,942	1.31	1.24	44
Iola	Allen	6,351	1.36	0.87	NA
Johnson CO WD[δ]	Johnson	205,521	0.12	0.78	NA
Junction City	Geary	20,604	1.68	1.04	47
Kansas City, KS	Wyandotte	149,767	1.41	0.72	NA
Lyons	Rice	3,688	0.84	2.07	41
Manhattan	Riley	37,712	1.17	1.06	NA
Neodosha	Wilson	2,837	1.26	1.05	30
Olathe	Johnson	63,352	0.79	0.81	39
Osage City	Osage	2,689	0.82	1.00	32
Ottawa	Franklin	10,667	1.40	0.95	53
Paola	Miami	4,698	1.11	1.00	46
Parsons	Labette	11,924	1.25	0.74	46
Pittsburg	Crawford	17,775	1.10	1.07	NA
Salina	Saline	42,303	2.01	1.01	30
Scott City	Scott	3,785	1.17	1.53	Natural
Topeka	Shawnee	119,883	1.44	1.09	NA
Ulysses	Grant	5,900	1.33	1.77	Natural

Note: Thirty-four Kansas cities with a population $\geq$ 2,500 had a water fluoridation level $\geq$ 0.70 parts per million (ppm).

*1990 U.S. Census data[17]

&Average annual cancer mortality rate for 1995-1998.

†Average 1997 water fluoridation levels (based on water points of entry) indicating parts per million. Data provided by the Bureau of Water, Kansas Department of Health and Environment.

‡Number of years of water fluoridation as of 1999.[2] Communities for which the years of fluoridation are unknown are indicated as NA (not available).

δ Johnson County Water District #1

Table 2. Kansas Cities with Nonfluoridated Water Systems

City	County	City Population*	Total Age-Adjusted Cancer Death Rate (per 1,000 persons) 🕮	Fluoride (ppm)†
Abilene	Dickinson	6,242	1.20	0.11
Anthony	Harper	2,516	1.54	0.21
Augusta	Butler	7,876	1.45	0.15
Baxter Springs	Cherokee	4,351	1.00	0.25
Belleville	Republic	2,517	0.88	0.14
Beloit	Mitchell	4,066	1.09	0.21
Cherryvale	Montgomery	2,596	1.21	0.11
Clay Center	Clay	4,613	1.35	0.19
Concordia	Cloud	6,167	1.01	0.34
Galena	Cherokee	3,260	1.90	0.18
Haysville	Sedgwick	8,364	1.31	0.26
Hesston	Harvey	3,012	0.86	0.15
Hiawatha	Brown	3,603	1.52	0.19
Hillsboro	Marion	2,704	0.89	0.24
Hoisington	Barton	3,182	1.24	0.32
Holton	Jackson	3,196	1.57	0.28
Hugoton	Stevens	3,179	1.24	0.33
Kingman	Kingman	3,302	1.24	0.15
Leavenworth	Leavenworth	38,495	1.21	0.22
Liberal	Seward	16,573	1.17	0.31
Lindsborg	McPherson	3,076	0.82	0.20
Marysville	Marshall	3,359	0.94	0.16
McPherson	McPherson	12,422	1.05	0.17
Mulvane	Sumner	4,674	1.42	0.12
Newton	Harvey	17,011	1.21	0.17
Norton	Norton	3,017	1.35	0.26
Osawatomie	Miami	4,590	1.15	0.09
Park City	Sedgwick	5,050	0.31	0.28
Phillipsburg	Phillips	2,828	0.75	0.18
Pratt	Pratt	6,687	1.02	0.22
Russell	Russell	4,781	0.83	0.26
Valley Center	Sedgwick	3,624	1.55	0.35
Wamego	Pottawatomie	3,706	0.72	0.19
Wellington	Sumner	8,411	1.15	0.05
Wichita	Sedgwick	316,350	1.35	0.32
Winfield	Cowley	11,931	1.28	0.15

Note: Thirty-six Kansas cities with a population $\geq$ 2,500 had a water fluoridation level $\leq$ 0.35 parts per million (ppm).

*1990 U.S. Census data.[17]
🕮Average annual cancer mortality rate for 1995-1998.
†Average 1997 water fluoridation levels (based on water points of entry) indicating parts per million. Data provided by the Bureau of Water, Kansas Department of Health and Environment.

Table 3. Kansas Cities with Intermediately Fluoridated Water Systems

City	County	City Population*	Total Age-Adjusted Cancer Death Rate (per 1000 persons)🕮	Fluoride (ppm)†
Fort Scott	Bourbon	8,362	1.28	0.61
Frontenac	Crawford	2,628	1.80	0.55
Garden City	Finney	24,097	1.21	0.47
Great Bend	Barton	15,427	1.24	0.50
Hays	Ellis	17,767	1.25	0.42
Hutchinson	Reno	39,308	1.09	0.46
Larned	Pawnee	4,490	1.34	0.55
Lawrence	Douglas	65,608	0.83	0.46

Note: Eight Kansas cities with a population $\geq$ 2,500 had a water fluoridation level between 0.35 and 0.70 parts per million (ppm).

*1990 U.S. Census data.[17]
🕮Average annual cancer mortality rate for 1995-1998.
†Average 1997 water fluoridation levels (based on water points of entry) indicating parts per million. Data provided by the Bureau of Water, Kansas Department of Health and Environment.

Assumptions and Limitations

Although adjustments were made according to standard epidemiological procedures for age, adjustments were not made for other potential demographic variables (e.g. gender, race, and income). There is no reason to believe these factors are not evenly distributed across the cities in our sample and therefore should not lead to any potential bias in the results.

Since this study included only those cities with a population of more than 2,500, it excluded more rural populations. (Fluoridation of water systems serving less than 2,500 is uncommon and many rural residents obtain their drinking water from personal wells.)

Finally it should also be noted that it is very difficult to "prove" the lack of a relationship, in this case between cancer and water fluoridation. There is always a possibility that an undetected relationship may exist. However, the authors are confident that this study has the ability to detect any meaningful relationship between cancer mortality and community water fluoridation in Kansas.

Results

The results from all analyses of the data revealed the same finding: There is no observable relationship between water fluoridation and cancer mortality in Kansas communities (either for all cancers combined or for specific types of cancer). The findings are discussed below in more detail.

Scatter Plot

It is often useful to examine a graphical representation of the relationship between important factors. This visual inspection can often reveal subtle relationships within the data. Figure 1 plots the rate of cancer deaths per one thousand individuals (*y* axis) and the level of water fluoridation in each community (*x* axis). A visual examination of the scatter plot indicates no clear relationship between these two items.

Spearman Rank Correlation

The results of the Spearman Rank Correlation test indicated no significant relationship between water fluoridation levels and total cancer death rates ($r_s = 0.15$, $p=0.18$).

Analysis of Variance (ANOVA)

The ANOVA results indicated that average cancer death rates were not significantly different between fluoridated and nonfluoridated communities (see Table 4).

Regression

The regression demonstrated that total cancer death rates were not associated with water fluoridation levels (see Table 5).

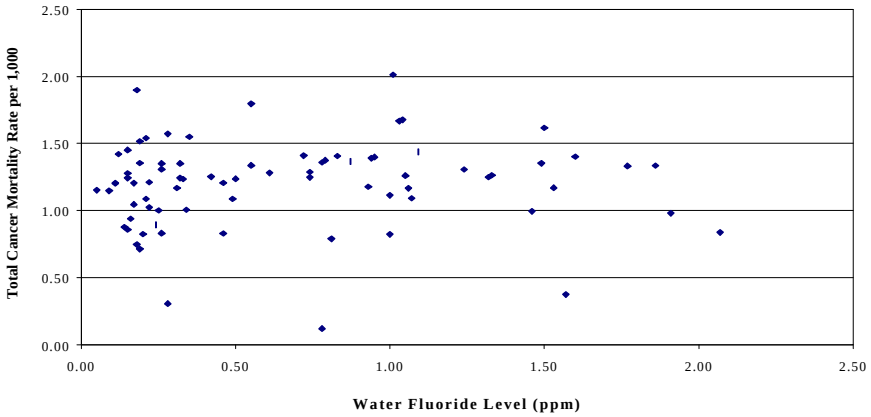

Figure 1. Total Cancer Mortality Rate vs. Average Community Water Fluoride Level

Table 4. Analysis of Variance (ANOVA) Between Fluoridated and Nonfluoridated Cities for Seven Groupings of Cancer

Model	Sum of Squares	*df*	Mean Square	*F*	Significance
All Cancers					
Between groups	0.128	2	6.409E-02	0.605	0.549
Within groups	7.308	69	0.106		
Total	7.437	71			
Gastrointestinal tract					
Between groups	[illegible]	2	7.769E-03	0.496	0.611
Within groups		69	1.567E-02		
Total		1			
Breast					
Between groups	1.143E-02	2	5.713E-03	0.961	0.388
Within groups	0.410	69	5.946E-03		
Total	0.422	71			
Reproductive Tract					
Between groups	1.593E-03	2	7.964E-04	0.169	0.845
Within groups	0.325	69	4.704E-03		
Total	0.326	71			
Kidney					
Between groups	6.231E-04	2	3.115E-04	0.106	0.900
Within groups	0.203	69	2.949E-03		
Total	0.204	71			
Brain					
Between groups	6.031E-04	2	3.015E-04	0.095	0.910
Within groups	0.220	69	3.183E-03		
Total	0.220	71			

Leukemia					
Between groups	9.417E-05	2	4.709E-05	0.020	0.980
Within groups	0.163	69	2.356E-03		
Total	0.163	71			

Table 5. Regression Coefficients

Model	*b*	Standard Error	*t*	Significance
(Constant)	1.181	0.058	20.217	0.000
Fluoride Level	2.970E-02	0.069	0.428	0.670

Discussion

Three different analyses of the cancer mortality data failed to indicate any statistically significant relationship between community water fluoridation and total cancer mortality rates for the selected cities in Kansas. Moreover, not only was there no significant relationship between fluoridation and total cancer mortality rates, but analyses of specific cancer mortality rates (i.e. gastrointestinal tract, breast, reproductive tract, kidney, brain, and leukemia) also failed to indicate any significant relationship.

These findings are consistent with the results of national research that strongly supports the safety of community water fluoridation. More specifically, this and other studies employing standard epidemiological methods have consistently found no association between community water fluoridation and cancer mortality rates. Thus these results suggest that fluoridation of drinking water in Kansas, whether natural or supplemental, does not lead to increased cancer mortality.

Finally, the importance of this research lies in the degree to which it aids communities that are debating the relative risks and benefits of adding fluoride to their water systems. Local leaders must weigh all the factors, including what this and other research indicate. First, there is a high level of certainty that water fluoridation has significant dental benefits, particularly for persons at high risk. Second, there is a low probability that water fluoridation poses serious health risks. In particular, these data indicate that there is no significant relationship between cancer mortality rates and community water fluoridation in Kansas.

Appendix A. Organizations and agencies which support fluoridation of community water supplies for the prevention of dental decay (taken from the American Dental Association, *Fluoridation Facts*).[1]

Academy of Dentistry International
Academy of General Dentistry
Academy of Sports Dentistry
Alzheimer's Association
American Academy of Allergy, Asthma, and Immunology
American Academy of Family Physicians
American Academy of Oral and Maxillofacial Pathology
American Academy of Pediatrics
American Academy of Pediatric Dentistry
American Academy of Periodontology
American Association for the Advancement of Science
American Association for Dental Research
American Association for Community Dental Programs
American Association of Dental Schools
American Association of Endodontists
American Association of Oral and Maxillofacial Surgeons
American Association of Orthodontists
American Association of Public Health Dentistry
American Cancer Society
American College of Dentists
American College of Physicians – American Society of Internal Medicine
American College of Prosthodontists
American Council on Science and Health
American Dental Assistants Association
American Dental Association
American Dental Hygienists' Association
American Dietetic Association
American Federation of Labor and Congress of Industrial Organizations
American Hospital Association
American Medical Association
American Osteopathic Association
American Pharmaceutical Association
American Public Health Association
American Society of Clinical Nutrition
American Society for Dentistry for Children
American Society for Nutritional Sciences
American Student Dental Association
American Veterinary Medical Association
American Water Works Association
Association for Academic Health Centers
Association for Maternal and Child Health Programs
Association of State and Territorial Dental Directors
Association of State and Territorial Health Officials
British Dental Association
British Fluoridation Society
British Medical Association
Canadian Dental Association
Canadian Dental Hygienists Association
Canadian Medical Association
Canadian Nurses Association
Canadian Paediatric Society
Canadian Public Health Association
Chocolate Manufacturers Association
Consumer Federation of America
Delta Dental Plans Association
European Organization for Caries Research
FDI World Dental Federation
Federation of Special Care Organizations in Dentistry
- Academy of Dentistry for Persons with Disabilities
- American Association of Hospital Dentists
- American Association for Geriatric Dentistry

Health Insurance Association of America
Hispanic Dental Association
International Association for Dental Research
International Association for Othodontics
International College of Dentists
Institute of Medicine
National Academy of Sciences
National Alliance for Oral Health
National Association of Dental Assistants
National Confectioners Association
National Council Against Health Fraud
National Dental Assistants Association
National Dental Association
National Dental Hygienists' Association
National Down Syndrome Congress
National Down Syndrome Society
National Foundation of Dentistry for the Handicapped
National Kidney Foundation
National PTA
National Research Council
Society of American Indian Dentists
The Dental Health Foundation (of California)
US Department of Defense
US Department of Veterans Affairs
US Public Health Service
- Centers for Disease Control and Prevention (CDC)
- Health Resources and Services Administration (HRSA)
- Indian Health Service
- National Institute of Dental and Craniofacial Research

World Federation of Orthodontists
World Health Organization

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