

WATER FLUORIDATION COSTS IN TEXAS:
TEXAS HEALTH STEPS (EPSDT-MEDICAID)

In Fulfillment of
House Concurrent Resolution 145, Texas 75th Legislature

The Texas 75th Legislature passed House Concurrent Resolution 145 requiring the Texas Department of Health to conduct a study of the cost of publicly financed dental care in relation to community water fluoridation.

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SUMMARY

Tooth decay is responsible for children being less ready to learn and results in lower productivity at work and school. It causes pain and infection resulting in impaired chewing, speech, facial expression and self-esteem. It is estimated that 1.57 million days of absence from school per year in the United States are due to dental conditions.

There have been many studies verifying the safety and efficacy of community water fluoridation in reducing tooth decay. In order to evaluate fluoridation cost outcomes in Texas, the Texas 75th Legislature passed House Concurrent Resolution 145 requiring the Texas Department of Health (TDH) to conduct a study of the cost of publicly financed dental care in relation to community water fluoridation.

The study assessed the impact of one public program for prevention of tooth decay, community water fluoridation, on another program, Medicaid, which provides publicly funded dental care for a group known to be at greater risk for disease. The median water fluoride level was calculated for each county, weighted by population, and compared with the claims paid to dentists in fiscal year (FY) 1997 for treatment of children, from low income families, aged 1 through 20 years, under the Texas Health Steps (EPSDT-Medicaid) Program. Over 80% of the Texas Health Steps (EPSDT-Medicaid) costs are related to examination, prevention and treatment of tooth decay.

Statistical analysis of dental care costs and county water fluoride levels showed that for an initial one part per million rise in water fluoride level (from 0.0 to 1.0 ppm fluoride), the average cost of dental care per child declined \$24 per year. This estimated cost savings in public dental care could be realized if water fluoridation was provided in communities with less than optimal water fluoride levels. Approximately 30% of Texas citizens currently experience less than optimal levels.

In Texas, the following savings in publicly financed dental program costs are estimated to follow implementation of optimal water fluoridation at 0.8 ppm (Table 1). In addition, the estimated cost of installing water fluoridation systems in these four counties ranges from \$0.71 to \$1.90 per person for one year and would cost under \$0.35 per person to maintain.

Table 1 - Public Dental Program Costs

<i>Major City</i>	<i>County</i>	<i>County Fluoride Level (ppm F)</i>	<i>Per Year Estimations</i>	
			<i>Average Savings per Child*</i>	<i>County Total Savings</i>
Abilene	Taylor	0.32	\$15	\$58,266
San Angelo	Tom Green	0.40	\$12	\$35,357
San Antonio	Bexar	0.24	\$18	\$1,071,666
Texarkana	Bowie	0.14	\$19	\$68,522

** Texas Health Steps (EPSDT-Medicaid)*

The wide implementation of community water fluoridation in Texas has resulted in substantial savings in publicly financed dental care under the Texas Health Steps (EPSDT-Medicaid) Program. Further savings may be made by implementing community water fluoridation in areas where it is lacking and feasible. Failure to implement this public dental preventive measure will continue to result in substantially greater costs of dental care in some Texas communities, including the costs of publicly financed dental care borne by all taxpayers.

The study’s findings are consistent with national studies which report a reduction in childhood caries in communities with optimal water fluoridation levels.

INTRODUCTION

Community water fluoridation has a fifty-year history of effectively and safely preventing dental caries (tooth decay). Most studies of fluoridation have examined effectiveness: the degree of caries reduction in the community. This was assessed in the early decades as a median 58% reduction. In recent decades, this figure has declined to a range of 30% to 60% reduction, largely due to the use of other fluorides, particularly in toothpaste. Fluoridation provides the greatest benefits for deciduous and permanent teeth.

Studies in New Zealand in the 1960's and in Eastern Europe in the 1970's reported dental treatment costs, a measure of efficiency, were cut by half with fluoridation. The efficiency of water fluoridation to reduce dental costs can be expected to have declined due to the introduction of other sources of fluoride, but this is less studied. It is currently estimated by the Centers for Disease Control and Prevention (CDC) that each \$1 expended on fluoridation results in a savings of \$80 in dental treatment costs, across the whole population. The estimated non-discounted per capita expenditure for water fluoridation during a lifetime (51 cents per year times 75 years) for the United States was approximately equal to the average, non-discounted cost of one dental restoration or filling. In 1989, a study in Scotland reported a rise of 21% in all dental treatment costs and a doubling of cost of dental restorations (fillings for tooth decay) with cessation of water fluoridation.

The only scientifically established effect of water fluoridation, along with its reduction in caries, is that 8% to 15% of children whose teeth develop with fluoridation show varying degrees of tooth whitening known as dental fluorosis. This whitening is graded as very mild and mild by Dean's Index of dental fluorosis. More severe forms of fluorosis, such as brown staining and hypoplasia (tooth surface defects), are not associated with optimal fluoride levels in water. There is evidence that fluorosis has risen in recent decades in prevalence but not in severity. This increase is attributed to fluorides other than those derived from water fluoridation, including intake of fluoride by young children as a result of swallowing toothpaste.

Texas is highly fluoridated in keeping with U.S. Public Health Service (USPHS) recommendations. Communities access their water from primary and/or wholesale (secondary) water supplies. Based exclusively on water fluoridation levels obtained from primary and wholesale water supplies, approximately 70% of the population uses fluoridated water. The beneficial 'halo' effects associated with the coverage of optimal water fluoridation will be realized in non-fluoridated communities by the consumption of foods processed in the fluoridated communities. These benefits will be relatively high. Such an effect will tend to obscure the full benefits of water fluoridation.

In addition, the distribution of caries has become even more skewed as decay rates have declined. Only one-fourth of children and teens account for over two-thirds of the disease. Higher caries rates are experienced by those from low income households, those with lower educational attainment or opportunity, and those from certain racial and ethnic minorities. Children with special health and developmental needs and persons from non-fluoridated communities also experience increased rates of decay.

METHODS

Data Description

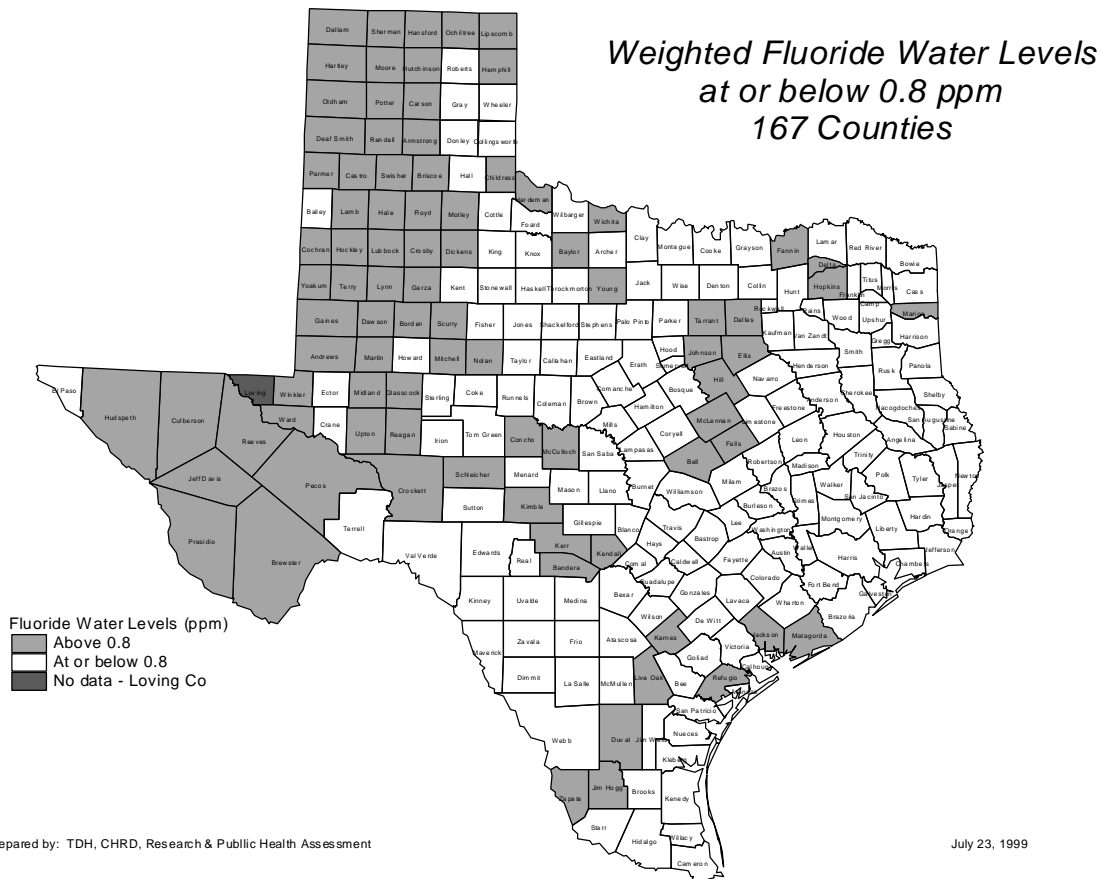
Water Fluoridation: Water fluoridation levels were determined from 1998 TDH data compiled by fluoridation engineers. For each of the 254 Texas counties, the differing primary public water systems were tabulated including multiple measurement of fluoride level in parts per million (ppm F) and the population served by that system.

The fluoride analysis of each primary public water system generated a ‘representative ‘ value calculated as the median value for that system. Using the median value avoids undue influence by outlier values. Water fluoride levels fluctuate slightly due to seasonal changes in natural fluoride levels and operational variations in water fluoridation equipment. In some communities, fluctuation can result from varying the mix of naturally fluoridated water sources with seasonal changes in pumping rates from these sources.

The population served by each system was then used to weight those representative values to derive a population weighted average fluoride level for each county.

$$\text{County Wt. Av. (CWA) Fluoride Level (ppm F)} = \frac{\sum (\text{median fluoride level} \times \text{pop. served})_{\text{systems in the county}}}{\sum \text{populations served}}$$

Of the 254 Texas counties, 253 had incurred Medicaid dental costs and were used in the analysis. Optimal public water fluoride levels were found in 86 of the 253 counties, with the remaining counties (167) identified as having less than or equal to optimal water fluoride (≤ 0.8 ppm).



Water Fluoridation Costs: Costs for public water fluoridation systems installation and maintenance costs were derived using 1999 dollar value.

Dental Care Costs: Costs for Medicaid dental services were derived for FY 1997 (TDH-MMIS Report # 1242). The cost data were based on claims paid to dentists under the Texas Health Steps (EPSDT-Medicaid) Program for services provided eligible children aged 1 through 20 years. Hospitalization and day surgical center costs associated with dental treatment, anesthesia and related costs (if billed by physicians) were excluded. Costs were associated with the child's county of residence, not necessarily the county in which services were provided.

Routine dental treatment costs, defined as examination, prevention, restoration and extraction of teeth, endodontics, and tooth replacement, are predominantly tooth decay related in clients under age 21. For fiscal year 1997, routine dental services of these treatment types accounted for 83.7% (\$104,037,257) of total dollars paid on claims (\$124,255,529) with the remainder of the cost (16.3%) being associated with other treatments. Preventive treatments alone accounted for 20.9% of the Texas Health Steps (EPSDT-Medicaid) total dental cost. Appendix I, Table 2, provides the listing of procedure codes found in the cost data. An undetermined amount of this other treatment would also have been decay-related, e.g. cast restorations, complex endodontics, fixed prosthodontics. Therefore, the cost of Texas Health Steps (EPSDT-Medicaid) dental care is overwhelmingly related to procedures involving the prevention and treatment of dental caries.

Other Data: Other data used in the analysis included demographic data by county from 1995 population estimates based on the 1990 U.S. Census. Texas Health Steps (EPSDT-Medicaid) Program data was the source for county totals of the numbers of active Medicaid dental providers and dental groups and the number of children eligible and enrolled for services. Appendix I, Table 3, contains a list and definition of the data variables used in the analysis.

Statistical Analysis

Descriptive Analysis: Standard descriptive statistics were employed to review the data. Appendix II, Table 4, contains statistics on the data variables used in the analysis.

Regression Analysis: The cost of Texas Health Steps (EPSDT-Medicaid) dental care was related to the county weighted average fluoride level and to other county data. Univariate and multivariate regression [linear, curvilinear] analyses were made to derive cost models of dental care associated with variations in water fluoride levels. Potential savings for non-fluoridated counties were estimated.

Different types of regression models were assessed in this study. Based on theoretical and empirical information presented in the scientific literature and after testing several regression models, the relationship between water fluoridation level and dental treatment cost was found to be non-linear. A curvilinear model significantly fit the data and was chosen for general application to the Texas Health Steps (EPSDT-Medicaid) program data. The basic relationship is defined in the following quadratic equation:

$$Cost = [(-33.513 \times (\text{LOG}(\text{CWA Fluoride Level}))^2) + (-57.755 \times (\text{LOG}(\text{CWA Fluoride Level}))) + 106.644]$$

In addition, multiple regression analysis revealed weighted water fluoridation level similarly predicted total dental care cost and total dental treatment cost. No other independent variable significantly contributed to the relationship between dental care cost and water fluoridation level.

RESULTS AND DISCUSSION

The total Medicaid claims paid for Texas Health Steps (EPSDT-Medicaid) dental services (excluding orthodontia) for FY 1997 was \$104,037,527 and served 642,028 children aged 1 through 20 years. Of the total Texas Health Steps (EPSDT-Medicaid) dental services cost, \$78,022,179 was spent on dental treatment services and \$26,015,077 on prevention services. Thus, the state average cost per child receiving a Texas Health Steps (EPSDT-Medicaid) dental treatment service was \$122 in FY 1997.

State Level

Comparing FY 1997 annual Texas Health Steps (EPSDT-Medicaid) dental treatment costs across the whole state and between large counties was appropriate; however, comparison of small counties was problematic due to large variability. An estimated average cost decline over an initial 1.0 ppm F rise was \$24. That is, for a unit rise of 1 ppm F (0.0 ppm F to 1.0 ppm F), the average Texas Health Steps (EPSDT-Medicaid) dental treatment cost per child across the entire state falls by \$24.

Based on the analysis, estimation of potential dental treatment cost savings for incremental increases in water fluoridation levels are possible. Table 5 depicts water fluoride levels in increments of 0.1 ppm F intervals along with the estimated change between increments and the cumulative cost savings. It is expected that the relationship between water fluoridation levels and cost will diminish at the higher levels of water fluoridation, in part, due to the increased incidence of fluorosis. Since 0.8 ppm F is the optimal water fluoride level for most of Texas, adjustment from a very low natural level to 0.8 ppm F will lower the average cost of dental treatment by \$19 per child. Table 5 lists the cost savings at incremental unit changes in water fluoride level.

Table 5 shows the expected savings in dental treatment costs for each 0.1 ppm F increment of water fluoride level. For example, an additional estimated savings in Texas Health Steps (EPSDT-Medicaid) dental treatment costs of \$3.33 could be realized for an increase in water fluoride level from 0.4 ppm F to 0.5 ppm F; the estimated cumulative Texas Health Steps (EPSDT-Medicaid) dental treatment cost savings at 0.5 ppm F would be \$9.89. Figures 1 and 2, Appendix III, illustrate the incremental and cumulative cost savings.

Table 5 - Texas Health Steps (EPSDT-Medicaid) Dental: Incremental & Cumulative Treatment Cost Savings

<i>CWA Fluoride Level (0.1 ppm F intervals)</i>	<i>Cost Savings</i>	
	<i>Incremental</i>	<i>Cumulative</i>
0.1	n/a	n/a
0.2	\$0.25	\$0.25
0.3	\$2.96	\$3.21
0.4	\$3.36	\$6.57
0.5	\$3.33	\$9.89
0.6	\$3.19	\$13.08
0.7	\$3.02	\$16.10
0.8	\$2.86	\$18.96
0.9	\$2.70	\$21.67
1.0	\$2.60	\$24.24
1.1	\$2.45	\$26.69
1.2	\$2.34	\$29.03
1.3	\$2.23	\$31.26
<i>Selected Fluoride Levels</i>		
0.24	\$1.07	\$1.32
0.56	\$1.93	\$11.82
0.89	\$2.45	\$21.40

County Level

The following example, Table 6, compares water fluoridation, demographic and cost characteristics between two large population counties.

Table 6 - County Comparisons

<i>County Comparison Characteristics</i>	<i>Bexar County</i>	<i>Tarrant County</i>
Fluoridation status	<i>Not fluoridated</i>	<i>Fluoridated</i>
County Population	1,403,275	1,223,416
County Population using optimal water fluoridation	51,000	1,170,000
% County Population using optimal water fluoridation	4%	96%
CWA Fluoride Level	0.24	0.89
THS Medicaid Eligible	136,807	79,995
THS Dental Clients-Dental	59,537	26,469
# Medicaid Dental Providers	445	102
THS Dental Cost-Treatment Services	\$8,106,823	\$3,093,434
THS Dental Cost-Treatment Services Per Client	\$136	\$117

The differences in average Texas Health Steps (EPSDT-Medicaid) dental care treatment costs between these two counties can be viewed or calculated in three ways:

1. *Optimal* - In Bexar County, at a level of 0.24 ppm F, 0.56 ppm F would be the adjustment needed to reach the optimal 0.8 ppm F level in water. The estimated cost savings per treated Texas Health Steps (EPSDT-Medicaid) child on average in Bexar County would be \$18 [Table 5: 0.8 ppm F = \$18.96, 0.24 ppm F = \$1.32, (\$18.96 - \$1.32 = \$17.64)].
2. *Actual* - The actual difference in CWA Fluoride Level (weighted average fluoride) between Bexar and Tarrant counties is 0.65 ppm F (0.89 ppm F - 0.24 ppm F). Then the estimated cost savings per treated Texas Health Steps (EPSDT-Medicaid) child on average in Tarrant versus Bexar County would be \$20 [Table 5: 0.89 ppm F = \$21.40, 0.24 ppm F = \$1.32, (\$21.40 - \$1.32 = \$20.08)].
3. *Observed* - The observed difference between Bexar and Tarrant counties in THS Dental Cost-Treatment Services per Client on average is \$19 [Table 6: \$136-\$117].

Based on statewide experience, as estimated by this analysis, water fluoridation of Bexar County can be expected to save approximately \$18 to \$20 per Texas Health Steps (EPSDT-Medicaid) child per year. Using the more conservative \$18, the 59,537 children treated in 1997 would have cost approximately \$1,071,666 less if Bexar County had been fluoridated. At a revised average cost of \$118 per child (\$136-\$18) and utilizing the same dental care expenditures for the year, an estimated 9,082 children, in addition to those already enrolled and receiving services, could have been provided Texas Health Steps (EPSDT-Medicaid) dental care. Note: Participation and utilization of Texas Health Steps (EPSDT-Medicaid) is highly dependent on access characteristics of the service delivery system.

Smaller population counties show considerable variations in average Medicaid costs. Therefore, their projections are best based on statewide observations, not on a comparison of pairs of counties. For example:
 - a county with a present weighted average fluoride level of 0.14 ppm F, e.g. Bowie County (Texarkana) could thus expect average savings per Texas Health Steps (EPSDT-Medicaid) child of \$19 if it were optimally fluoridated at 0.8 ppm F. The total annual Medicaid dental care savings estimate for Bowie County would be \$68,522.

- a county with a present weighted average fluoride level at approximately 50% of the optimal level or 0.4 ppm F, e.g. Tom Green County (San Angelo) could expect savings of \$12 per Texas Health Steps (EPSDT-Medicaid) child on average if it were optimally fluoridated at 0.8 ppm, with an annual Medicaid dental care savings estimate of \$35,357.
- a county such as Taylor County (Abilene) with a weighted average fluoride level of 0.32 ppm F, the savings estimate would be \$15 per Texas Health Steps (EPSDT-Medicaid) child receiving services, totaling \$58,266 savings in Medicaid dental care per year.

Water Fluoridation

The installation and maintenance costs incurred by a community for a public water fluoridation system can be sizeable, depending on the complexity of the water system. A public water system may have multiple wells or multiple surface water treatment plants. Some water systems have both.

In order to depict the installation and maintenance of a public water fluoridation system, anticipated cost estimates were developed for four Texas cities: Abilene, San Angelo, San Antonio and Texarkana. Table 7 outlines the overall anticipated costs associated with the installation and annual maintenance of water fluoridation systems.

Table 7 - Water Fluoridation System Cost Estimates

City	County	Population	Fluoride ppm F	# Treatment Points *	Annual Water Pumpage [MGY]	Estimated Costs			
						Start Up **		Maintenance ***	
						Total	per Person	per Year	per Person
Abilene	Taylor	129,983	0.32	3	10,950	\$172,111	\$1.32	\$33,840	\$0.26
San Angelo	Tom Green	105,338	0.40	1	7,019	\$74,636	\$0.71	\$17,353	\$0.16
San Antonio	Bexar	1,403,275	0.24	86 ¹	59,161	\$1,998,649	\$1.42	\$182,832	\$0.13
Texarkana	Bowie	88,344	0.14	3	7,268	\$167,933	\$1.90	\$31,446	\$0.36

* Treatment Points = water treatment plants and wells¹ ** Costs include engineering, chemicals system installation & 10% contingency
 *** Per year cost for chemicals [fluorosilicic acid] MGY = million gallons per year Source: TDH Oral Health Division, Texas Fluoridation Project

For these four Texas cities maintenance costs represent from 9% to 23% of the installation start-up costs. More importantly, based on these costs and the estimated cost savings realized in the Texas Health Steps (EPSDT-Medicaid), water fluoridation systems cost could be recouped in 2 to 7 years depending on the funding methodology employed. These figures do not include intangible benefits and cost savings to society.

It is important to remember that water fluoridation benefits water consumers of all ages. The whole population benefits in decay prevention and, ultimately, in lower dental costs. As with most preventive strategies, cost savings are not realized immediately. Moreover, costs are incurred to implement the strategy. However, costs will dramatically decline following the installation of a community water fluoridation system. The maintenance of public water fluoridation systems providing optimal water fluoride to communities will result in dental health care cost savings in communities with less than optimal water fluoride levels. For those communities, cost savings based on this cost description of the Texas Health Steps (EPSDT-Medicaid) will be on average a 16% (\$19 per child) reduction in annual dental treatment care costs.

CONCLUSIONS

This study assessed the preventive cost of community water fluoridation on the average Medicaid cost per child aged 1 through 20 years, who received dental care under the Texas Health Steps (EPSDT- Medicaid) Program in 1997. The results of this study conclude:

1. Approximately 70% of the Texas population presently benefits from natural or adjusted water fluoridation – all age, income, ethnic and racial groups benefit without regard to educational attainment or opportunity.
2. A reduction in the average Texas Health Steps (EPSDT- Medicaid) dental care costs by \$19 could be realized if communities maintain optimal water fluoride levels (0.8 ppm).

RECOMMENDATIONS

The Texas Legislature should facilitate, when economically feasible, fluoridation for communities with a less than optimal public water fluoridation level. In addition, it is recommended that all fluoridated water systems be required to conduct routine monitoring and reporting of fluoride levels.

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APPENDIX I

Table 2 - Texas Health Steps (EPSDT-Medicaid) Dental Procedures Codes

<i>Texas Health Steps (EPSDT-Medicaid)</i>	<i>Dental Procedure Codes</i>
Total Dental Service:	as defined by procedure codes D0100 through D9999
Preventive Dental Service:	as defined by procedure codes D1000 through D1999
Treatment Dental Service:	as defined by procedure codes D2000 through D9999

Table 3 - Data Variable Definitions

<i>Data Variables</i>	<i>Definitions</i>
THS Medicaid Eligibles	Texas Health Steps (THS) eligibles age 1 through 20
THS Dental Clients-Total	total THS clients receiving a dental / orthodontia service
THS Dental Clients-Dental	total THS clients receiving a dental service excluding orthodontia
County Population	total county population
Log County Population	common log transformation of county population
Median Household Income	median household income
% Poverty	county population at or below 100% of Federal Poverty
THS Dental Cost-Total	total THS paid dental claims
THS Dental Cost-Dental	total THS paid dental claims excluding orthodontia
THS Dental Cost-Total per Client	total THS paid claims ÷ total THS clients receiving a dental service
THS Dental Cost-Prevention Services	total THS paid claims for dental preventive services
THS Dental Cost-Prevention Services per Client	total THS paid claims ÷ number of THS clients receiving a dental service
THS Dental Cost-Treatment Services	total THS paid claims for dental treatment services
THS Dental Cost-Treatment Services per Client	total THS paid claims ÷ number of THS clients receiving a dental service
THS Dental Services-Total	total THS dental services delivered excluding orthodontia
THS Dental Services-Prevention	total THS dental preventive services delivered
THS Dental Services-Treatment	total THS dental treatment services delivered
# Medicaid Dental Providers	number of unduplicated active Medicaid providers (provider/group number)
Medicaid Dental Provider Density	number of Medicaid providers ÷ number of THS clients receiving a dental service
CWA Fluoride Level	[median average × population served] ÷ population served
Log Fluoride Level	common log of CWA Fluoride Level

APPENDIX II

Table 4 - Descriptive Statistics

<i>Descriptive Statistics</i>	<i>Sum</i>	<i>Minimum</i>	<i>Maximum</i>	<i>Mean</i>	<i>Median</i>
<i>Medicaid Eligibles</i>	1,687,968	4	254,859	6,671.8	1,507
<i>THS Dental Clients-Total</i>	653,021	2	116,076	2,581.1	489
<i>THS Dental Clients-Dental</i>	642,028	2	114,129	2,537.7	484
<i>County Population</i>	19,013,489	150	3,325,120	75,152.1	15,318
<i>Log County Population</i>	--	2.17	6.52	4.21	4.18
<i>Median Household Income</i>	--	\$10,182.00	\$46,020.00	\$21,742.06	\$20,898.00
<i>% Poverty</i>	--	5.8%	59.9%	21.8%	20.4%
<i>THS Dental Cost-Total</i>	\$124,255,528.90	\$119.50	\$26,880,533.22	\$491,128.57	\$82,256.69
<i>THS Dental Cost-Dental</i>	\$104,037,256.79	\$84.25	\$22,828,307.19	\$411,214.45	\$68,819.01
<i>THS Dental Cost-Total per Client</i>	--	\$59.75	\$347.31	\$172.82	\$172.15
<i>THS Dental Cost-Prevention Services</i>	\$26,015,077.26	\$50.00	\$5,686,786.49	\$102,826.39	\$15,682.01
<i>THS Dental Cost-Prevention Services per Client</i>	--	\$13.98	\$119.40	\$34.91	\$34.09
<i>THS Dental Cost-Treatment Services</i>	\$78,022,179.56	\$0.00	\$17,141,520.70	\$308,388.06	\$54,398.25
<i>THS Dental Cost-Treatment Services per Client</i>	--	\$0.00	\$270.71	\$113.14	\$109.37
<i>THS Dental Services-Total</i>	5,353,979	7	1,152,051	21,161.9	3,482
<i>THS Dental Services-Prevention</i>	1,582,148	3	368,361	6,253.5	911
<i>THS Services-Treatment</i>	1,991,250	0	441,591	7,870.6	1,364
<i># Medicaid Dental Providers</i>	3,167	0	539	12.5	3
<i>Medicaid Dental Provider Density</i>	--	0	0.22	0.007	0.005
<i>CWA Fluoride Level</i>	--	0.1	5.4	0.85	0.62
<i>Log Fluoride Level</i>	--	-1	0.73	-0.19	-0.20

THS Dental information based on FY1997 reporting (TDH-MMIS #1242)

APPENDIX III

Figure 1 - Cumulative Treatment Cost Savings per THSteps Dental Client

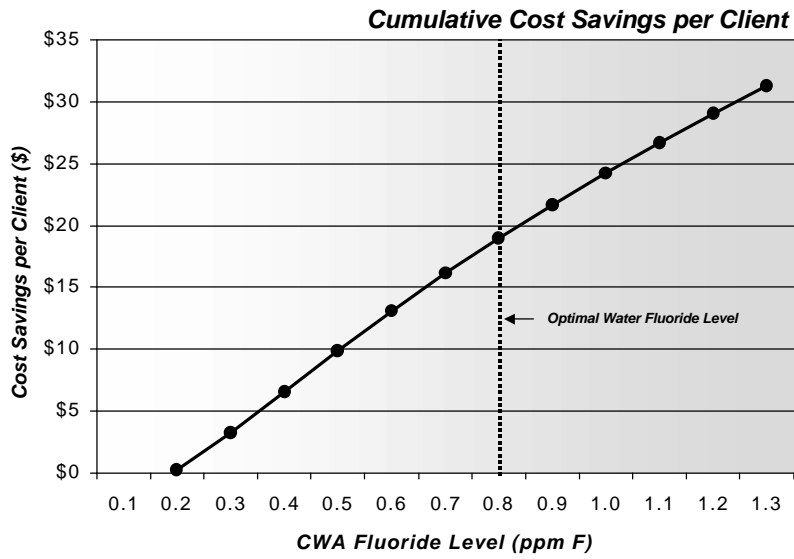
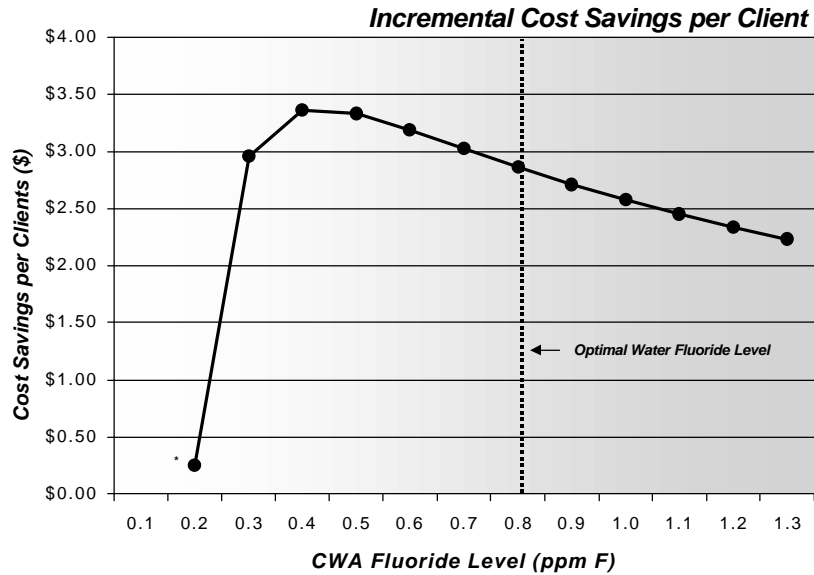


Figure 2 - Incremental Treatment Cost Savings per THSteps Dental Client



* Counties with low dental treatment costs per client and low water fluoride levels.