From: Roger.D.Masters@Dartmouth.EDU
Sent: Friday, August 9, 2002 3:11 PM
To: masten@niehs.nih.gov
Subject: Nomination of Silicofluorides for Toxicological Studies

TO; Scott Masten
FROM: Roger Masters

Needless to say, I was greatly pleased to read (in the Federal Register for 6/12/02) of the decision of the NTP to include Hexafluosilicic acid and sodium hexafluorosilicate in its nominations for toxicological studies.

It will not be a surprise, of course, that I warmly endorse that nomination and strongly recommend a decision to engage in both the chemical characterization and toxicological studies. Indeed, given Westendorf's experimental findings and our epidemiological data, I would urge the NTP to include, under the rubric of toxicological studies, research on the interaction of exposure to lead or other heavy metals and exposure to water treated with silicofluorides, with a special focus on behavioral neurotoxicity.

New developments in behavioral neurotoxicology show the need to go beyond traditional methods due to varying genetic susceptibilities (see the latest SCIENCE for an excellent study of differential response to environmental insults due to a mutant gene for MAO A in males).

I've delayed communicating my recommendations because it seemed appropriate to send you the final version of the paper I will be giving next week at the annual meeting of the Association for Politics and the Life Sciences in Montreal. That paper is enclosed herewith.

Please let me know if I can be of any assistance in the NTP decision (on silicofluorides or on any other issue that touches on behavioral neurotoxicology). I am struck, for example, by the tendency to ignore behavioral dysfunction when assessing the effects of mercury. Similarly, several months ago I heard a very interesting presentation on the effects of nutrient imbalances (e.g., abnormal calcium magnesium ratios) on responses to hormone replacement -- yet in the recent discussions of this issue, there was virtually no mention of individual differences in response. In the case of any environment in which lead uptake is a risk, a similar factor arises from lactose intolerance (a genetic condition with, as you know, differential frequency in various ethnic groups).

The role of lead uptake in ADHD and violent crime should underscore the importance of behavioral assessments of potential toxins. It follows that some traditional approaches in toxicology (particularly on the assumption that effects would be uniform through a population and would primarily be harmful to health) will fail to identify environmental factors with immensely costly effects to our society.

With best regards,

Roger D. Masters
Research Professor

Science, Bureaucracy, and Public Policy:
Can Scientific Inquiry Prevail Over Entrenched Institutional Self-Interest?

Roger D. Masters*
Dartmouth College

ABSTRACT

In an age of unparalleled scientific activity, especially in the areas of human biology, brain function, and behavior, contradictions between established governmental policies and new research findings are inevitable. A troubling question arises: *If an established governmental policy is challenged by new scientific findings, will bureaucrats and professionals committed to current practices and responsibilities admit that established policies may be based on an error and need to be reexamined?* In the case of the addition of fluosilicic acid or sodium silicofluoride to public water supplies, our published epidemiological analyses indicated that the consequences of error seem to be substantial harm to the exposed population. This case illustrates how academic research could have an essential role in opening accepted decisions and ways of thinking to further inquiry. Since this paper was first drafted as a response to a CDC report in 2001 that ignored the issue, the National Toxicology Program nominated fluosilicic acid and sodium silicofluoride for toxicological study due to "lack of toxicity information"; though it cannot be guaranteed that the NTP's Interagency Committee For Chemical Evaluation and Coordination will recommend toxicology studies of these silicofluorides, this action officially confirms that the "assumed complete dissociation" after these chemicals are added to water is "not supported by experimental evidence." In addition, however, since this paper was drafted, Senator Bingaman of New Mexico introduced legislation on dental health which assumed that, without reference to the chemicals used, "fluoridation" is consistent with the "best-science in oral health"; while I have suggested an amendment to that bill to study all chemicals added to public water supplies and prohibit the use of untested compounds after a fixed date, passage of the bill as drafted would expose more Americans to silicofluorides. As this case has illustrated, bureaucratic and professional reactions to new scientific evidence can be to ignore them through self-interest and/or inertia, or to open them to further research and policy revision. In this process, the scientific community has an ethical responsibility to combine open-minded assessment of new evidence with communication of results in a manner that will facilitate legislative and administrative restudy and revision of doubtful public policies. While political interests and bureaucratic resistance can block consideration of needed policy changes, academic researchers who are unwilling to consider new evidence (exemplified in this case by many dental professionals) may share responsibility for the persistence of a harmful decision.

Paper Presented To The Annual Meeting Of The
ASSOCIATION FOR POLITICS AND THE LIFE SCIENCES,
Panel 4-3, Public and Private Capabilities in Serving the 'Public Good'
Mon., Aug. 12: 10:30AM - Hotel Gouverneur, Montreal, Que – Rimouski Room, 4th Floor

Science, Bureaucracy, and Public Policy: Can Scientific Inquiry Prevail Over Entrenched Institutional Self-Interest?

Roger D. Masters

I. The Problem

On August 16, 2001, the U. S. Centers for Disease Control and Prevention (CDC) announced release of a document that – in the best of worlds – would have been widely questioned.[1] In fact, nothing happened. The document, entitled "*Recommendations for Using Fluoride to Prevent and Control Dental Caries in the United States,*" was authored by a "working group" of 11 "fluoride experts" – two government employees, nine representatives of dental schools, and two dental specialists in graduate schools of public health – who "evaluated the scientific evidence for the various fluoride products used in the United States."[2] The authors, all of whom are associated with institutions having a vested interest in current dental policies, recommended that the U.S. "continue and expand fluoridation of community drinking water."[3] The report thereby confirmed the wisdom of policies initiated in the 1940s, adding only marginal suggestions in the light of practical changes in dental care over the last half century.

One might have expected journalistic comment on this report because it did NOT mention new "scientific evidence" concerning the "various fluoride products" added to public water systems in the United States. New scientific research has been noteworthy in two areas. The first concerns the effectiveness of adding fluoride to public water supplies as a strategy for reducing tooth decay, especially for poor and disadvantaged populations with poor dental care. The second concerns evidence that the chemicals normally used for water fluoridation -- two untested compounds (hydrofluosilicic acid and sodium silicofluoride – jointly, "silicofluorides") -- may have unexpected and extremely harmful biological effects on consumers. In the CDC *Recommendations for Using Fluoride,* the Work Group does not mention the second of these issues and treats the first in a puzzling manner. Since public policies are conventionally assessed by comparing costs and benefits, the principal question concerns a recommendation for government policy that fails to consider potentially harmful consequences identified by new research. While both costs and benefits of fluoridating public water supplies needed more thorough reassessment before the CDC officially "recommended" its expansion in August 2001, why did the report ignore the need to question (or even merely dismiss) recent evidence of possible harm to the public? Could this omission be due to bureaucratic reluctance to question the 1950 decision to approve the substitution of silicofluorides for sodium fluoride as compounds added to a public water supply?

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* Research described in this article was conducted jointly with Myron J. Coplan, a senior chemical engineer and former Vice President of Albany International whose expertise in the chemistry of silicofluorides is based on direct professional experience and has been indispensible.

Harmful Effects of Fluoridating Public Water Supplies. Over 90% of the U.S. population receiving fluoridated water is exposed to water treated with either hydrofluosilicic acid (H_2SiF_6) or sodium silicofluoride (Na_2SiF_6). Although sodium fluoride (NaF) -- the chemical originally used for water fluoridation and familiar in toothpaste – has been tested for safety,[4] silicofluorides have largely replaced them and are now used in water delivered to approximately 140 million people. It is therefore surprising to find that silicofluorides have never been adequately tested. As a result, the Chief of the Treatment Technology Evaluation Branch of the EPA's Water Supply and Water Resources Division now admits that his agency is "unable to find any information on the effects of silicofluorides on health and behavior."[5]

The admitted lack of knowledge about silicofluoride safety increases the importance of recently published epidemiological data concerning effects of these chemicals on health and behavior. Since some critics of fluoridation have cited these findings favorably while several government scientists have attacked them, why did a major government report recommending adding fluoride to public water supplies make no mention whatever of the controversy?

Scientific assessment of the hypothesis that silicofluorides differ from sodium fluoride is inhibited by the CDC's habit of discussing fluoridation without reference to the chemicals involved. In the CDC *Recommendations for Using Fluoride,* this silence hardly seems an accident. The document names specific chemicals when discussing fluoride mouthwashes ("sodium fluoride"), gel and foam ("acidulated phosphate fluoride," "sodium fluoride," or "stannous fluoride"), and varnish ("sodium fluoride " or "difluorsilane"). Even if the research questioning silicofluoride safety is questioned on methodological grounds – as two EPA employees have claimed[6] – it would seem normal for the "fluoride experts" to *name* the compounds used and provide some evidence of their safety. To be sure, most critics of water fluoridation, like government policy-makers and dentists supportive of this policy, have also spoken of "fluoridation" without referring to the chemicals used. With the recent publication in peer reviewed journals of a series of studies questioning the safety of silicofluorides, however, silence on their existence takes on a different character.

At least one earlier publication of the CDC indicates that the agency is fully aware of differences in the chemicals used to fluoridate public water supplies. In *Engineering and Administrative Recommendations for Water Fluoridation, 1995*, the discussion of "Technical Requirements" includes separate instructions for:"Sodium Fluoride Saturator Systems," (section III,B), "Fluorosilicic Acid Systems" (Section III.C), and "Dry Fluoride Feed Systems" -- which include those "when sodium fluorosilicate (i.e., silicofluoride) is used" (Section III.D). That some danger from fluorosilicic acid is recognized is clear from the first recommendation for systems using that chemical: "To reduce the hazard to the water plant operator, fluorosilicic acid (hydrofluosilicic acid) must not be diluted. Small metering pumps are available that will permit the use of fluorosilicic acid for water plants of any size."[7]

In contrast to the distinction in this technical manual, CDC documents proclaiming the benefits of fluoridating public water supplies are generally silent on the chemical compounds in use.[8] The second paragraph of Introduction to the CDC's *Recommendations for Using Fluoride* makes it seem that the treatment of fluoride chemistry in this document is intentionally selective:

> "Fluoride is the ionic form of the element fluorine, the 13th most abundant element in the earth's crust. Fluoride is negatively charged and combines with positive ions (e.g., calcium or sodium) to form stable compounds (e.g., calcium fluoride or sodium fluoride). Such fluorides are released into the environment naturally in both water and air. Fluoride compounds also are produced by some industrial processes that use the mineral apatite, a mixture of calcium phosphate compounds. In humans, fluoride is mainly associated with calcified tissues (i.e., bones and teeth) because of its high affinity for calcium."

While true in general, this paragraph does not mention that hydrofluosilicic acid and sodium silicofluoride are toxic compounds that originate as byproducts in the production of phosphate fertilizer and weapons grade uranium (or fuel for nuclear power plants).

The difference matters because a crucial issue in the safety of using silicofluorides concerns the chemical reactions when they are added to water.[9] In 1950, the Public Health Service formally approved their use based on the assumption – unsupported by empirical data -- that, like sodium fluoride, the silicofluorides dissociate completely into their component elements when added to water. Although this claim was supported by a theoretical argument, it was not confirmed by empirical data.[10] In 1975, incomplete silicofluoride dissociation was found in Westendorf's laboratory studies in Germany, which have recently been translated and posted on a web site in the U.S.[11] This German study suggests that the "residual complexes" remaining after silicofluorides are added to public water supplies are not necessarily the "stable compounds" ("calcium fluoride or sodium fluoride") formed from "a positive ion (e.g., calcium or sodium)" and the fluoride anion. Moreover, Westendorf found that when humans drink water treated with silicofluorides, the residuals left by SiF act to inhibit a key enzyme (acetylcholinesterase) with important biological consequences.[12] The CDC *Recommendations for Using Fluoride* are so written that the existence of this and other scientific questions surrounding the use of silicofluorides remain invisible.

Benefits of Fluoridating Public Water Supplies. Serious new questions have also been raised about the efficacy of controlling caries by *ingesting* fluoride. Recent studies of this issue have emphasized that the effects of fluoride in reducing tooth decay depend primarily on topical contact of fluoride with the tooth surface, as occurs with fluoridated toothpaste, gels, varnishes, or mouthwash. One widely used measure of such topical contact is the fluoride content of saliva (which – as will be seen in Section III below – - is increased to a much lesser degree by fluoridated water than by fluoridated toothpaste or other topical treatments). In this case, the CDC *Recommendations for Using Fluoride* refers to some of the relevant evidence, but does so in a puzzling manner.

For example, despite recent findings on the mechanisms by which fluoride influences tooth decay (to be discussed in Section III below), the CDC apparently bases its support of water fluoridation on historical evidence of an overall decline in dental caries after water fluoridation began. As evidence in the *Recommendations for Using Fluoride*, the CDC Working Group states that "National surveys have reported that the prevalence of any dental caries among children aged 12—17 years declined from 90.4% in 1971—1974 to 67% in 1988—1991." [13] Later in the *Recommendations for Using Fluoride,* the authors admit that the proportion of this decline in caries due to fluoridated water has been open to disagreement: "Initial studies of community water fluoridation demonstrated that reductions in childhood dental caries attributable to fluoridation were approximately 50%--60% (*94-97*) More recent estimates are lower – 18% --40% (*98,99*). This decrease in attributable benefit is likely caused by the increasing use of fluoride from other sources." [14] The divergence of these estimates of effectiveness indicates methodological problems from time series data that could be avoided by controlled ecological comparisons between fluoridating and non-fluoridating communities.

The extent of benefits due to fluoridated water is further questioned by data showing that untreated public water supplies are not a major risk factor underlying higher levels of tooth decay. "Populations believed to be at increased risk for dental caries are those with low socioeconomic status (SES) or low levels of parental education, those who do not seek regular dental care, and those without dental insurance or access to dental services."[15] That water fluoridation does not effectively counteract such risk factors is demonstrated by recent studies of dental disease and access to dental treatment among minorities (see Section III below). Moreover, skepticism about the claimed size of benefits is reinforced by data showing that the decline in dental disease since 1940 is parallel in communities that do and that do not fluoridate their public water supplies (Figure 1).[16]

Published evidence that silicofluoride-treated water seems to be associated with harmful effects puts these questions about supposed benefits in a different light, Whatever the benefits of water fluoridation in reducing tooth decay, the most urgent policy issue should be a thorough and open-minded assessment of the hypothesis that silicofluorides have harmful effects on health and behavior not observed where sodium fluoride is used. Consideration of this research is especially important because the harmful effects observed in recent epidemiological studies are influenced by neurotoxicological and endocrinological processes that were not studied in 1950, when the Public Health Service first approved silicofluorides for use in water treatment.

II. Silicofluoride Treated Water, Enhanced Lead Uptake, and Dysfunctional Behavior

Despite some early studies showing differences in evoked metabolic response between sodium fluoride and sodium silicofluoride, to this day the substitution of silicofluorides in public water treatment facilities has never been subjected to appropriate animal or human testing.[17] Because silicofluorides are by-products of processes by which fertilizer is produced and uranium extracted from phosphate rock, some observers fear these chemicals may carry toxic substances including arsenic, heavy metals, and uranium radioactive decay products. Uncertain standards and protocols for determining the toxicity of silicofluorides prior to their use in public water supplies provide added reasons for concern.[18]

Apart from possible contamination, silicofluorides are themselves toxins whose biochemical effects are in need of study. In addition to showing that silicofluoride dissociation is incomplete, Westendorf's research in Germany (apparently unknown to the EPA and CDC) found that enzyme inhibition by water treated with silicofluorides (e.g., acetylcholinesterase inhibition) occurs at a lower threshold and to a greater extent than similar effects due to the fluoride ion released by sodium fluoride.[19] Other chemical properties have been hypothesized to explain the neurotoxicological effects apparently associated with silicofluoride treated water.[20]

To ascertain whether this issue needs further research, we compared children's blood lead levels in communities using silicofluoride-treated water with blood lead levels in communities using sodium fluoride or with non-fluoridated water. In epidemiological analyses of three separate samples, totalling over 400,000 children, silicofluoride treated municipal water was always significantly associated with increased blood lead levels in children. While the precise mechanisms remain to be determined, these studies show that, taking economic, social and racial factors into account, where silicofluorides are used children seem to absorb more lead from the environment. Based on hypotheses derived from neurotoxicology, epidemiological data also show higher rates of diseases and behavioral problems associated with lead poisoning (including hyperactivity, substance abuse, and violent crime).

This effect was evident in a Massachusetts survey of lead levels in 280,000 children (see Figure 2, showing blood lead levels among children exposed to silicofluorides from the Greater Boston water system or from towns that add silicofluorides locally, communities using sodium fluoride, and towns without fluoridation).[21] For the state of New York, data was available on venous blood lead levels for 151,225 children in communities of 15,000 to 75,000. Controlling for other factors associated with higher blood lead, silicofluorides were again significantly associated with higher uptake of lead from the environment.[22] As in other studies (see Figures 6 and 7 below), this effect was especially pronounced among Black children, who were more likely to have lead over 10μg/dL and correspondingly less likely to have low blood lead (Figure 3).[23]

To confirm that these results are not due to other socio-economic or demographic factors, additional statistical tests were run. For the New York sample we compared the "odds" of having blood lead over 10μg/dL if silicofluorides were in the water (the percentage of such children in silicofluoride treated communities divided by the percentage in communities without these chemicals in the water). An odds ratio of 1.0 means that the risk of high blood lead is identical whether or not a child is exposed to silicofluoride treated water. Taking into consideration a series of risk factors linked with high blood lead, the data show that odds of blood lead levels over 10μg/dL are often higher in communities where silicofluorides are in use but other risk factors for high blood lead are *below* average (Figure 4).

To double-check that this wasn't a statistical artifact, we then looked at the difference in lead levels of Black and non-Black children in New York communities with overall low or high risk for blood lead. Three main findings appeared. First, when New York children living in communities with less risk for lead uptake (0 to 4 "risk factors" for high blood lead) are compared with those living in high risk communities (5 to 7 "risk factors"), those exposed to silicofluoride treated water are always worse off than those without these chemicals in their water, Second, these silicofluoride effects are worse when children are also exposed to more environmental risk factors for blood lead uptake. Finally, these effects are strikingly worse for Black children than for Whites (Figure 5).

The third study concerned children's blood lead levels in the National Health and Nutrition Evaluation Survey (NHANES III), which had reports for 7224 children from 80 counties with populations over 500,000. Since only 4 of these counties had any communities that used sodium fluoride, analysis of the NHANES III data focused on the percentage of the entire county population exposed to silicofluoride treated water.

Among the 1543 children of all ages from large urban counties with over 80% of the population exposed to fluoridation (almost all of whom receive water treated with silicofluorides), average blood lead was 5.12 μg/dL whereas the average for 1139 children in low fluoride exposure counties was 3.64 μg/dL Blood lead in the 473 children sampled from the medium fluoridation counties was 3.23 μg/dL, which was significantly different from the high fluoridation counties but not from either low fluoridation counties or those with unknown fluoridation status, where average blood lead levels were 3.16 μg/dL (standard deviation = 2.83).

Broken down by age and race, the findings are impressive. For children aged 3 to 5, although Blacks have higher levels of blood lead than Hispanics, who in turn have higher levels than Whites, for each race blood lead is significantly higher where silicofluorides are in use (Figure 6). Exactly the same pattern occurs for children aged 5-13 (Figure 7). To see whether this could be attributed to poverty rather than chemicals in water supplies, we then separated children living in counties with fewer people (less than 28%) or more people living in poverty. Again, a comparison of average blood lead levels by rce and community shows that silicofluoride use is significantly associated with higher levels of lead in children's blood ($p < .0001$). And once again, Blacks are harmed more than other races (Figure 8).

In all three populations studied, multivariate statistical analyses confirmed that those children in each racial category and each age group who were likely to be exposed to silicofluorides differ strongly in levels of blood lead from those not exposed. This conclusion was further checked by analyzing available data for health and behavioral traits associated with high blood lead (such as violent crimes, cocaine use and asthma). In each case, children in communities exposed to silicofluoride treated water were more likely to have higher rates of behavioral or health problems associated with lead toxicity.

The clearest data concern rates of violent crime. Lead has the effect of disturbing the function of the neurotransmitter dopamine. As neuroscientists have shown, neuronal pathways activated by this neurotransmitter are associated with learning, impulse control, substance abuse, and aggressive behavior. Other tests have confirmed that violent behavior is more likely among those who have high levels of lead in their blood and bodily organs. For example, in two studies, blood lead was measured in groups of children at the age of 6, and then the same children were studied for arrests for violent crime by the late teen-age years. In both studies, the children with high blood lead at age 6 were much more likely to engage in violence before the age of 20.[24]

It should hardly be surprising that because lead is a poison that reduces impulse control, children who have absorbed lead are more likely to grow up to have records of violent crime. Moreover, other toxic chemicals can have the same effect. For example, manganese reduces the functions of the neurotransmitter serotonin (the brain chemical whose activity is increased by Prozac). Analyses of criminals in jails has found that violent offenders are likely to have absorbed either manganese or lead. My own research in this area began by showing that communities with industrial pollution with either lead or manganese had higher rates of violent crime -- and, consistent with this hypothesis, communities where releases of both lead and manganese were recorded by the EPA, the violent crime rates were even higher.[25]

If silicofluorides are dangerous for the reasons outlined above, it follows that they should increase rates of violent crime. We can show that this is the case not only where lead pollution occurs (Figures 9 & 10), but where manganese pollution is present (Figure 11). In short, the use of silicofluorides in a public water supply not only is associated with increased rates of violent crime, but this effect is substantially worse where industrial pollution with either lead or manganese is combined with silicofluoride treated water.

Statistics for learning disabilities associated with lead toxicity are not as reliable, but one study provides reasonably good data on substance abuse among criminals. Since lead uptake undermines dopamine function in a way that has been linked to higher rates of addiction, we analyzed data from a National Institute of Justice study to compare the frequency of substance abuse at time of arrest among 30,000 criminals in communities that do and do not use silicofluorides. Consistent with thehypothesis outlined above, where silicofluorides are in public water, cocaine use by criminals at time of arrest was more pronounced (Figure 12).

The injection of silicofluorides in public water supplies is therefore a practice whose elimination could possibly contribute to reduced rates of learning disabilities, substance abuse, violent crime, and possibly asthma (all of which have been associated with lead and other toxins). Whatever the benefits to teeth (and this remains controversial), this research indicates that silicofluoride chemistry, toxicology, and the effects on behavior or health should be matters of scientific research and public discussion. Before SiF chemicals are used, citizens must know that they are safe for all.

Although this is a national issue, the epidemiological data show that the effects are particularly severe among Blacks and Hispanics. The reasons for this difference are probably a combination of socio-economic, environmental, and dietary factors. Children are likely to have higher blood lead where there are environmental sources of lead, such as old housing with lead paint or lead in public water supplies (Figure 13). Other factors that are also more likely among minorities, such as diets low in calcium, probably contribute to observed outcomes. Whatever the mixture of causes, it is unpardonable to poison children in a manner that has a particularly severe influence on minorities. As a society, we ought to clean up the toxins that harm all of our children but are especially dangerous for those who are socially disadvantaged.

Of course, science is an ongoing process and no one research project is perfect. Since silicofluorides have never been tested for safety, however, it is hard to understand

Figure I - Decline in DMFS Index in 12-14 Year Olds (12)

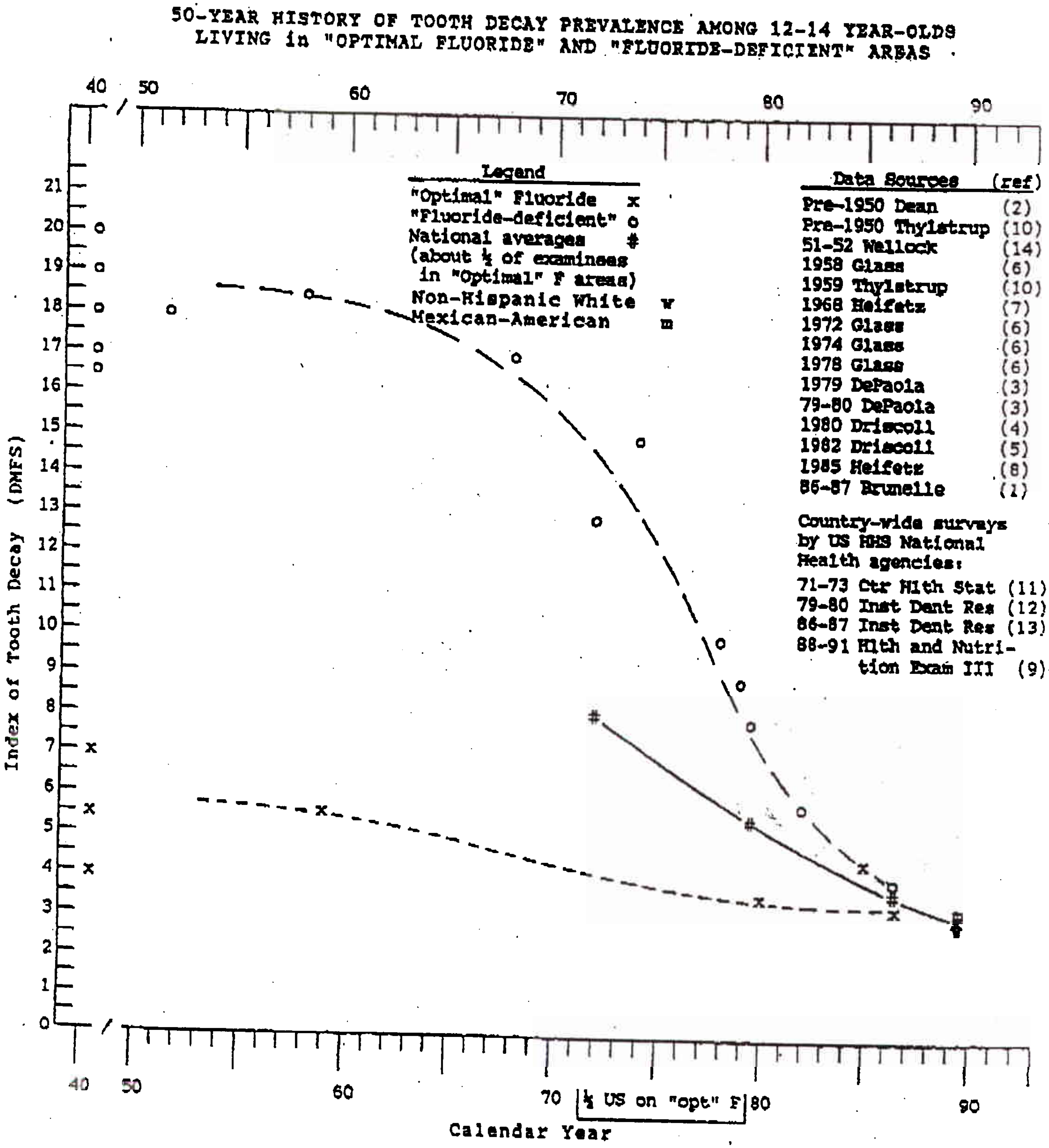

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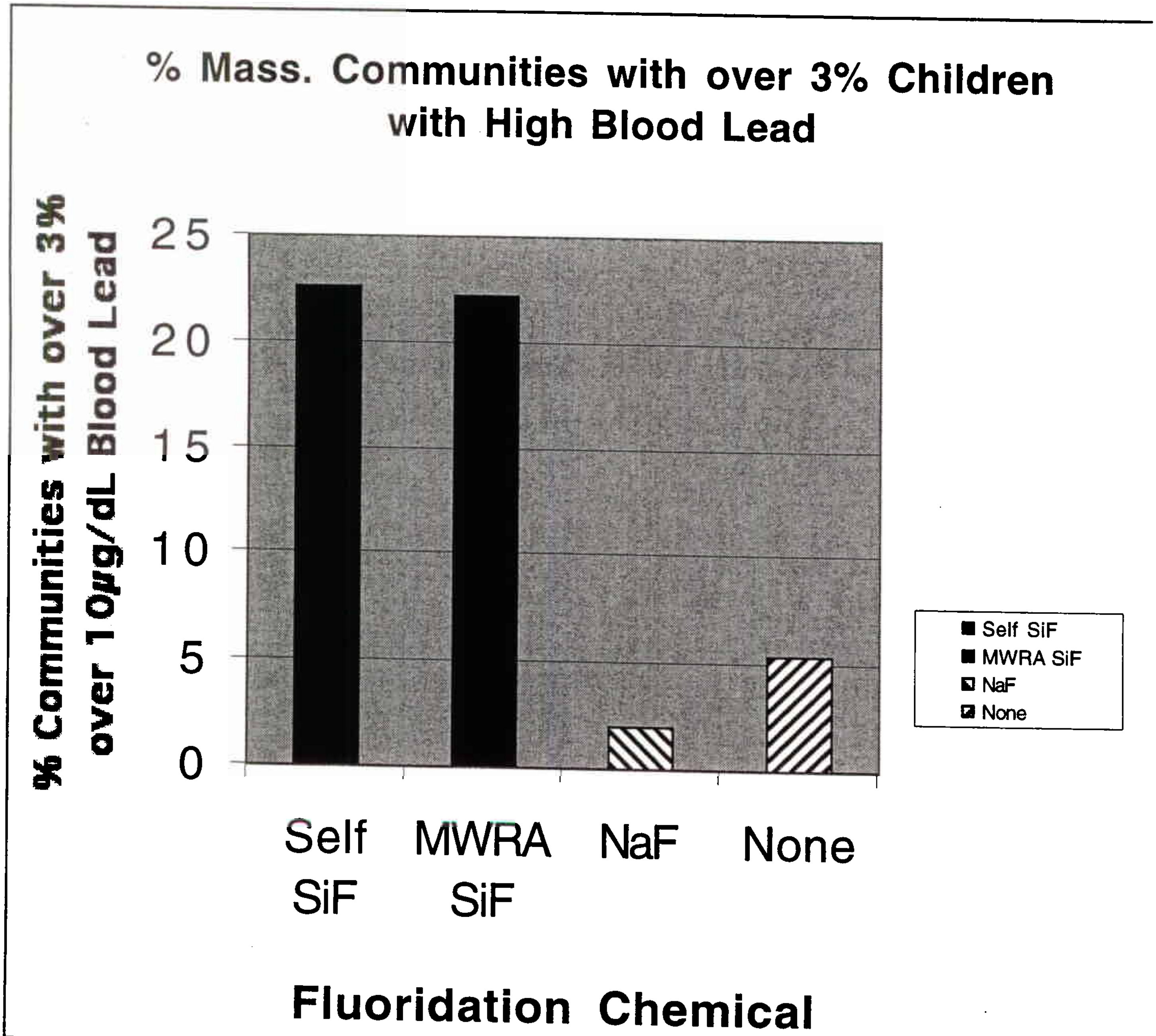
FIGURE 2



NOTE: "Self Silicofluorides" = communities with local water treatment using silicofluorides; "MWRA" = Greater Boston Communities served by Metropolitan Water Resource Authority, which adds silicofluorides; NaF" = sodium fluoride. "None" no fluoride. Excluded: 3 communities with naturally fluoridated water

Figure 3

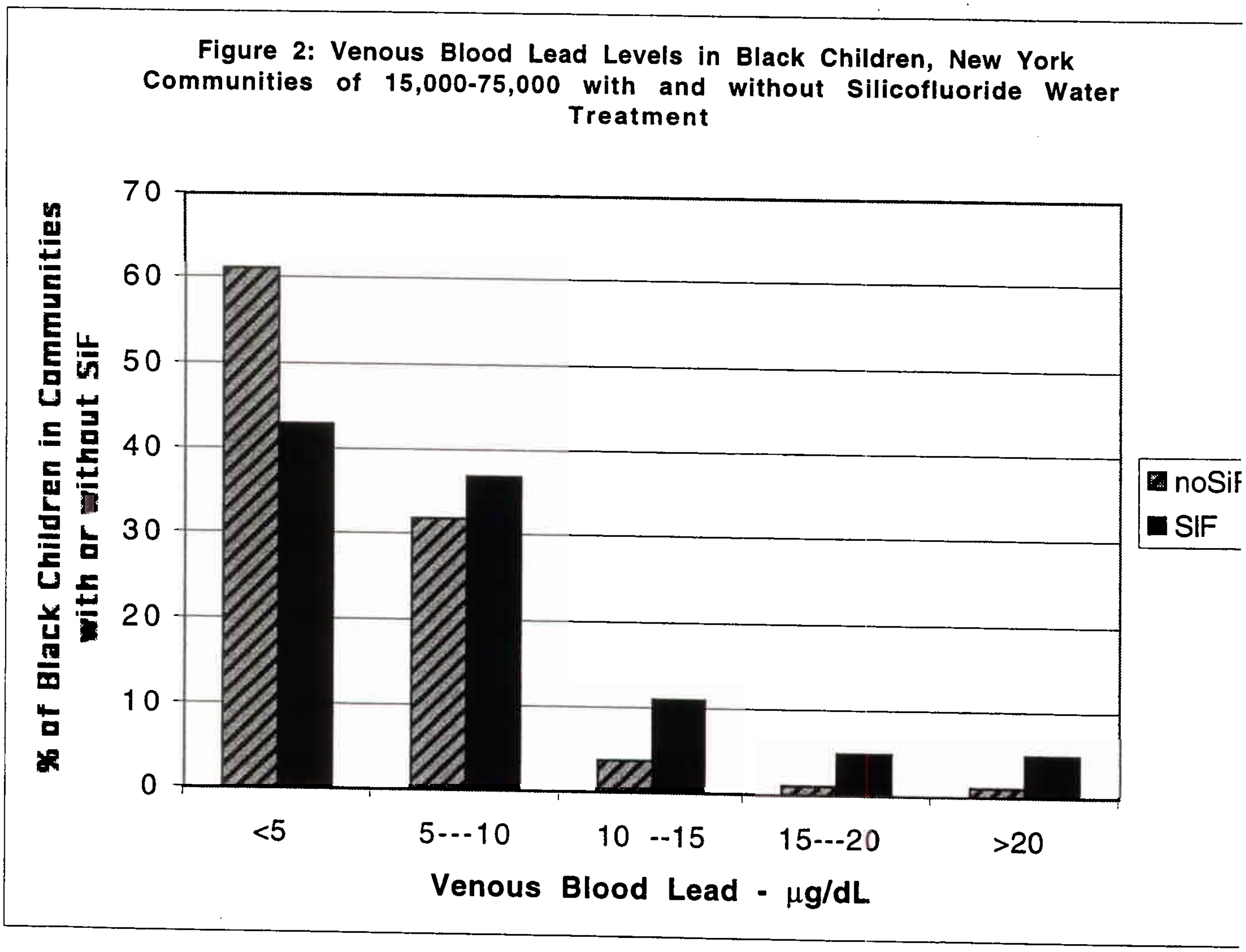
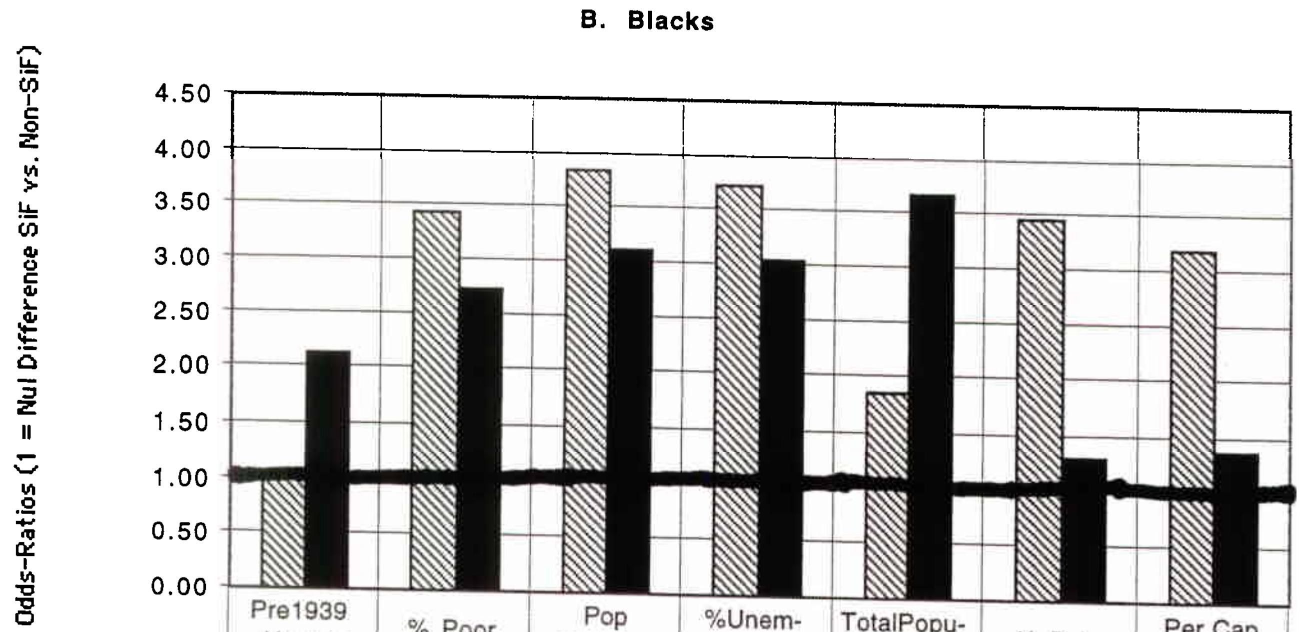


Figure 2: Venous Blood Lead Levels in Black Children, New York Communities of 15,000-75,000 with and without Silicofluoride Water Treatment
% of Black Children in Communities with or without SiF
70
60
50
40
30
20
10
0
<5
5---10
10 --15
15---20
>20
Venous Blood Lead - µg/dL
noSiF
SIF

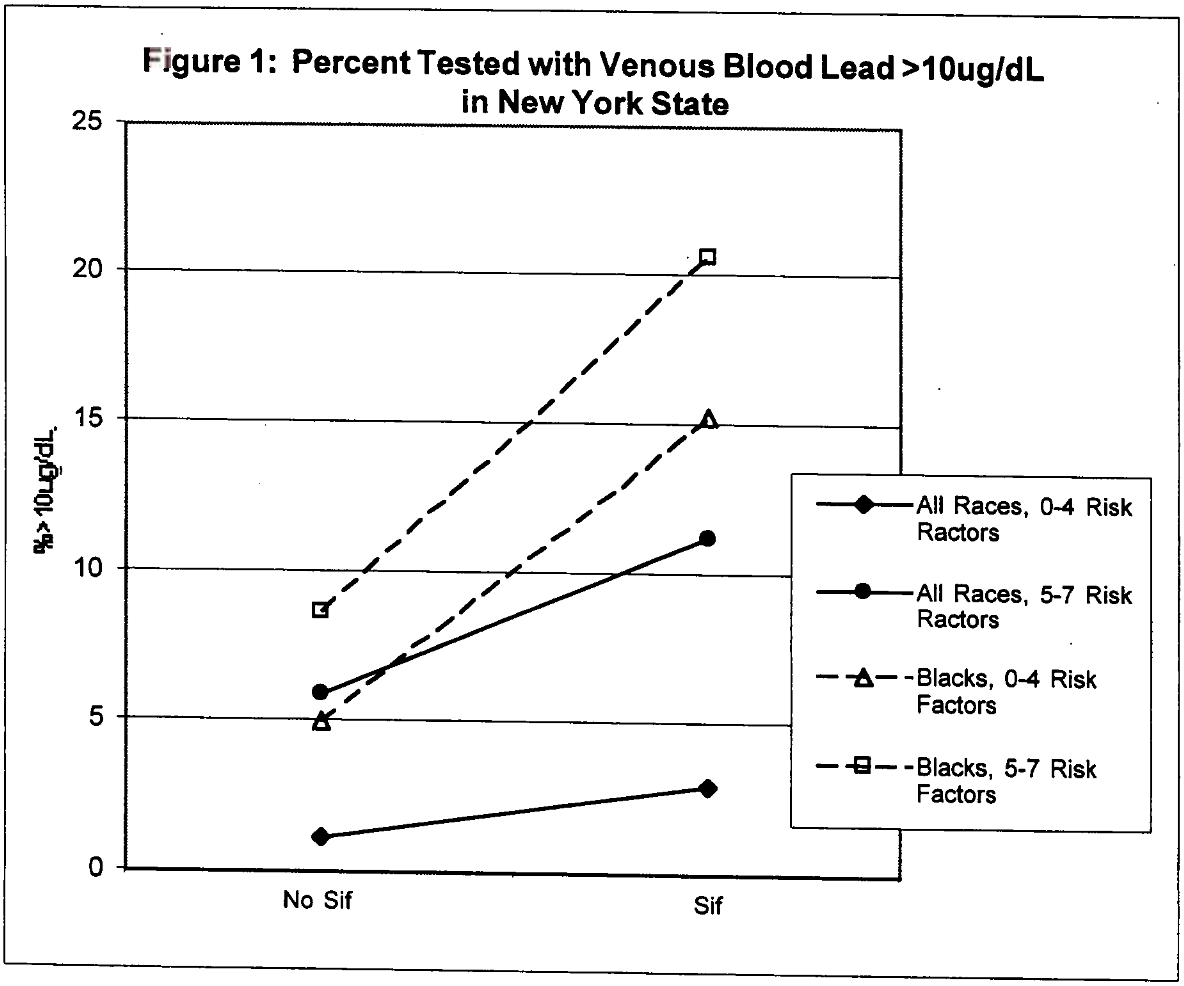
Figure 4: Logistic Regression for Odds of Higher Blood Lead If Exposed to Silicofluorides, Controlling for Other Risk Factors For High Blood Lead: Black Children, NY State



	Pre1939 Houses	% Poor	Pop Density	%Unem-ployed	TotalPopu-lation	% B.A.	Per Cap Income
Lower Risk	1.00	3.44	3.85	3.72	1.87	3.47	3.19
Higher Risk	2.13	2.73	3.12	3.06	3.69	1.31	1.38

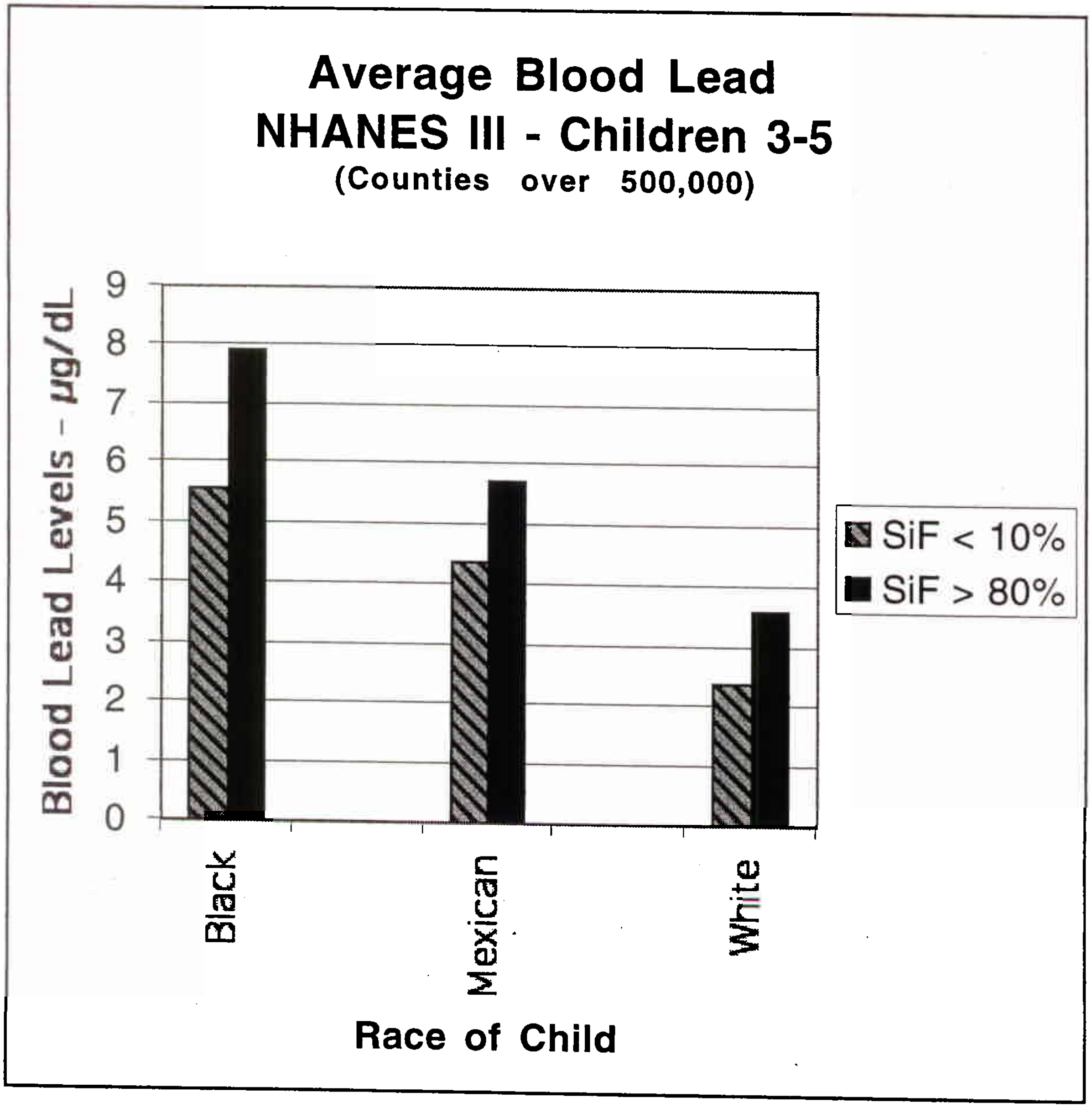
For each of seven factors associated with children having blood lead over 10μg/dL, communities below the mean (diagonal stripes) and above the mean (solid bar) were compared. An odds ratio of 1.0 (horizontal line) equals a 50-50 chance of higher blood lead where silicofluorides are used; hence all bars above that level reflect more children with high blood lead where silicofluorides are in public water, It will be noted that five of seven environmental risk factors for lead uptake in blood (% poor, population density, % unemployed, % B.A., and per capita income), silicofluorides actually have even worse effects where the risk factor is below the mean. This demonstrates that the association in question is not an artifact of measurement

FIGURE 5



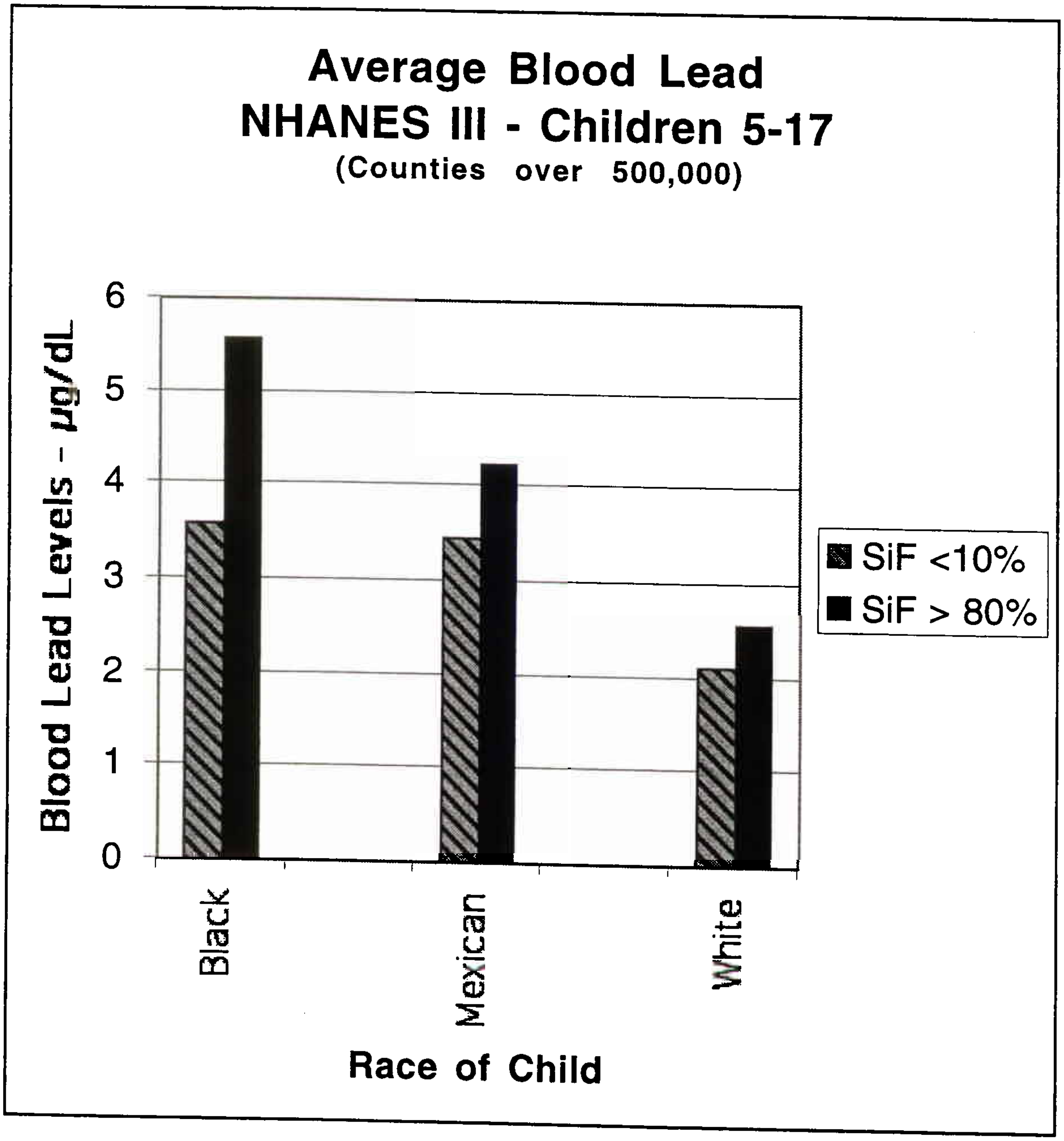
This figure divides all New York communities into those with above average levels of 0-4 of the risk factors and communities with 5-7 of these risk factors. For each level of risk, blood lead levels are higher where silicofluorides are in use; and this effect especially pronounced for blacks

FIGURE 6



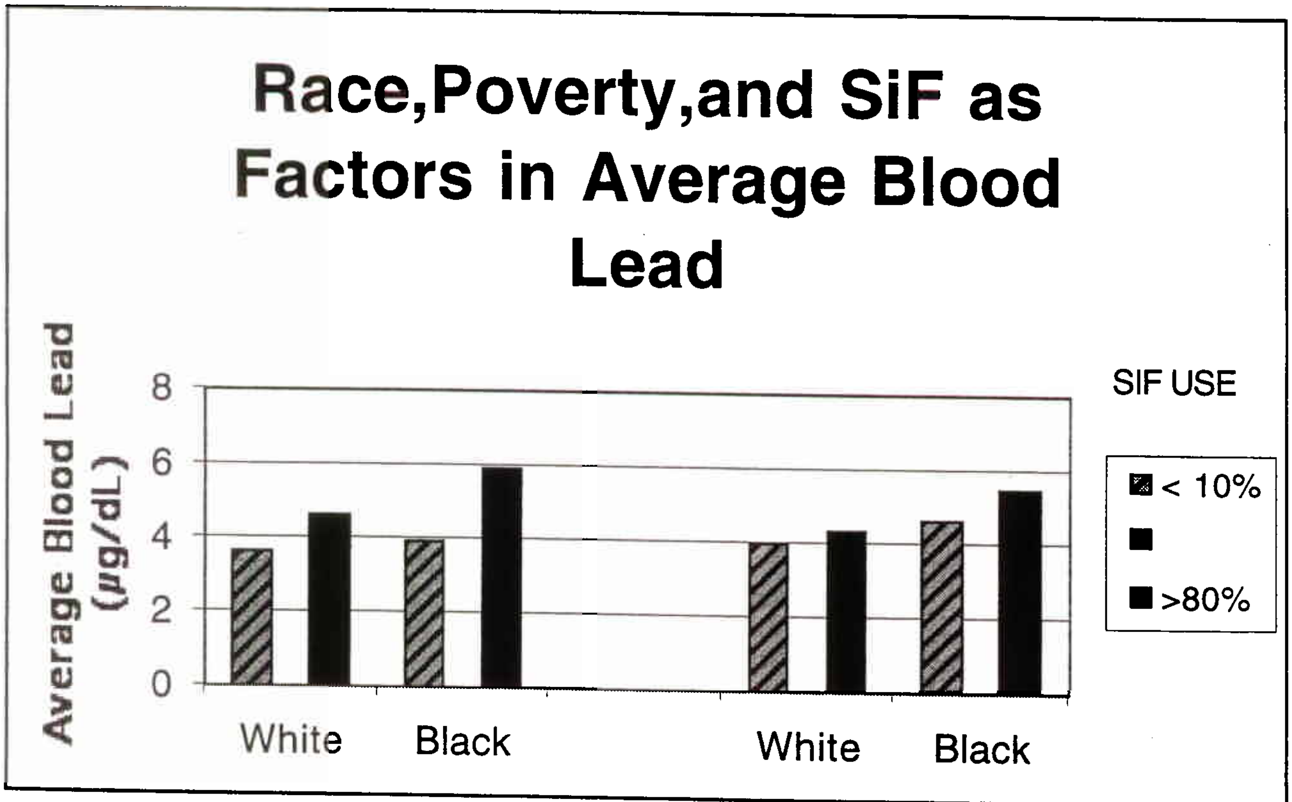
For NHANES III Children 3-5, mean blood lead is significantly associated with fluoridation status (DF 3, F 17.14, $p < .0001$) and race (DF 2, F 19.35, $p < .0001$) as well as for poverty income ratio (DF 1, F 66.55, $p < .0001$). Interaction effect between race and fluoridation status: DF 6, F ;3.333, $p < .0029$;

FIGURE 7



Significance, for ages 5-17: fluoridation status (DF 3, F 57.67, $p < .0001$), race (DF2, 28.68, $p < .0001$), Poverty-Income Ratio (DF 1, 252.88, $p < .0001$). Interaction between race and fluoridation status DF 6, F 11.17, $p < .0001$

FIGURE 8



Counties with <12.8% Poor **Counties with >12.8% Poor**

Overall population averages:

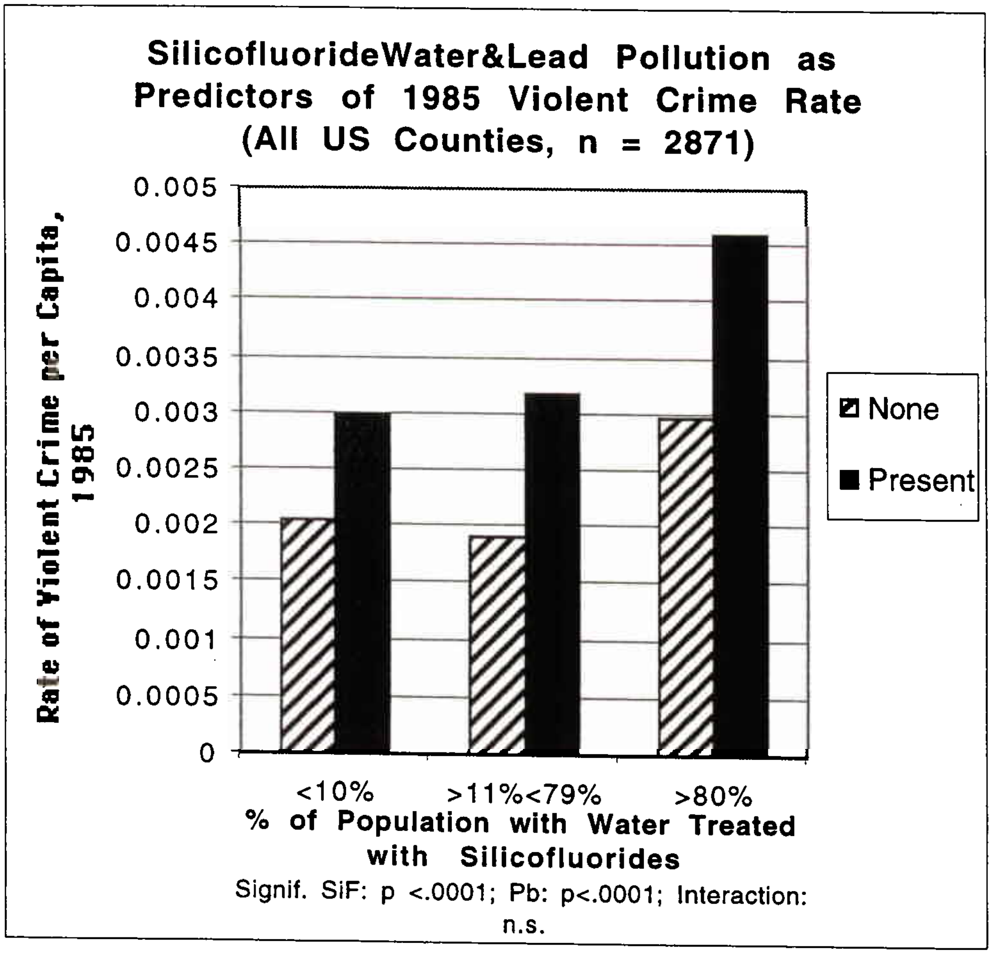
Counties with < 12.8% Poor (wealthy) < 10% SiF = 3.72µg/dL
>80% SiF = 5.17µg/dL

Counties with > 19.8% Poor (poor): <10% SiF = 4.10µg/dL
> 80% SiF = 5.07µg/dL

Anova for BLACKS: SIF Usage: F 6.634, p = .0042; %County in Poverty: n.s.; Interaction – n.s.

WHITE: SiF Usage: n.s., % County in poverty, n.s., Interaction, n.s.

FIGURE 9



Lead Pollution: Industrial Release of Lead in EPA Toxic Release Inventory

FIGURE 10

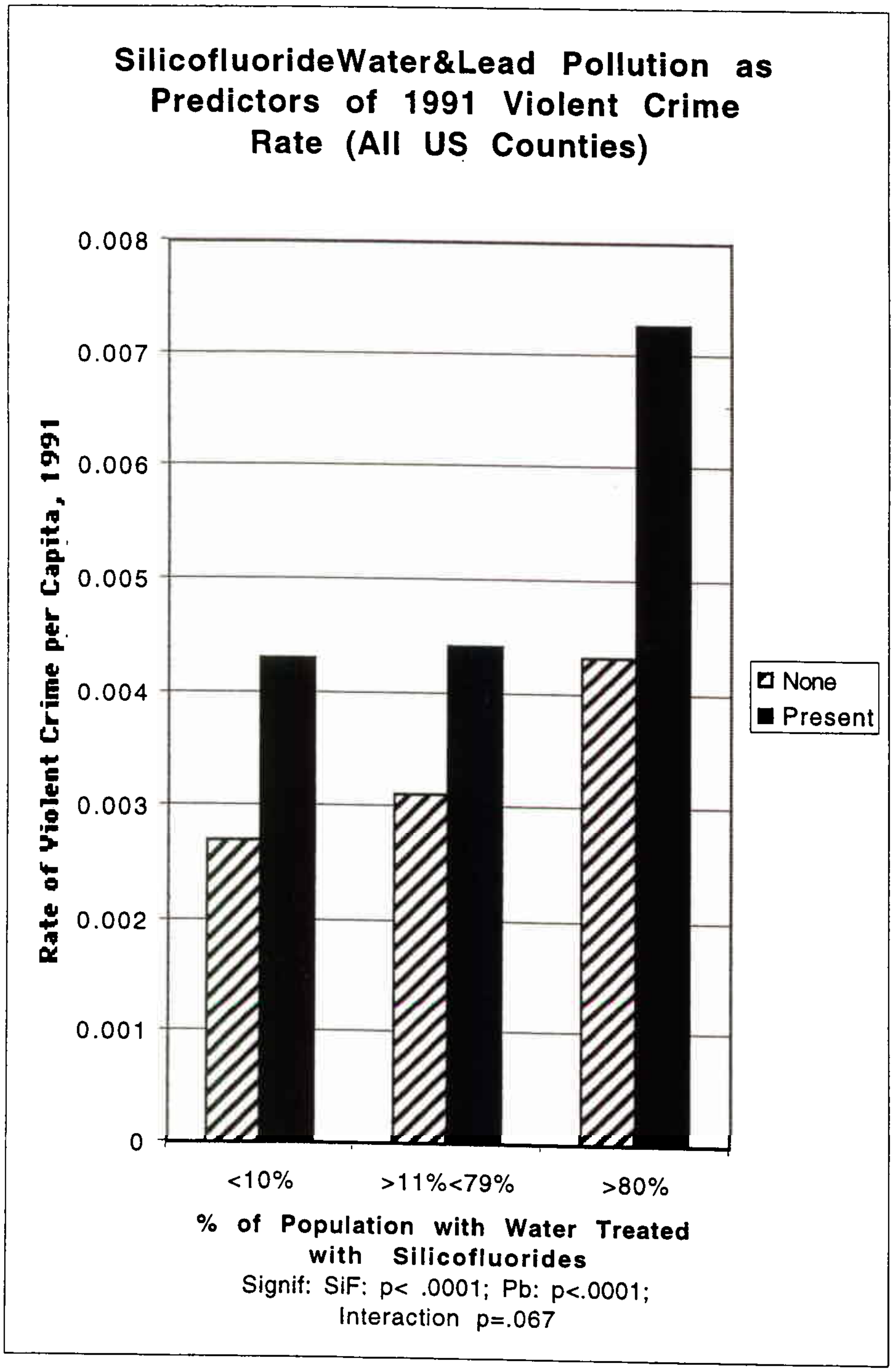
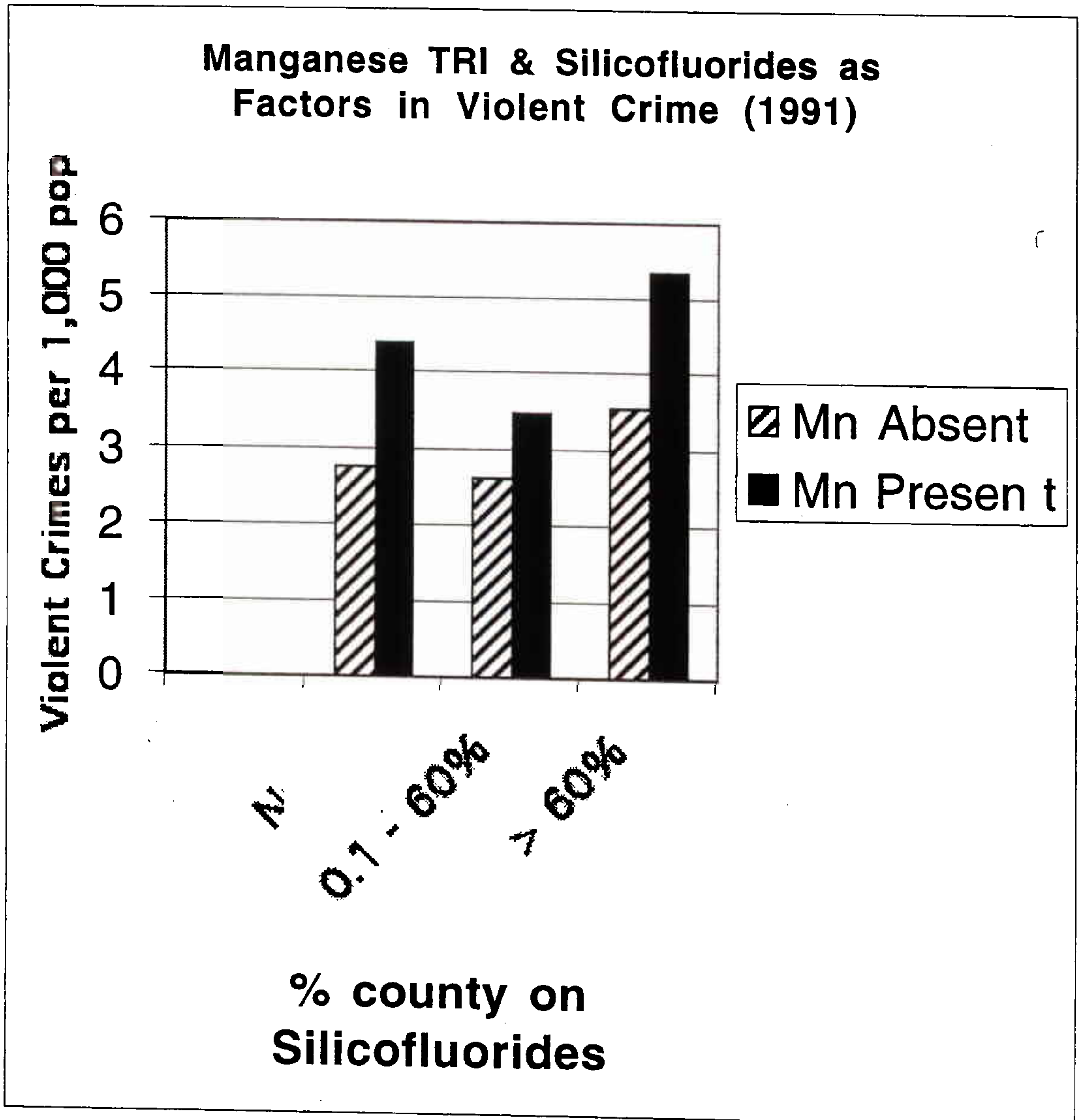

SilicofluorideWater&Lead Pollution as Predictors of 1991 Violent Crime Rate (All US Counties)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
Rate of Violent Crime per Capita, 1991
None
Present
<10%
>11%<79%
>80%
% of Population with Water Treated with Silicofluorides
Signif: SiF: p< .0001; Pb: p<.0001;
Interaction p=.067

Figure 11

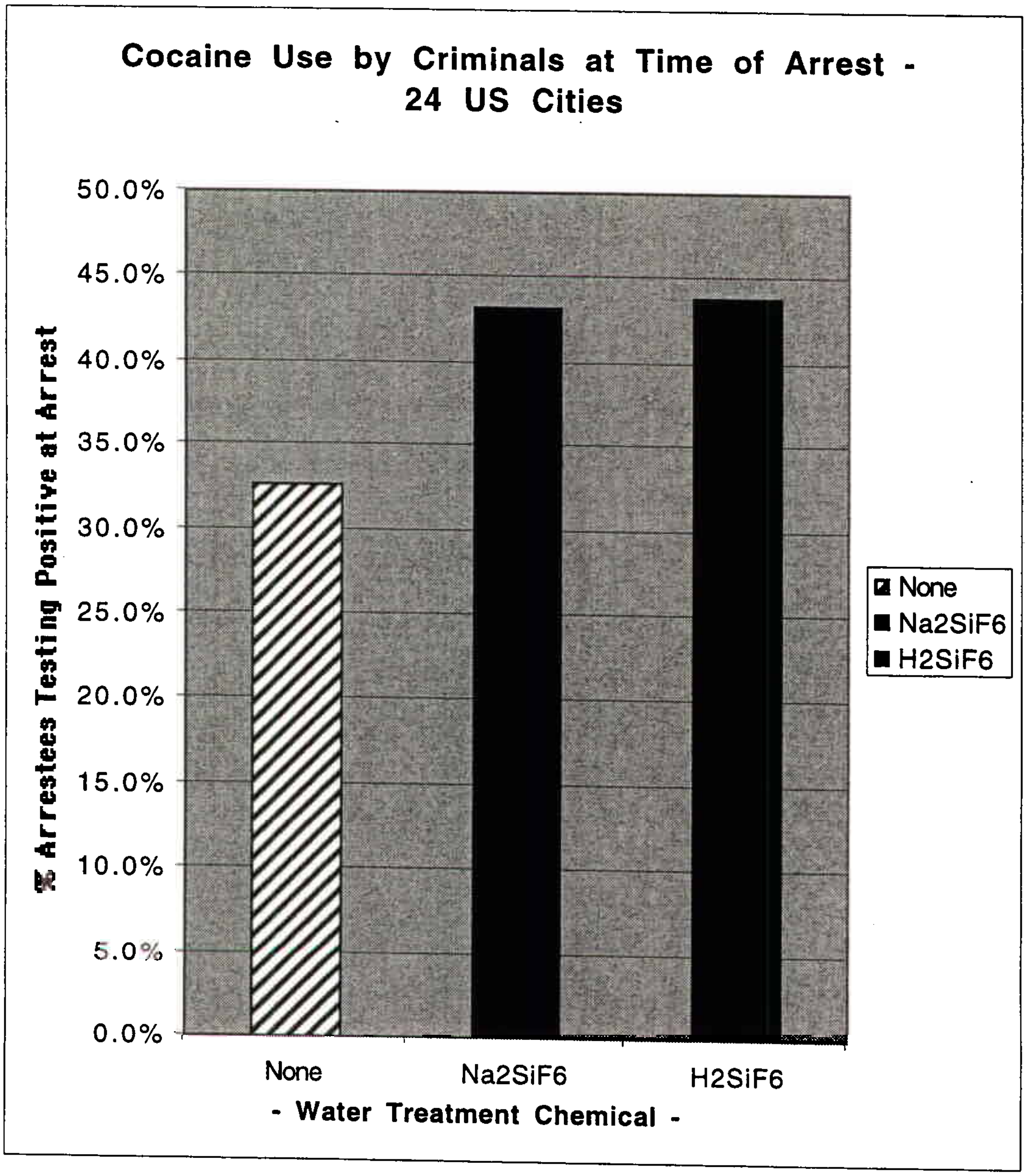


Significance:

Silicofluoride Usage: p = .0001, F 27.605;
Manganese Pollution: p = .0001, F 79.005;
Interaction of SiF and Mn: p = ..0239, F 3.739

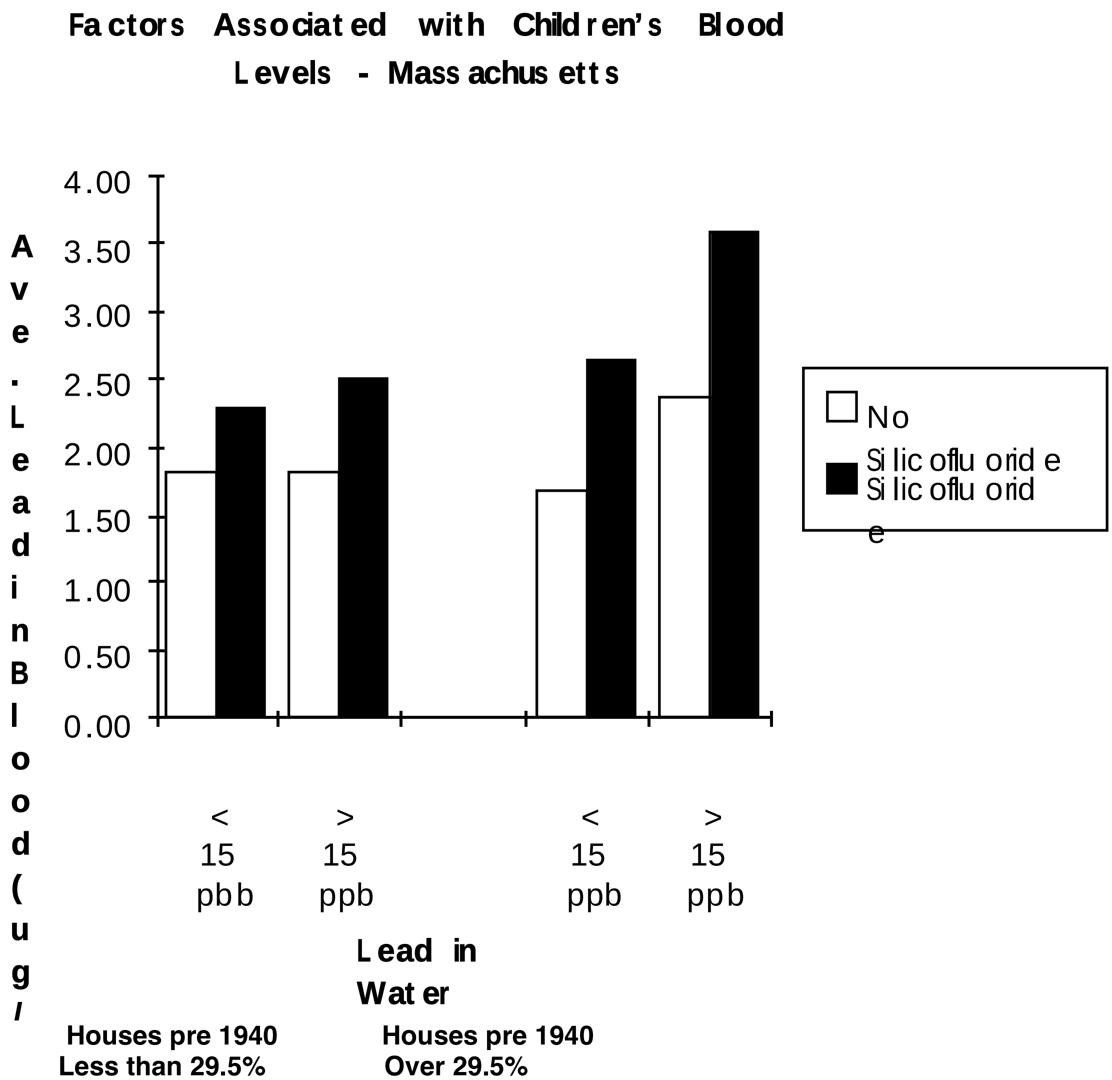
NOTE: For the 369 US counties where over 60% received water treated with silicofluorides, and there is no Toxic Release Inventory record for manganese, the violent crime rate in 1991 (3.53 per 1000) was intermediate between rates in the 109 counties with manganese TRI and no silicofluorides (4.40) or the 217 counties with between 0.1 and 60% receiving silicofluorides (3.49). Where both silicofluorides are delivered to over 60% of the population and manganese TRI is present, the crime rate was 5.34. In 1991, the national county average was 3.12 violent crimes per 1000.

Figure 12:



Cocaine Use by Criminals at Time of Arrest - 24 US Cities
50.0%
45.0%
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
% Arrestees Testing Positive at Arrest
None
Na2SiF6
H2SiF6
- Water Treatment Chemical -
None
Na2SiF6
H2SiF6

Figure 13



ANOVA Significance:
Main EFFECTS

% Houses pre 1940: p = .00901, F 21.17
90th percentile 1st Draw Lead > 15ppb: p = .0101, F 6.75
Silicofluoride use: p = .0177, F 5.63

Interaction effect:: silicofluoride use AND 1st Draw Lead in Water: p = .0422, F 4.18

how responsible public health authorities could object to a moratorium on silicofluoride usage pending tests that demonstrate conclusively their safety. The data cited here indicate that such a step might well make a large contribution to reducing children's blood lead levels and associated problems of health and behavior. Even more important, this action could have especially large benefits for thousands of Blacks living in poverty in many American cities.

III. Mechanisms of Fluoride Action to Reduce Tooth Decay

As noted above, the CDC Working Group repeatedly claims that "Fluoridated Drinking Water" reduces dental caries without mentioning the specific chemicals used. Given evidence that silicofluorides seem to be associated with harmful effects on health and behavior, the benefits attributed to fluoridated water in *Recommendations for Using Fluoride* also deserve more careful attention.

> "Fluoridated drinking water contains a fluoride concentration effective for preventing dental caries… When fluoridated water is the main source of drinking water, a low concentration of fluoride is routinely introduced into the mouth. Some of this fluoride is taken up by dental plaque; some is transiently present in saliva, which serves as a reservoir for plaque fluoride, and some is loosely held on the enamel surfaces."

This mechanism is, apparently, essential for the conclusion that "fluoride is both safe and effective in preventing and controlling dental caries, … the work group recommends that all persons drink water with an optimal fluoride concentration and brush their teeth twice daily with fluoride toothpaste." Did the Work Group that authored this report ignore the possibility that their conclusion is contradicted by other data in *Recommendations for Using Fluoride* on the mechanisms by which fluoride reduces tooth decay?

To assess claimed benefits of water fluoridation, it is essential to consider the mechanisms of action according to the *Recommendations for Using Fluoride* in the light of debates in the scientific community. Dr. Hardy Limeback, former President of the Canadian Dental Association, has recently challenged the view that water fluoridation is beneficial by arguing that the benefits of fluoride only occur due to topical applications of fluoride or fluoride compounds on the tooth surface. According to his analysis, the ingestion of fluoride – usually assumed to be the mechanism associated with fluoridated drinking water – does not contribute significantly to reduced tooth decay.[26] If so, the use of fluoridated toothpaste, other products (such as gels, varnish, or mouthwash with fluoride), or diet and overall life-style changes would account for the observed fall in rates of caries over the last half-century. And fluoridating public water supplies would have at best a minimal effect in reducing tooth decay.

The relevance of this issue was recognized in the CDC's *Recommendations for Using Fluoride*, which explicitly states that "Fluoride concentrated in plaque and saliva inhibits the demineralization of sound enamel and enhances the remineralization (i e., recovery) of demineralized enamel, As fluoride concentrates in dental plaque, it inhibits the process by which cariogenic bacteria metabolize carbohydrates to produce acid and affects bacterial production of adhesive polysaccarides." (p. 5). Moreover, the report notes that the current view of this process differs from hypotheses in "the earliest days of fluoride research," which attributed the benefits of fluoride to its effects when "incorporated into developing dental enamel (i.e., preeruptively).".

In this context, the *Recommendations for Using Fluoride* of the CDC explicitly presents research findings directly relevant to the effectiveness of water fluoridation:

> Saliva is a major carrier of topical fluoride, The concentration of fluoride in ductal saliva, as it is secreted from salivary glands, is low --- approximate 0.016 parts per million (ppm) in areas where drinking water is fluoridated and 0.0006 ppm in nonfluoridated areas (*27*)…. This concentration of fluoride is not likely to affect cariogenic activity. However, drinking fluoridated water, brushing with fluoride toothpaste, or using other fluoride dental products can raise the concentration of fluoride in saliva present in the mouth 100- to 1,000-fold. The concentration returns to previous levels within 1—2 hours but, during this time, saliva serves as an important source of fluoride for concentration in plaque and for tooth remineralization (*28*).[27]

Since fluoridated water itself only increases the levels of fluoride in saliva by a factor of about 2.7 times, whereas tooth brushing with fluoride toothpaste can increase fluoride in saliva between 100 and 1000 times, it appears – though it is not explicitly stated – that ingestion of fluoride is probably not particularly beneficial. Although fluoridated toothpaste and other "fluoride dental products" seem to be effective ways to increase fluoride in saliva, no data are presented to show that the *combination* of fluoridated toothpaste and fluoridated water is significantly more efficacious in this regard than fluoridated toothpaste alone.[28] In short,, the mechanisms by which fluoride compounds can reduce caries seem to be most dependent on topical applications, with at best only a minimal role of ingested fluoride from public water supplies.

While this summary indicates the importance of fluoridated tooth paste, gels, or varnishes as well as regular treatments by dental professionals, in *Recommendations for Using Fluoride* the CDC Work Group treats fluoridating public water supplies as an indispensable aspect of community dental health and public policy. Why should this be? Quite apart from the question of the chemicals chosen for use when fluoridating public water supplies, the need for this practice seems to differ depending on the overall risk of tooth decay: "Children and adults who are at low risk for dental caries can maintain that status through frequent exposure to small amounts of fluoride (e.g., drinking fluoridated water and using fluoride toothpaste). Children and adults at high risk for dental caries might benefit from additional exposure to fluoride (e.g., mouth rinse, dietary supplements, and professionally applied products)." [29] Although some proponents of water fluoridation have suggested that the policy is particularly beneficial for those poor who do not adequately care for their teeth or receive oral health services, the foregoing passage implies that the largest relative benefits will accrue to those at lowest risk for dental disease. Just who actually benefits from public water fluoridation?

IV. Does Water Fluoridation Help the Poor?

After noting that reported prevalence of dental caries among 12 to 17 year old children in the U.S. has "declined from 90.4% in 1971-1974 to 67% in 1988-1991," the text notes that "decreases in caries prevalence and severity have been uneven across the general population." The reasons for differential risk have sometimes been used to justify fluoridating public water supplies: "Populations believed to be at increased risk for dental caries are those with low socioeconomic status (SES) or low levels of parental education, those who do not seek regular dental care, and those without dental insurance or access to dental services." By implication, the uneducated poor are more likely to have tooth decay because they lack access to dental treatment and don't care properly for their teeth. For these groups, therefore, the CDC *Recommendations for Using Fluoride* (like other statements in favor of water fluoridation) implies that even if fluoridated water has only a marginal effect on saliva, the practice of fluoridating public water supply is likely to be beneficial. Data from several scholars, including individuals who favor fluoridation, have challenged this assumption empirically.[30]

Two articles published in the *American Journal of Public Health* after the CDC *Recommendations for Using Fluoride* challenge this assumption, suggesting that fluoridating public water supplies is not always effective as a way to improve the dental health of our disadvantaged poor,. One of these articles suggests that part of the problem of tooth decay among the poor – and especially poor from racial minoriy groups – arises from discriminatory practices in the provision of services by the dental profession.[31] Because this report provides data at variance with the analysis of the CDC Working Group, it will be useful to cite the Abstract in full:

> " *Objectives*: This study aimed to gain insight into the experiences, attitudes, and perceptions of a racially and ethnically diverse group of caregivers regarding barriers to dental care for their Medicaid-insured children.
>
> *Methods* Criterion-purposive sampling was used to select participants for 11 focus groups, which were conducted in North Carolina. Seventy-seven caregivers of diverse ethnic and racial backgrounds participated. Full recordings of sessions were obtained and transcribed. A comprehensive content review of all data, including line-by-line analysis, was conducted.
>
> *Results*. Negative experiences with the dental care system discouraged many caregivers in the focus groups from obtaining dental services for their Medicaid-insured children. Searching for providers, arranging an appointment where choices were severely limited, and finding transportation left caregivers describing themselves as discouraged and exhausted. Caregivers who successfully negotiated these barriers felt that they encountered additional barriers in the dental care setting, including long waiting times and judgmental, disrespectful, and discriminatory behavior from staff and providers because of their race and public assistance status.
>
> *Conclusions*. Current proposals to solve the dental access problem will be insufficient until barriers identified by caregivers are assessed. (*Am J Public Health*. 2002; 92:53-58)"

The implications of these findings are potentially explosive. Could it be that the dental profession has favored water fluoridation in order to deflect possible criticisms from populations at risk for tooth decay who are not adequately served by dentists? Does the analysis of the CDC Working Group blame the victims, thereby making water fluoridation the most effective means of helping groups in the population who do not help themselves?

This question is reinforced by the evidence of high rates of tooth decay among the Black population of Harlem. Since New York City's water is treated with silicofluorides, one might assume that the problems of poor dental health among the poor are reduced to some degree thanks to water fluoridation. The second of the articles in the latest issue of the *American Journal of Public Health* provides data flatly contradicting that expectation.[32] Once again, it will be useful to cite the Abstract in full:

> " *Objectives*: Profound and growing disparities exist in oral health among certain US populations. We sought here to determine the prevalence of oral health complaints among Harlem adults by measures of social class, as well as their access to oral health care.
>
> *Methods*. A population-based survey of adults in Central Harlem was conducted from 1992 to 1994. Two questions on oral health were included: whether participants had experienced problems with their teeth or gums during the past 12 months and, if so, whether they had seen a dentist.
>
> *Results*. Of 50 health conditions queried about, problems with teeth or gums were the chief complaint among participants (30%). Those more likely to report oral health problems than other participants had annual household income of less than $900 (36%), were unemployed (34%), and lacked health insurance (34%). The privately insured were almost twice as likely to have seen a dentist for oral health problems (87%) than were the uninsured (48%).
>
> *Conclusions*. There is an urgent need to provide oral health services for adults in Harlem. Integrating oral health into comprehensive primary care is one promising mechanism." (49)

Once again, failure of the dental profession to provide "oral health services" is identified as a crucial problem -- and in this instance, water fluoridation by no means alleviates the problem.

Indeed, consideration of the finding that silicofluoride treated water enhances lead uptake may help explain the severity of the dental disease among Blacks in Harlem. Among Blacks in the U.S., perhaps due to lactose intolerance, calcium intake tends to be lower than average among Whites. Insofar as silicofluoride-treated water enhances uptake of lead from environmental sources (such as old housing with lead paint) and has worse effects for Blacks than Whites, it can be predicted that lead uptake in Harlem would be significantly higher than elsewhere in New York City. Lead, however, is itself a risk factor for caries and other oral health problems. Hence it might be the case that by enhancing uptake of lead from the environment, silicofluoride usage actually contributes to the severity of dental disease among Blacks in Harlem.

V. The Urgent Need for Further Study

From a strictly scientific perspective, all propositions concerning the fluoridation of public water supplies – whether supportive or critical of current policies -- must be viewed as falsifiable empirical hypotheses.[33] The puzzles outlined above indicate that the CDC, Dental Associations, and EPA have been committed to fluoridating public water supplies for so long that they seem unwilling or unable to consider the possibility that the chemical most frequently used for that purpose may be harmful rather than beneficial. Unfortunately, although we have called for a moratorium on the use of silicofluorides pending testing that demonstrates the safety of these toxic residues from the production of phosphate fertilizer and weapons grade uranium, both governmental scientists and dental authorities have refused to admit the possibility of error.

The refusal of officials to discuss the issue of silicofluoride safety is particularly disquieting. For example, in one case, an official of the Department of Health testified at a state legislative committee hearing that all water fluoridation was safe, but when invited after the hearing to participate in a university seminar on "Fluoridation Revisited," the official demurred on the grounds that he was not "expert." In another instance, the Director of a state Dental Society refused to appear at a university seminar on fluoridation because his association has endorsed the practice, the CDC *Recommendations for Using Fluoride* confirm endorsement of this policy, and he was unwilling to "redebate" it. Such attitudes are disconcerting in any public policy issue, but they pose serious ethical as well as scientific issues when new research findings call into question a practice that has never been properly studied.

The CDC's assertions of safety in the absence of adequate scientific testing along with their refusal to discuss the specific chemicals used in fluoridation along with is not new. Indeed, in 1951 (the year after silicofluorides were formally approved for use), the same rhetorical combination was explicit in a statement to a meeting of State Dental Directors with representatives of the Public Health Service and the Children's Bureau:

> "Now, in regard to toxicity – I noticed that Dr. Bain used the term 'adding sodium fluoride.' We never do that. That is rat poison. You add fluorides. Never mind that sodium fluoride business, because in most instances we are not adding sodium fluoride anyhow. All of those things give the opposition something to pick at, and they have got enough to pick at without our giving them any more. But this toxicity question is a difficult one. I can't give you the answer on it. After all, you know fluoridated water isn't toxic, but when the other fellow says it is, it is difficult to answer him… So when you get the answer on the question of toxicity, please write me at once, because I would like to know…"[34]

The speaker, Francis Bull of Wisconsin, was known as one of the most outspoken proponents of fluoridation and played a major role in the decision to fluoridate Madison, Wisconsin in 1947 (perhaps the first community to use a silicofluoride chemical agent)[35].

These rhetorical tactics of fluoridation supporters and persistent claims of safety by governmental agencies may explain why attempts to secure funding for animal studies of the neurochemical effects of silicofluoride treated water have not been successful. Today, both governmental bureaucracies and dental associations may have good reason to fear opening this issue to debate since the Clean Water Act establishes legal liability for causing water supplies to be polluted.[36] It follows that huge suits for tort liability might be filed should this provision b e extended to toxic effects like the hypothesis that silicofluorides harm brain chemistry and increase rates of learning disabilities, substance abuse and violent behavior.

It should be evident that, in a scientific age, such self-interest should not outweigh the social and human benefits of further study. If the “Neurotoxicity Hypothesis” with regard to silicofluorides is confirmed, many of the negative educational and behavioral outcomes among Blacks and other minorities (corresponding to racist stereotypes) would seem to be substantially aggravated by current water treatment practices. Moreover, even among middle class populations, the effect of lead uptake of rates of hyperactivity (“Attention Deficit Hyperactivity Disorder” or ADHD) is sufficient to call for careful consideration. For example, a recent study shows that over 70% of children diagnosed as having ADHD are receiving stimulant medications such as Ritalin.[37] Although such drug treatment of ADHD children provides a rapid improvement in behavior, recreational misuse of drugs like Ritalin not to mention the human and monetary costs of hyperactivity would more than justify ending treatment of public water supplies that apparently enhances lead uptake from the environment.[38]

This conclusion is further strengthened by the statistical evidence linking silicofluoride usage with higher rates of violent crime. Not only is there an association between counties in the US whose populations are exposed to silicofluorides and higher rates of violent crime, but multiple regression and other statistical tests show that this effect is highly significant after controlling for other factors traditionally linked to violent crime. Indeed, if the statistics in these analyses are correct, usage of silicofluorides for the purpose of water fluoridation would be unwise whether or not the CDC Work Group’s Recommendations on tooth decay are valid.

To conclude, there is great danger in the practice of relying on precedent and “argument from authority” to defend an established policy from scientific question. Even if the approval of silicofluorides in 1950 had been based on extensive scientific research, new theories and methods of analysis might lead to a different conclusion. Since our society has become so dependent on science and technology , it is imperative that bureaucratic resistence to research reconsidering an established policy be replaced by acceptance of scientific controversy as a necessary element in public policy. As the foregoing analysis of the CDC *Recommendations for Using Fluoride* has indicated, the public deserves careful reconsideration of the implications of new scientific evidence. The Health Committee of the New Hampshire State House of Representatives recently voted (13-0) for form a Committee for this purpose. Perhaps it would also be timely for hearings by the U.S. Congressional committee.

VI: CONCLUSION: Benefits of Listening to Science

By way of conclusion, it is useful to consider briefly an example from the past to illustrate the long term benefits of scientific findings that are used to block activities and practices of immense advantage to specific business or political interests. The ban on the sale of leaded gasoline was justified by the finding that lead is a neurotoxin that causes great harm to children. Among the negative effects now associated with lead uptake are lower intelligence (as measured by IQ scores), higher rates of learning disabilities, poor impulse control (hyperactivity), and higher likelihood of engaging in violent criminal behavior. While not all of these behavioral dysfunctions now associated with lead were fully established at the time the U.S. Congress banned the addition of Tetrethyl lead to gasoline, enough was known of the harmful character of this product to justify ending the benefits leaded gasoline generated for powerful industrial interests.[39] For example, General Motors held the patents on the production of Tetrethyl lead. Hence each gallon of leaded gasoline used in a Ford or Chrysler also benefitted GM. Whether anyone was aware of this advantage, the challenge to both the automobile industry (which had to redesign automobile and truck engines) and the oil industry was substantial, yet the Congress was not deterred.

The willingness to ban leaded gasoline despite its costs to powerful business interests turned out to have been especially prudent. As two recent studies have shown, the ban on leaded gasoline seems to have had an unanticipated benefit with a lag-time of about 17 years. Time series analyses indicate that ending leaded gas sales apparently had the effect – with a delay of over a decade -- of lowering rates of violent crime in the U.S. [40] Since the uptake of lead from the environment and its harmful effects are particularly severe early in infant development, it has been suggested that fumes or particles from leaded gas probably had serious effects on prenatal and early childhood brain development. Even though this precise link between early infant exposure and crime was unknown at the time, the ban on leaded gasoline is an excellent illustration of the benefits of basing public policies on the best available scientific findings even when they challenge establish policies and interests.

The current case suggests, however, that the obstacles to considering scientific findings that challenge an established public policy are far greater when the initiative and support for the policy has been largely based in government agencies. The practice of adding chemical compounds including fluoride to public water supplies ("fluoridation") was first introduced as an experiment in 1945. Intended to last 10 to 12 years, the experiment was ruled a success before completion and, since that time, both the CDC and the dental profession have assumed that fluoridation is an unqualified success as a means of reducing tooth decay.

POSTCRIPT (ADDED AUGUST 8, 2002)

Two developments occurred after the foregoing text was drafted during theWinter of 2002 First, Senator J. Bingaman of New Mexico introduced legislation concerning dental health (S.1626). : Section 301 (b) (3) of this bill includes the following provision:

> " (3) carry out activities to reduce the disease burden in high risk populations through the application of best-science in oral health, including programs such as community water fluoridation and dental sealants."

On learning of this proposal, I wrote Senator Bingaman and his legislative assistant in early July, 2002, proposing the following amendment to replace this section with new text as Section 301 (b) 4) after inserting a new text as subsection (3):

> "301 (b) (3) initiate and coordinate a national research program to determine safe, effective, and efficient policies of preventing dental disease and caries in the light of recent developments in biological and health science.
>
> a. Research in this program shall be administered by the National Science Foundation with funding of $10,000,000 for the fiscal years 2003 through 2005.
>
> b. Research projects in this program shall be chosen from proposals submitted to the National Science Foundation (NSF) for peer review.
>
> 1. For research projects addressing dental benefits, the NSF shall consult with the National Institute for Dental Research (CDC) and other appropriate offices of the Department of Health and Human Sevices prior to making final decisions.
>
> 2. For research projects addressing negative side effects and other costs, the NSF shall consult with the Food and Drug Administration (FDA) and other appropriate offices of the Department of Health and Human Sevices prior to making final decisions..
>
> 3. To insure the absence of negative side-effects, as with other drugs or medications, all compounds to be added to public water for fluoridation or other purposes shall be subjected to animal studies of possible harmful effects on health and behavior.
>
> 4. Pending demonstration of safety and effectiveness of the specific methods used in water fluoridation, and approval by the FDA, no untested chemical compound may be used in a public water supply system after December 31, 2002."

Current Section 301 (b) (3) is renumbered 301 (b) (4) and amended to read:

> "(4) based on the findings of research conducted under 301 (b) (3) and other scientific evidence, carry out activities to reduce the disease burden in high risk populations through the application of best-science in oral health.

As of this date, I have no indication of whether any version of this Amendment will be introduced when the Senate reconvenes after its August recess and S. 1626 is brought up in committee. It is my hope, however, that through such an Amendment or some other action, the Senate committee hearing on S. 1626 will include an opportunity for discussion and debate under oath with regard to the lack of scientific evidence for the safety of adding silicofluorides to public water supplies.

More recently, there has been a further development of great importance. The *Federal Register* for June 12, 2002 (Vol. 67, number 113, pp. 40319-49333) reported the “Announcement of and Request for Public Comments on Substances Nominated to the National Toxicology Program (NTP) for Toxicological Studies and on Study Recommendations Made by the NTP Interagency Committee for Chemical Evaluation and Coordination (ICCEC).” Among 14 substances for which “one or more types of toxicological studies are recommended" were "Hexafluorosilicic acid and Sodium hexafluoro-silicate - primary agents used to fluoridate public drinking water supplies."[41]

The precise wording of this nomination is directly germane to the issues under consideration:

“Substances Nominated to the NTP for Toxicological Studies and Recommendations Made by the ICCEC on April 17, 2002[42]

Table 1.--Substances Recommended for Study

Substance [CAS No.]	Nominated by	Nomination rationale; other information	Recommendations for toxicological studies
……..			
Hexafluorosilicic acid [16961-83-4] and Sodium hexafluorosilicate [16893- 85-9].	Private Individuals (multiple nominations).	Primary agents used to fluoridate public drinking water systems; lack of toxicity information; assumed complete dissociation to free fluoride under normal conditions of use not supported by experimental evidence.	--Chemical characterization studies to assess chemical fate under aqueous conditions; --Toxicological studies may be considered when results of chemical characterization studies are available for review.”

In the Federal Register announcement, the procedures related to “New Nominations for NTP Study” are described as follows:

> Evaluation by the NTP Interagency Committee for Chemical Evaluation and Coordination (ICCEC) is the initial external review step in the NTP's formal selection process for NTP study nominations. The ICCEC is composed of representatives from the Agency for Toxic Substances and Disease Registry,

> U.S. Consumer Product Safety Commission, Department of Defense, U.S. Environmental Protection Agency, U.S. Food and Drug Administration's National Center for Toxicological Research, National Cancer Institute, National Center for Environmental Health, National Institute of Environmental Health Sciences, National Institute for Occupational Safety and Health, National Library of Medicine, and the Occupational Safety and Health Administration. The ICCEC meets once or twice annually to evaluate groups of new study nominations and to make recommendations with respect to both specific types of studies and testing priorities."[43]

While it is impossible to predict the outcome, two comments are appropriate at this time.

First, it is extremely welcome that the National Toxicology Program's ICCEC has changed a 1999 decision and "nominated" silicofluorides on the list of substances needing additional toxicological study. If nothing else, this nomination confirms our statements concerning the absence of testing and knowledge concerning the safety of adding fluosilicic acid or sodium silicofluoride to a public water supply. To be sure, numerous concerned researchers believe that our research along with Westendorf's findings provide enough evidence to justify "toxicological studies" even in the absence of "results of chemical characterization," Perhaps more important, given our data, is the need to include behavioral toxicology in research on the potentially harmful effects of simultaneous exposure to silicofluorides and toxic heavy metals such as lead. Only time will tell the answers to the response of the various agencies concerned within the Department of Health and Human Services.

Second, this decision of the National Toxicology Program may – or may not – already have had an effect on the CDC. On the morning of August 8, 2002, I received a telephone call from the CDC asking for my title and confirmation of my mailing address in order to send a reply to my inquiry to the Secretary of Health and Human Services of last winter. Since the caller did not have substantive knowledge of the issues, she was unable to tell me whether the authors of the CDC reply were aware of the NTP action. I mentioned to her that this action is relevant to my request for a moratorium on the use of silicofluorides in public water supplies and that it might be embarrassing if a CDC communication were to ignore the grounds on which the NTP nominated silicofluorides for toxicological study.

I have no way of knowing the content of the communication that was the subject of this telephone call, nor can I tell how it might or might not be related to the NTP decision. Whether the CDC will modify the position stated in its "Guidelines" (see reference in note 1) is impossible to say. Hence this Postscript is a confirmation of the concluding remarks in Section VI above and provides unexpected factual evidence reinforcing the ethical responsibility of scientists whenever they become cognizant of research that calls for a fundamental reconsideration of established policies and programs.

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[1] CDC Office of Communication, Press Release: "CDC releases new guidelines of fluoride use to prevent tooth decay," August 16, 2001. URL: http://www.cdc.gov/od/oc/media/pressrel/4r010817.htm

[2] Fluoride Recommendations Work Group, "*Recommendations for Using Fluoride to Prevent and Control Dental Caries in the United States,* "*MMWR* (August 17, 2001) 50 (RR14): 1-42. URL: http:www.cdc.gov/mmwr/.

[3] CDC Press Release: "CDC releases new guidelines of fluoride use to prevent tooth decay," p. 1.

[4] Although sodium fluoride has been tested, critics point out that studies of this chemical do not adequately measure chronic effects and were sometimes contrived. As one critic put it (Albert Burgstahler, pers. com.): "I do NOT think NaF has been PROPERLY "tested for safety"! Yes, it has been "tested" in many carefully contrived experiments, but in the honest experiments, as by Mullenix, Varner, and others, it has FAILED the test for safety, even at 1 ppm! Short-term experiments sometimes seem to give it a clean bill of health, but chronic toxicity studies do not, even with the less sensitive laboratory rat." For an example of the research showing that even sodium fluoride is toxic, see: Mullenix, P. et al, (1995) "Neurotoxicity of Sodium Fluoride in Rats," *Neuorotoxicology and Teratology*, 17: 169-177. In the current context, however, the most striking point is that whatever the adequacy of tests of sodium fluoride, at least *some* testing of that compound was conducted whereas this has not been the case for the silicofluorides (which are now used for over 90% of water fluoridation in the U.S.).

[5] Letter of Robert C. Thurnau (Chief Treatment Technology Evaluation Branch, Water Supply and Water Resources Division, US EPA National Risk Management Research Laboratory, Cincinatti, Ohio) to Roger D. Masters, November 16, 2000. For the text of this letter, see www.dartmouth.edu/~rmasters/ahabs.htm

[6] Urbansky, Edward T. and Schock, Michael R., "Can Fluoridation Affect Lead (II) In Potable Water? Hexafluorosilicate and Fluoride Equilibria In Aqueous Solution," *International Journal of Environmental Studies,* 57 (2000) 597-637, available on the web at http://fluoride.oralhealth.org/papers/urbansky.pdf. This paper presents a critical analysis previously outlined in a Memoradum to Stan Laskowski, Director, Region III Environmental Services Division, US EPA, dated January 14, 1999 and entitled "Review of work by Roger Masters and Myron Coplan about the effects of common water utility fluoridation practices on (1) lead concentrations in drinking water and (2) the bioavailability of lead." In criticizing the first article in a series of research studies, on grounds of faulty methodology and presentation, Urbansky and Schock state its thesis inaccurately (see note 21 below).

[7] CDC, *Engineering and Administrative Recommendations for Water Fluoridation, 1995. MMWR* 44 (RR-13) (1995), 1-40 at p. 8. URL: http://wonder.cdc.gov/wonder/prevguid/m039178/entire.htm.

[8] E.g., CDC, *Achievements in Public Health, 1900-1999: Fluoridation of Drinking Water to Prevent Dental Caries, MMWR* (October 22, 1999) 48(4): 933-940.

[9] On the differences between silicofluorides and sodium fluoride, see Myron J. Coplan and Roger D. Masters, Guest Editorial: Silicofluorides and fluoridation," *Fluoride* 34 (2001), 161-164. See also Myron J. Coplan and Robert J. Carton, "Silicofluorides Should Not be Added to Municipal Water without Safety Testing Adequate to Protect children and Other Vulnerable Populations," Resolution proposed to the American Public Health Association, January 11, 2001 and idem, "Answers to APHA Oral health Section Response to Proposed Resolution, April 22, 2001.

[10] Feldman, I, Morkin, D, and Hodge ,HC. "The State of Fluoride in Drinking Water," *Journal of Dental Research,* 36:2 (1957) 192-202. The first sentence of this article confirms that, at the time of their approval in 1950, the extent of dissociation of silicofluorides injected in a water supply was unknown: "The widespread use of sodium silicofluoride in fluoridating drinking water has made it important to determine the state of the fluoride in such water, specifically, how much is fluoride ion, how much, if any, is unchanged silicofluoride, how much is fluoride bound to other ions. If all or nearly all of the fluoride is the ion F^-, the great body of information about the biologic effects of fluorides can be brought forward as a guarantee of safety. If considerable amounts of silicofluoride remain, a question can legitimately be raised since comparatively little work has been done on the biologic effects of silicofluorides." (192). Despite the authors' claim to present (in 1957) "experimental results," their analysis is essentially a theoretical extrapolation which does not provided a direct test of chemical and biochemical effects under conditions approximating actual usage. Compare the citation in the next note. As confirmation that U.S. governmental agencies (including the EPA as well as CDC) still lack scientific evidence on the chemical effects of treating public water with silicofluorides, a letter to the author, dated March 15, 2001 from Sally C. Gutierrez, Director, Water Supply and Water Resources Division, Office of Research and Development, National Risk Management Research Laboratory, U.S. EPA, Cincinatti, wrote of a meeting in January 2001: "Several fluoride chemistry related research needs were identified including; (1) accurate and precise values for the stability constants of mixed fluorohydroxo complexes with aluminum (III), iron (III) and other metal cations likely to be found under drinking water conditions and (2) a kinetic model for the dissociation and hydroloysis (sic) of fluosilicates and stepwise equilibrium constants for the partial hydrolyisis products. As a result of these discussions, ORD is exploring options to initiate research in the identified research areas."

[11] Johannes Westendorf, Doctoral thesis translated at: http//www.dartmouth.edu/~rmasters/ahabs. Evidence on the extent of SiF dissociation into its component elements is at odds with the assumption that SiF and NaF are equivalent sources of free fluoride when used for water fluoridation. A 1975 Ph.D. thesis (Westendorf, J), presented at the University of Hamburg, Germany, found that at physiological conditions and in the regime of 1 ppm fluoride, the dissociation of the silicofluoride anion $[SiF_6]^{2-}$ stopped when four of its six fluorides had been released If the dissociation had occurred equally among the SiF involved, the resulting incompletely dissociated species would be the anion $[SiF_2(OH)_4]^{2-}$. Although this product could account for the observed cholinesterase inhibition by so-called "non-competitive" mechanisms, the experimental data also indicates that other "residual compounds" are found in water after the dissociation of SiF has taken place. Due to such incomplete dissociation, use of SiF probably introduces toxic substances in public water supplies. ON effects of silicofluoride treated water,see Knappwost, A, and Westendorf , J, "Hemmung von Cholinesterasen durch Fluorokomplexe des Siliciums und des Eisens [Inhibition of cholinesterasse by fluorocomplexes of wsilicon and iron]" *Naturwiswsenschaften* 61 (1974) 275.

[12] Knappwost A, Westendorf J, "Hemmung von Cholinesterasen durch Fluorokomplexe des Siliciums und des Eisens [Inhibition of cholinesterasse by fluorocomplexes of silicon and iron]"

Naturwiswsenschaften 61 (1974) 275.

[13]*Recommendations for Using Fluoride*, p. 6. The reduction between 1971-74 and 1989-91 amounts to 23.4% of the overall incidence or about 26% of the earlier rate. No evidence is presented to compare increases in water fluoridation with increased sales of fluoridated toothpaste or other fluoridation modalities that might contribute to this outcome. As has often been noted, an uncontrolled time series comparison is subject to a very high risk of confounding covariation.

[14] Ibid., p.8.

[15] Ibid., p. 6. Although this list of factors does not specifically identify Blacks and other racial minorities as at higher risk for dental disease, others have made this link and related it to evidence that Blacks are denied dental treatment under Medicaid and confront discrimination from dental care providers (see the study cited in note 23 below).

[16] Figure 1 and its accompanying list of sources was prepared by Myron J. Coplan and is reproduced with his permission. It has been presented at a number of scientific meetings and included with memoranda to government officials.

[17] See notes 4 through 8 and 10 above.

[18] Safety standards and testing procedures for silicoflurides are established by a "stake-holder consensus" process managed by a private agency, NSF-International, a contractor to the EPA. A direct inquiry of senior staff of NSF-International revealed that neither NSF-I nor any agency it accepts as qualified to do standards compliance tests on silicofluorides has ever conducted animal studies of their toxicity. Specifications for SiFs are established for individual producers, individual plants of any producer, and for different processes of any one producer, all of which are treated as protected by proprietary rights of confidentiality. And only one sample per year needs to be tested for compliance with such individualized specifications with no regard for product variability from time to time within any year.

[19] Westendorf's Doctoral thesis,: http//www.dartmouth.edu/~rmasters/ahabs. At the biochemical level in a cell, Westendorf found that inhibition of cholinesterase enzymes by a silicofluoride was significantly stronger than by sodium fluoride and began to be expressed with no concentration threshold. By contrast, inhibition of acetylcholinesterase by sodium fluoride was not found until a threshold of fluoride was exceeded, and then did not increase with concentration at rates similar to those found when a silicofluoride was the agent. These results were found at fluoride concentrations in the parts per million range, and include exposures comparable to those of humans drinking silicofluoride treated water in the U.S. communities where it is used.

[20] Coplan, Myron J. and Masters, Roger D. August 12, 2000. "Is Silicofluoride Safe? Comments Re EPA Response to Rep. Calvert's Inquiry" Submission to Representative Kenneth Calvert, Subcommittee on Energy and Science, Committee on Science, U.S. House of Representatives. See also Coplan, Myron J. and Masters, Roger D., "Scientific Misconduct at EPA," Reply to Kenneth Calvert, Chair of Subcommittee on Energy and the Environment, U.S. House of Representatives, September 25, 2000; Coplan, Myron J. and Masters, Roger D., "Response to EPA Staff Unsupportable Dismissal of Evidence of Adverse Silicofluoride Health Effects, June 12, 2000.

[21] Masters, Roger D. and Coplan, Myron J., "Water Treatment with Silicofluorides and Lead Toxicity," *International Journal of Environmental Studies* 56 (1999) 435-449. In the criticism by

two EPA employees (memorandum of Urbansky and Schock to Laskowski, Jan. 14, 1999; note 6 above), the "main assertions" in this article are not stated accurately. Urbansky and Schock state: "The authors suggest that the hexafluorosilicate ion (SiF_6^{2-}) promotes the solubilization of lead (II) from the distribution system, thereby increasing the lead(II) concentration at the tap. In addition, they believe that residual SiF_6^{2-} is responsible for lowering gastric pH and therefore converting particulate lead(0) to bioavailable lead(II) ion or for complexing with Pb(II) to make it more amenable to permeating the gastric wall and being absorbed into the bloodstream." While the last phrase at least refers to the hypothesis that residues of silicofluorides enhance lead uptake, the claim that epidemiological findings of such an association is due to increase "solubilization of lead(II) from the distribution system" is contradicted by the data reproduced in Figure 13 of the present article.

[22] Masters, Roger D., Coplan, Myron J., Hone, Brian T, and Dykes, James E. "Association of Silicofluoride Treated Water with Elevated Blood Lead," *Neurotoxicology* , 21 (2000), 1091-1100.

[23] Masters, Roger D. and Coplan, Myron J., "A Dynamic, Multifactorial Model of Alcohol, Drug Abuse, and Crime: Linking Neuroscience and Behavior to Toxicology," *Social Science Information* 38 (1999), 591-624. Masters, Roger D., "Biology and Politics: Linking Nature and Nurture," in Nelson Polsby, ed., *Annual Review of Poliical Science* 4 (2001), 345-369.

[24] Denno, D. W. "Gender, Crime, and the Criminal Law Defenses," *Journal of Criminal Law and Criminology*, 85 (1994), 80-180; Needleman, H.L., Schell, A, Bellinger, D; Lenton A, Allred R.N. "The Long-term Effects of Exposure to Low Doses of Lead in childhood," *New England Journal of Medicine* 322 (1990), 83-88.

[25] Masters, R,, Hone, B, and Doshi, A. (1998). "Environmental Pollution, Neurotoxicity, and Criminal Violence," in J. Rose, ed., *Environmental Toxicology: Current Developments* (London: Gordon and Breach, 1998), pp. 13-48.

[26] Limeback, Hardy. "A Reexamination of the pre-eruptive and post-eruptive mechanism of the anti-caries effects of fluoride: is there any anti-caries benefit from swallowing fluoride?" *Community Dent. Oral Eidemiol.* 27 (1999) 62-71. For epidemiological evidence that fluoridating public water supplies has not actually had the benefits claimed by the CDC, see note 30 below.

[27] CDC, *Recommendations for Using Fluoride* p. 5. The citations are: reference 27: Oliveby A, Twetman S,. Ekstrand J., "Diurnal fluoride concentration in whole saliva in children living in a high- and a low-fluoride area," *Caries Res.* 24 (1990) 44-47; reference 28: Rölla G, Ekstrand J, "Fluoride in oral fluids and dental plaque," in Fejerskov O, Ekstrand J, Burt B.A., eds., *Fluoride in Dentistry,* 2nd Ed. (Copenhagen: Munksgaard, 1996), pp. 215-229.

[28] Ibid. This point is underscored later in the *Recommendations for Using Fluoride* in a general discussion of "combinations of fluoride modalities": "Studies comparing various combinations of fluoride modalities have generally reported that their effectiveness in preventing dental caries is partially additive. That is, the percent reduction in the prevalence or severity of dental caries from a combination of modalities is higher than the percent reduction from each modality, but less than the sum of the per cent reduction of the modalities combined…. For example, if the first modality reduces caries by 40% and the second modality reduces careis by 30%, then the calculaton that caries will be reduced by a total of 58% (i.e., 40% plus 18% [30% of the 60% decay remaining after the first modality]) will likely be an overestimate." Ibid., p. 13. Applying this approach to the figures presented for levels of fluoride in saliva (on the assumption that reductions in caries would

be proportional to this level) suggests that fluoridated public water supplies have virtually no significant additional effect on the caries reduction due to fluoridated toothpaste. No data are presented contrary to this inference.

[29] *Recommendations for Using Fluoride*, p. 6.

[30] De Liefde, B. (1998) "The Decline of Caries in New Zealand Over the past 40 Years," *New Zealand Dental Journal*, 94: 109-113; Colquhoun, J. 1987. "Child Dental health Differences in New Zealand," *Community Health Studies*, 11: 85-90; Colquhoun, J. 1997. "Why I changed my mind on Fluoridation." *Perspectives in Biology and Medicine*, 41:1-16. For data that the decline in tooth decay in non-fluoridated European communities paralleled that in fluoridated communities in the U.S., see Diesendorf, M. 1986. "The Mystery of Declining Tooth Decay," *Nature*, 322: 125-129. For a reexamination of the U.S. data, indicating no difference in caries incidence between children in fluoridated and non-fluoridated communities, see Youmouyiannis, J.A. (1990), "Water Fluoridaton and Tooth decay: Results from the 1986-87 National Survey of Us Schoolchildren," *Fluoride* 23: 55-67 (URL: http://www.dluoridealert.org/DMFTs.htm. On the issue generally, see Waldbott, G. L., Burgstahler, A. W., and McKinney, H. L., 1978. *Fluoridation: the Great Debate* (Lawrence, Kansas: Cofonado Press, Inc.); Paul Connett and Michael Connett (1999), "The Emperor Has No Clothes: A Critique of the CDC's Promotion of Fluoridation," *Waste Not #468,* (Canton, N.Y. Fluoridation Action Network).

[31] Mofidi, Mahyar; Rozier, R. Gary, and King, Rebecca S., "Problems with Access to Dental Care for Medicaid-Insured Children: What Caregivers Think," *American Journal of Public Health*, 92 (2002) 53-58.

[32] Zabos, Georgina P.; Northridge, Mary E.; Ro, Marguerite Jul., Trinh, Chau; Vaughan, Roger; Howard, Joyce Moon, Lamster, Ira; Bassett, Mary T; and Cohall, Alwyn T., "Lack of Oral Health Care for Adults in Harlem: A Hidden Crisis," *American Journal of Public Health*, 92 (2002) 49-52.

[33] E.g., Hempel, Carl G and Oppenheim, Paul, "The Logic of Explanation," *Philosophy of Science* (1948) 15: Popper, Karl, *The Logic of Scientific Discovery* (London: Hutchinson, 1959). On the weakness of post-modernist criticisms of scientific objectivity, especially as related to issues such as those posed in public policy, see Masters, Roger D., *Beyond Relativism* (Hanover, NH: University Press of New England, 1993).

[34] Francis Bull, *Proceedings, Fourth Annual Conference of State Dental Directors with Public Health Service and the Children's Bureau*, Federal Security Building, Washington, D.C.,June 6-8, 1951. URL: http://www.fortnecity.com/roswell/price/319/meeting6.jpg Bull was a leading activist pushing for the spread of fluoridation even before the comparison studies between several fluoridated and non-fluoridated communities, originally planned for ten years using sodium fluoride, were completed; "Dr. Bain" was the administrator responsible for these studies, which began in 1945 and were to run for 10-12 years.

[35] In Madison, Wisconsin, where Francis Bull was instrumental in a decision to begin fluoridation in 1947, the local water authority was unable to purchase sodium fluoride from the only major supplier, Alcoa Co. As a result, the Madison water system introduced

fluosilicic acid as the fluoridation agent. By 1951, after the approval of silicofluorides by the Public Health Service, Bull therefore was quite conscious of the chemicals involved when he said that "in most instances we are not adding sodium fluoride anyhow." On the history of fluoridation, see Andrew Rymer. *The (Political) Science of Fluoridating Public Water Supplies*. Senior Honors Thesis, Dartmouth College, Hanover, NH, 2000.

[36] Crawford, Colin, "Criminal Penalties for Creating a Toxic Environment: *Mens Rea*, Environmental Criminal Liability Standards, and the neurotoxicity Hypothesis," *Boston College Ednvironmental Affairs Law Review,*27 (2000), pp. 341-390.

[37] Rowland, Andrew S; Umbach, David M; Stallone, Lil; Naftel A. Jack; Bohlig, E. Michael; and Sandler, Dale P., "Prevalence of Medication Treatment for Attention Deficit-Hyperactivity Disorder Among Elementary School Children in Johnston County, North Carolina," *American Journal of Public Health*, 92 (2002) 231-234. This study is unusual as a virtually complete sample of "all children enrolled in grades 1 through 5" in the county, and it shows higher rates of medication for White children than for Blacks diagnosed with ADHD. But since Johnston county has no large cities -- communities range in size from Pine Level (population 953), Princeton (1034), or Four Oaks (1047) to Smithfield (7,288) -- silicofluoride water treatment is not a factor for most children, making it impossible to use this database to explore differential rates of ADHD.

[38] Winter, Dr. Sydney, *The Hyperactivity Hoax* (New York: St Martin's Press, 1998).

[39] Kitman, Jamie Lee; "The Secret History of Lead," *The Nation*, (March 20, 2000) 270: 11-44. As this survey points out, the studies cited as "scientific" evidence for the safety of tetrethyl lead were frequently severely flawed if not flagrantly dishonest. Indeed, the practices of both the Kettering Institute (a laboratory funded by General Motors) and the Public Health Service provide a striking parallel to the claims of the American Dental Association and the CDC.

[40] Masters, Roger, "Biology and Politics," in Nelson Polsby, ed., *Annual Review of Political Science* (Palo Alto: Annual Reviews, 2001), 4, 345-369. See also the parallel study by Nevin, Rick,

[41] Another fluoride compound was also on the list: "Nitrogen trifluoride - cleaning and etching agent in the semiconductor industry."

[42] *Federal Register*, June 12, 2002 (Volume 67, Number 113), pp. 40329-40333 at 40331.

[43] Ibid., p. 40330.