DENTAL CARIES AND FLUORIDATION IN NEVADA: A QUESTIONABLE PIERIAN SPRING REPORT?

SUMMARY: A recent cross-sectional dental caries survey of 4169 youths, aged 12–19, in the US State of Nevada found an association between living in a fluoridated area and being caries-free or having a lower DMFT score. However, socioeconomic status was not directly examined, and only the proxy of having dental insurance was included. When compared with official 2004 data from New Zealand and two other recent US studies, the data from the Nevada study do not provide firm support for an improved lower caries benefit from fluoridation.

Keywords: Critical co-factors; Caries research validity; Dental caries in Nevada; Pierian spring risk.

As abstracted in this issue of Fluoride (p. 253), a 2008–2009 dental caries survey in the State of Nevada in the USA of 4169 youths between the ages of 12 and 19 has been reported by Marcia Ditmyer and co-authors.\(^1\) Of these youths, 2045 were caries-free (control group) and 2124 had dental caries or decayed teeth (case group). Untreated decay (D) and DMFT (decayed, missing, filled) permanent teeth scores were computed for the 30% of the Nevada youth with the highest DMFT in the case group and compared to national averages.

Among the data tabulated for the two groups were sex (49% male, 51% female), age (12–15 and 16–19 age groups), dental insurance status, racial group (White and Black non-Hispanic and Hispanic), water fluoridation, second hand or current smoking status, and dental sealants. Significant differences between the case and control groups in the fluoridated and nonfluoridated areas were found in the mean DMFT scores for all these variables, and for all mean D scores except for gender.

In brief, 40% of the above-combined selected variables appeared to contribute to higher DMFT indices, with the strongest contributors coming from Hispanics and the higher 16–19-year-old group, and inverse correlations for youths living in a fluoridated vs. a nonfluoridated area and for having dental sealants. Contributions to increased caries from gender, second hand smoke, insurance status, and tobacco use were also “significant but to a lesser extent.”

Among the caries-free control group, 1324 resided in a fluoridated area and 721 in a nonfluoridated area, and among the DMFT case group, 580 lived in a fluoridated area and 1544 in a nonfluoridated area. The mean D score (untreated decay) in a fluoridated area was significantly lower (1.72/person) than in a nonfluoridated area (3.78/person), and the corresponding DMFT scores were 6.43 and 7.30, respectively.

Taken at face value, these differences suggest a definite anti-caries benefit from fluoridation in Nevada. When looked at more closely, however, this conclusion becomes questionable. First, as the authors note, most of the fluoridation in Nevada began after 1999 and is largely confined to Clark County in the southern part of the State where the largest cities of Las Vegas and Henderson are located and 75% of the State population reside. Thus the exposure to fluoridated water was limited to about 9 years in the largely urban fluoridated area, and the nonfluoridated areas elsewhere in the State are mainly rural. Moreover, socioeconomic status (SES) and access to dental care are likely to differ between such areas but were not addressed directly. Although the dental insurance variable was used as a proxy for SES, it was acknowledged that this was not very detailed. The presence of a larger difference between those in the fluoridated and the nonfluoridated areas in the D scores (1.72 vs. 3.78, test statistic 15.55, p<0.01) than in the DMFT scores (6.43 vs. 7.30, test statistic 14.20, p<0.01) is consistent...
with those in the fluoridated area having greater access to dental care which is associated with a higher SES.

Moreover, the increased caries rates of the older 16–19-year age group in a fluoridated area compared to that age group in a nonfluoridated area also call for closer scrutiny. In the Tiel-Culemborg study in Holland, for example, for whatever reason, the caries rates of the older children continued to increase in fluoridated Tiel but leveled off on nonfluoridated Culemborg.2-4 If due to delayed eruption of teeth, even by a few months, caries data in a fluoridated area can give misleading lower scores based on broad age groups. Delayed tooth eruption due to F exposure can, in part, account for apparent differences in tooth decay rates when measured in terms of DMFT.5

But of equal or even greater concern is that essentially only a single fluoridated area was involved in this study in Nevada. Similarly, in New Zealand, official data for 12-year-olds collected in 2004 purported to show a significant higher percentage of caries-free children (59.1%) in the fluoridated part of Waitemata compared with only 28.6% in the nonfluoridated part of Southland.6 However, the same data showed that 61.7% of children in the nonfluoridated part of Waitemata were caries-free compared to 31.0% in the fluoridated part of Southland. Similar findings for DMFT in the Northern region were also reported: 1.17 DMFT for the fluoridated vs. 1.68 for the nonfluoridated parts of the same area. However, the mean DMFT score of children in the entire nonfluoridated parts of South Island was 1.62 compared to 1.79 for children in the fluoridated parts. Thus, when caries data for a single fluoridated community are compared with data from entire nonfluoridated areas, the claims can be entirely misleading.

As further evidence for the validity of this concern, the role of SES and related disadvantages is also apparent in the New Zealand data. For example, in the fluoridated part of Waikato, 26.9% of Maori children were listed as caries-free compared to 34.6% of children classified as Other (non-Maori, non-Pacific Islander). Indicating independence from fluoridation, similar data from the nonfluoridated part of Waikato showed that 24.9% of Maori children were caries-free compared to 34.6% of children classified as Other.

Finally, it is worth noting that the dental literature cited by the authors of the Nevada study is also very selective. Understandably, references to research related to various aspects of the study are cited, but references to recent research showing little or no benefit from water fluoridation are completely absent. For example, two recent papers by leading US dental researchers showing no dental health benefit from ingested fluoride are not referred to. In the recent Iowa Fluoride Study, Levy and co-workers found no association between fluoride intake and caries experience with the caries rates at ages 5 and 9 being similar for all levels of fluoride intake.7 Their “findings suggest that achieving a caries-free status may have relatively little to do with fluoride intake” and that recommending an “optimal” fluoride intake was problematic. Earlier, in 1990, Yiamouyiannis had already confirmed this conclusion with his detailed analysis of the 1986-1987 US National dental caries survey of 39,207 US schoolchildren, aged 5–17, of whom 17,336 were life-long residents in the 84 communities surveyed.8 Recently, Iida and Kumar re-analyzed the same and additional data for children aged 7–17, of whom 16,689 were identified as having a history of single continuous residence.9 Although dental fluorosis became more prevalent as the water fluoride concentration increased, as is clear from the Figure below, no difference was seen in the percentage of children with dental caries experience in their permanent teeth in relation to different water fluoride levels.
A similar figure can be obtained from the data in Tables 2 and 5 of the 1997 analysis by Heller et al. of the same 1986–1987 National Survey.11

Osmunson also found a lack of effectiveness for fluoridation. His studies, of the 39 counties in Washington State and of the whole population of the fifty USA states and the District of Columbia, showed no evidence that dental decay decreased with increased fluoridation. There was a lack of correlation between the percent of the population exposed to fluoridated water and the quality of the teeth. In contrast, SES factors were of overriding importance. The reporting of very good or excellent teeth was more frequent in those with a high income than in those with a low income.12

Although, at first glance, the study on the prevalence of caries in Nevada youth might suggest that exposure to fluoridated water would be helpful, some caution is necessary. As already noted, the Nevada study did not directly assess important SES factors, and its findings are at variance with those of two recent US studies based on good quality data showing no beneficial dental effect from water fluoridation. Two additional research contributions in this issue of *Fluoride* are also relevant. In her review, Clinch found that not only did fluoride added to drinking water have no antibacterial effects on the bacteria involved in cariogenic activity but that *in vivo* evidence with the fluoride concentrations commonly used in fluoride toothpastes (500–1500 ppm) followed by mouth rinsing with water failed to show any clinically significant effect on these bacteria.13 This review indicates that fluoride in either water or toothpaste has little effect in reducing dental caries by killing or slowing down the metabolism of the bacteria that contribute to dental caries. Despite topical fluoride from toothpaste not having a significant bactericidal action, there is evidence from many randomized control trials that fluoride in topical dentifrices, depending on the presence of adequate levels of salivary calcium and phosphate, may help promote remineralization of dental enamel and thereby increase resistance to tooth decay.14 Without enough

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**Figure.** Percentage of continuous single residence children, aged 7–17, in the 1986–1987 US National dental survey with dental caries experience and very mild, mild, moderate, or severe (but not questionable) dental fluorosis in relation to different water fluoride levels. Based on a figure by Thiessen10 for which the numerical values were taken or calculated from the data in Table 1 of Iida and Kumar.8
calcium present, elevated exposure to fluoride has been shown to be associated with increased rather than decreased dental caries. In a second article, Mansfield reported that 25% of the population in the UK has a fluoride intake from all sources that exceeds the safe intake level defined by the Committee on Medical Aspects of Food Policy, regardless of the water fluoride concentration, and that this proportion increases to 65% in areas supplied with fully fluoridated water.

In this situation, the words of Titus Petronius Arbiter in the Satyricon, from the late 1st century AD, which were expanded on by Alexander Pope in 1709, are appropriate. They refer to a spring in Piera, in ancient Macedonia, which was considered to be the fountain of knowledge of art and science that inspired whoever drank from it. A cautionary note about acting on initial impressions is given by Pope in his poem “An essay on criticism”:

A little learning is a dang’rous thing;
Drink deep, or taste not the Pierian spring.

Since the relationship between fluoridation and dental health is complex, deep, not superficial, knowledge is required when assessing the validity of findings from caries research.

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