PREVALENCE OF DENTAL CARIES AND ITS RELATIONSHIP WITH TRACE ELEMENTS PRESENT IN DRINKING WATER AMONG 12 YEAR OLD CHILDREN IN RURAL AREAS OF ANDHRA PRADESH, INDIA

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ABSTRACT

AIM: The purpose of the present study was to assess the relationship of trace elements present in drinking water and dental caries in children aged 12 years in rural areas of Andhra Pradesh India. **MATERIAL AND METHODS:** A cross-sectional study was conducted among 451children aged 12 years. Clinical examination was carried out and caries experience was recorded. Drinking water samples were collected and subjected to trace element analysis using ICP-MS equipment. Oneway ANOVA, Chi-square test, Pearson's correlation coefficient and Multiple Logistic Regression were used for the statistical analysis. **RESULTS:** A statistically significant relation was found between caries and trace elements like Vanadium ($p<0.001$), strontium ($p<0.001$) and lead ($p<0.01$) in the drinking water. **CONCLUSION:** It may be postulated from this study that a mixture of trace elements such as fluorine, strontium, boron, and molybdenum may work together to retard caries.

KEYWORDS

Dental caries. Trace elements. Drinking water. Prevalence.

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INTRODUCTION

Tooth decay is a major oral health problem in most of the countries, affecting 60-90% of school children and the vast majority of adults. If left untreated, tooth decay can result insubstantial morbidity due to pain, dysfunction and poor appearance.[1] Different studies have established that the addition of fluoride to drinking water substantially reduces the prevalence of drinking water. Although the status of fluoridation as a public health measure is unquestionable, fluctuations in caries prevalence both within the country and between countries can be of such anorder that even with the benefits of fluoridation can remain in some places a problem of some magnitude.[1]

Individuals who are impoverished experience a disproportionately high burden of dental caries. One approach to this problem would be to attempt to determine the factors involved in producing the large differences in caries prevalence which have been shown to occur between places where low fluoride waters are used.[1]

Trace elements are known to have a role in metabolic processes of humans and who sedaily requirement is less than 100mg. Water and foods, especially unrefined foods are the major sources of trace elements. From the discovery of iron and then iodine as elements essential to life the study of trace elements has developed into an extensive field of research.[2] There was growing awareness of the need for an adequate intake of fruit and vegetables demonstrated by epidemiological studies. The beneficial effects of these foodstuffs are thought to reflect their importance as sources of micronutrients. This has led to an upsurge in interest in the metabolism and biological functions of trace elements and vitamins. The role of trace elements in the development of tooth decay has been an area of study since the identification of fluoride's protective effects.[2]

Regional differences in water and food choices may contribute information, as to which trace elements other than fluorine can affect caries development.[2]The recognition of the caries inhibiting effect of minute amounts of fluoride in the drinking water has stimulated interest in the possible effects of other trace elements or micronutrients on dental pathology.[3] Thus the purpose of the present study was to assess the relationship of trace elements present in drinking water and dental caries in children aged 12 years in rural areas of Andhra Pradesh, India.

MATERIAL AND METHODS

The present study was a cross-sectional observational study. Study population consisted of 451 children aged 12 years from 2 villages each of Warangal and Vishakapatnam districts of Andhra Pradesh. These two regions have almost similar levels of fluoride in the

water but the caries prevalence is markedly different. From the selected regions two areas whose data was available were selected randomly. Two villages were selected from each of the selected area using simple random sampling method. Permission to conduct the study was obtained from all the concerned authorities and ethical clearance was obtained from the institutional review board.

A written informed consent was obtained from the parents of all the children who were selected for the study. 12-year-old children who were permanent residents of Warangal and Vishakapatnam districts of Andhra Pradesh were included in the study. Data was collected through a special format designed exclusively for recording pertinent general information oral hygiene practices and clinical findings. The caries experience was assessed from the WHO dentition status and treatment needs (1997) .[4] Clinical examination was carried out in the school premises by the investigator herself who was trained and calibrated.

Six samples of drinking water from sources like tap water, hand pump, well etc. were collected in polyethylene bottles from each area of study so as to represent the geographical distribution of trace elements within practical limits. Water samples were collected according to the methods recommended by Chemical Division of Geological Survey of India, Hyderabad. The water samples were collected from the tap after a 3-minute run-off and after collection it was acidified with double distilled reagent-grade nitric acid to lower the pH and so to retain the elements in solution.

Analysis of the samples was undertaken by a standardized Inductively Coupled Plasma Mass Spectrometer (ICPMS) by trained personnel of the Chemical Division of the Geological Survey of India, Hyderabad. Fluoride levels were estimated using a fluoride ion selective electro decoupled with a standard pH meter. For each sample analysis were made of the concentrations present of twenty six minor elements. Of the twenty six values obtained the values of only eight elements were suitable for statistical analysis. These eight elements included Vanadium, Manganese, Iron, Copper, Zinc, Strontium, Lead, and Selenium.

The recorded data was entered into a standard Microsoft Excel 2003 and was analyzed using SPSS version 10.0. One way ANOVA, Chi-square test, Pearson's correlation coefficient and Multiple Logistic Regression was used for the analysis.

RESULTS

The present study was a cross-sectional study conducted to assess the relationship of trace elements present in drinking water and dental caries in children aged 12 years in rural areas of Warangal and Visakhapatnam District

of Andhra Pradesh. Table 1 shows the assessment of the relationship between trace elements present in drinking water and caries status of the children. A statistically significant relation was found with Vanadium ($p<0.001$), strontium($p<0.001$) and lead ($p<0.01$).

Table 2 reveals the Interrelationship between different trace elements present in drinking water. A statistically significant increase in the level of strontium with fluorine and a significant decrease in the level of manganese, iron, copper, zinc and lead($p<0.05$) was reported.

Multiple logistic regression (Table 3) of various factors affecting caries revealed a statistically significant association between caries and source of drinking water used ($p<0.05$) material used for cleaning teeth ($p<0.05$) fluoride content of water ($p<0.01$), Vanadium levels ($p<0.01$), Manganese levels ($p<0.01$) and strontium content ($p<0.05$) in the water.

DISCUSSION

The influence of trace elements on the prevalence of caries is a confused subject. However, sufficient evidence has been accumulated to suggest that it is a subject that justifies a continuing and expanding research effort. The recognition of the caries-inhibiting effect of minute amounts of fluoride in the drinking water has stimulated interest in the possible effects of other trace elements or micronutrients on dental pathology.[3] Trace elements influence the susceptibility to caries, by altering the resistance of the tooth itself or by modifying the local environment at the plaque tooth interface. Like fluoride, other elements can modify the chemical and physical composition of the teeth, especially the surface layers of enamel. They may alter the size of the enamel crystals available to acid exposure, thus influencing the solubility of the enamel.[1]

The effect of trace elements on dental caries susceptibility could not be evaluated without first recognizing the influence of fluoride in the water supplies. In the present study the fluoride content of the water supplies ranged from 0.4 to 1.8ppm. A caries inhibiting effect of fluoride ($p<0.001$) was noted for those children who consumed water containing >1ppm fluoride. Selenium is the only mineral element known that is present in food and forage crops insufficient amounts to make them lethal to animals and perhaps toxic to man.[5] Smith and Lillie postulated that, in man, a daily intake of 1.0 mg. of selenium/kg of body weight was dangerous and that continuous ingestion of food selenium in quantities as low as 0.2 mg/kg of body weight was potentially harmful.[6] Selenium was found to be equal in the drinking water supply of all the areas, and it failed to show any bearing on the prevalence and severity of dental caries in this study. Previous studies have indicated towards a cariogenic role of selenium.

Table 1. Relationship of different elements in drinking water with caries status in the study population.

Caries	No.	Fluorine	Vanadim	Manganese	Iron	Copper	Zinc	Strontium	Lead	Selenim
0 DMFT	330	0.9±0.5	4.2±2.8	9.3±20.2	136.2±70.7	3.8±3.9	129±133.7	461.5±150.3	3.2±0.9	<100
<3 DMFT	104	1.1±0.4	5.8±3.6	11.2±19.5	128.9±50.6	2.8±2.2	100.6±127.4	544.7±153.1	2.9±0.6	<100
>3 DMFT	17	1.2±0.4	5.3±2.9	10.9±18.3	110.5±47.5	3±2.1	101±111.4	482.8±163.5	2.8±0.4	<100
ANOVA	F	5.83	11.2	0.39	1.57	3.53	2.06	11.9	6.5	
	p	<0.01	<0.001	>0.05	>0.05	<0.05	>0.05	<0.001	<0.01	

Table 2. Interrelationship between different trace elements present in drinking water.

	Fluorine	Vanadium	Manganese	Iron	Copper	Zinc	Strontium	Lead
Fluorine	-	0.04	-0.25*	-0.44*	-0.27*	-0.46*	+0.15*	-0.29
Vanadium	-	-	-0.21*	0.04	0.03	-0.19*	+0.60*	-0.32
Manganese	-	-	-	0.01	-0.05	0.22*	-0.06	-0.23*
Iron	-	-	-	-	+0.51*	+0.40*	+0.40*	+0.42
Copper	-	-	-	-	-	+0.14*	0.06	-0.14*
Zinc	-	-	-	-	-	-	-0.01	+0.45*
Strontium	-	-	-	-	-	-	-	-0.24*
Lead	-	-	-	-	-	-	-	-

Vanadium is considered to be one of the more abundant trace elements and is widely spread in minute quantities. The levels of vanadium were found to be higher with high prevalence and severity of dental caries ($p<0.001$). There is a controversy on the effect of vanadium on dental caries. Hadjimarkos et al conducted an epidemiological survey in Wyoming and gave limited support for a protective effect of vanadium in man.[7]In the present study there was a highly significant association ($p<0.001$) between the level of zinc in drinking water and dental caries. The levels of zinc were found to be higher, with high prevalence and severity of dental caries. The literature on the role of zinc is rather sparse but it has been reported to have acrogenic effect. An inverse relationship was found between the levels of strontium in drinking water and dental caries status ($p<0.01$). These results are in agreement with a study conducted bycurzon et al in Ohio, USA.[8]

Copper in this study failed to show any definite trend of relationship with dental caries. There is a controversy in the literature on the effect of copper on dental caries.[9] Schroeder has demonstrated that there is a correlation between increased levels of copper in drinking water and the prevalence of cardiovascular diseases. The effect of high copper intake on caries prevalence must be considered at present to be unknown. In this

regard it is of interest that an independent evaluation by Adkins and Losee of water composition in relation to caries prevalence in 11 American states also showed increase in level of copper in communal water supplies where caries prevalence was highest.[10]

Table 3. Multivariate analysis - Multiple logistic regressions (Dependent variable: Caries).

	Model fitting criteria ratio tests2 log likelihood of reduced model	**Likelyhood ratio test**			
		Chi-square	Degree of freedom	Significance	p value
Intercept	133.9	0.00	0	-	
Sex	135.7	1.81	2	0.41	
Diet	135.4	1.39	2	0.50	
Staple diet	138.2	4.18	4	0.38	
Source of water	171.2	37.2	22	0.02	<0.05
Method of cleaning	136.8	2.77	2	0.25	
Material used for cleaning	139.6	5.65	2	0.05	<0.05
Frequency of brushing	138.8	4.87	4	0.30	
Fluoride	77.0	10.74	2	0.005	<0.01
Vanadium	71.1	4.98	2	0.01	<0.01
Manganese	71.7	4.98	2	0.03	<0.05
Iron	70.1	3.45	2	0.18	
Copper	70.7	4.07	2	0.13	
Zinc	69.1	2.89	2	0.3	
Strontium	72.9	6.25	2	0.04	<0.05
Lead	70.2	3.55	2	0.17	

The results of the present study have shown that there is an association between caries prevalence and the levels in water of fluoride, strontium, vanadium, and zinc at the concentrations in which they occurred in the public water supplies. It must however be borne in mind that the multiple trace analyses were on spot samples taken over years and would not have indicated any fluctuations that undoubtedly will occur on a daily or seasonal basis.

CONCLUSION

On the basis of several studies completed to date, it may be postulated that a mixture of trace elements such as fluorine, strontium, boron, and molybdenum may work together to retard caries. Conversely, Selenium, lead, and manganese either alone or in combination, may increase caries. Importantly, it may not be possible to find another single mineral element that will exert as great an anti-caries effect as fluoride. In future research on the effects of minerals on dental caries, our efforts should be directed to developing

mixtures of elements at optimal levels and in ratios to maximize their possible combined inhibitory effects on caries. Also, it is equally important to identify those mixtures of micro-minerals in foods or water supplies that exert acariogenic effect.

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