IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 15, Issue 1 Ver. X (Jan. 2016), PP 137-142
www.iosrjournals.org

Enamel defects seen among children residing near uranium mines. A case control study.

DrAdrijaKar, Dr Y RajmohanShetty, Dr. Amitha M. Hegde
A B Shetty Memorial Institute Of Dental Sciences.Derelakatte, Mangalore 575018 Karnataka India

Abstract:
Introduction:*Uranium in drinking water and food is known to cause many medical problems. Several studies have been conducted to enquire about the health of people around limestone, coal etc mining areas. But little has been known about the people around uranium mines. Hence this study was done to evaluate the enamel defects present among the children residing near uranium mines in the Gogi Village of Yadgir district in Karnataka.*
Methodology:*100 School children residing in Gogi village aged 6-12 who are exposed to uranium was categorised as the subjects of experimental group. Individuals beyond the age of 20 residing in the same area were taken as the control group. Enamel defects of deciduous teeth was recorded using developmental defects of enamel (DDE) index.*
Results:*The most frequently seen defect was yellow or brown opacities (41%) followed by discoloration other than opacities (36%).42% of children showed presence of enamel defects in multiple areas of tooth and when distribution of enamel defect was noted, it was found that the most prevalent area of distribution were the gingival and incisal surface (28%).*
Conclusion: *More studies should be conducted in different parts of the world near uranium mines to draw a definite conclusion.*
Keywords:*Enamel Defects, Uranium Mining, Dde Index, Chldren.*

I. Introduction

The heavy metal, Uranium is a naturally occurring radionuclide found in granite and other mineral deposits which enters local water and food supplies in different concentration through leaching from natural deposits. It can also be found in mill tailings, emissions from nuclear industry, phosphate fertilizers and during combustion of coal and other fuels. Natural uranium exists in the rock in the form of uranium ore which after mining becomes a yellow cake and gets converted into uranium hexafluoride. Depleted Uranium is a metal made up of uranium hexafluoride and is the by product of uranium enrichment process. Enriched uranium can be used for production of fuel and power plants while depleted uranium is used for mainly military purposes.[1]

Uranium in drinking water and food is known to cause many medical problems. It might cause severe kidney and lung problems. A study done among individuals in Canada , have shown that chronic ingestion of water containing uranium can be nephrotoxic and it affects the proximal tubule of kidney. In addition there are few reports on human studies where uranium has caused neurotoxicity, DNA-damage, musculoskeletal toxicity and pulmonary toxicity. Most of these effects are due to either radiation or inhaled dust containing uranium.

India is affected with numerous water quality problems due to various contaminants mainly of geogenic origin and fluoride stands first among them. The process of weathering of primary rocks and leaching of fluoride-containing minerals in soils results in fluoride rich groundwater in India .This water is generally associated with low calcium content and high bicarbonate ions, as is expected from uranium mining. Most of the scientific literature quotes the benefits of low fluoride concentrations in preventing dental caries. However, incidence of dental, skeletal and crippling skeletal fluorosis was reported in India even with an average fluoride concentrations as low as 0.5, 0.7 and 2.8 ppm respectively. Fluorosis, turns out to be the most widespread geochemical disease in India, affecting more than 66 million people including 6 million children under 14 years of age. [2]

All these reports and findings instil an inquisitive among the medical researchers to enlist the various health issues of the miners and their families and the local inhabitant of the area around mining. Several studies have been conducted to enquire about the health of people around limestone, coal etc mining areas. But little has been known about the people around uranium mines. Almost no study has been attempted worldwide concerning the oral health status of children residing near the uranium mines. Hence this study was done to evaluate the enamel defects present among the children residing near uranium mines in the Gogi Village of Yadgir district in Karnataka.

II. Methodology

100 School children residing in Gogi village aged 6-12 who are exposed to uranium was categorised as the subjects of experimental group. Individuals beyond the age of 20 residing in the same area were taken as the control group. Informed consent was taken from the school authority before commencement of the study. Children who have recently shifted to Gogi village and are not born there, children with systemic disorders, trauma and dental infections which can lead to enamel defects and children on drugs like tetracycline or any other medication which can cause staining of teeth were excluded from the study group.

A detailed medical history was taken to exclude the prevalence of any systemic disease or intake of medications that can lead to any staining of teeth. A single person observed the enamel defects to exclude bias.

Enamel defects of deciduous teeth was recorded using developmental defects of enamel (DDE) index given by FDI commission on Oral health, Research and Epidemiology, in 1982. Enamel defects were detected under natural light using mouth mirror and probe, and appropriate scores were given.

Chi square test was done to find any association with the case and control group, in relation to the enamel defect present. Fisher exact test was done to find any correlation between the type of enamel defect present between the study and control group. In addition, the prevalence of enamel defect was also calculated in percentages.

III. Results

Table 1: Distribution of study population

Age	gender		Total
	Male	Female	
6	4(10.8%)	3(4.8%)	7(7.0%)
7	4(10.8%)	9(14.3%)	13(13.0%)
8	1(2.7%)	3(4.8%)	4(4.0%)
9	13(35.1%)	19(30.2%)	32(32.0%)
10	7(18.9%)	19(30.2%)	26(26.0%)
11	8(21.6%)	10(15.9%)	18(18.0%)
Total	37	63	100

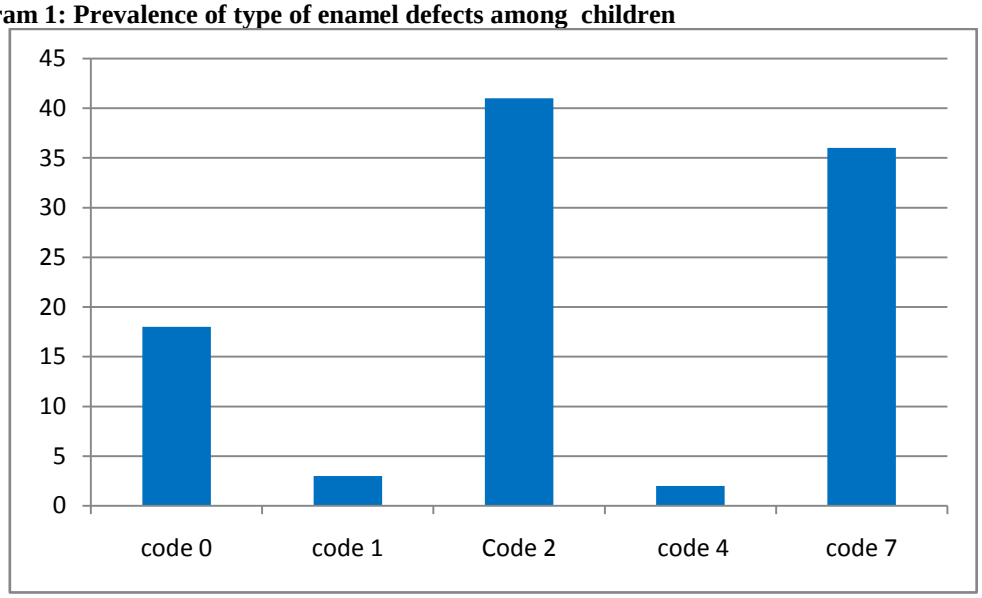
The study sample consisted of 100 children in the age group of 6 to 11 years out of which 37 were boys and 63 were girls.

Table 2: Distribution of enamel defects among study and control group

	Cases	Control	
Defect Present	82	5	77
No defect	18	95	113
Total	100	100	200
	Chi square value(df) - 120.6(1), P<0.001*		

Out of 100 children who participated in the study, 72 children showed presence of some enamel defects where as only 5 among 100 in control group showed enamel defects. The association between enamel defects and the study group was highly significant.($p<0.001$*)

Bar diagram 1: Prevalence of type of enamel defects among children



Code 0=normal;Code 1=opacity (white/cream);Code 2=opacity (yellow/brown);Code 4=hypoplasia(grooves:horizontal);Code 7= discoloured enamel(other than opacity)

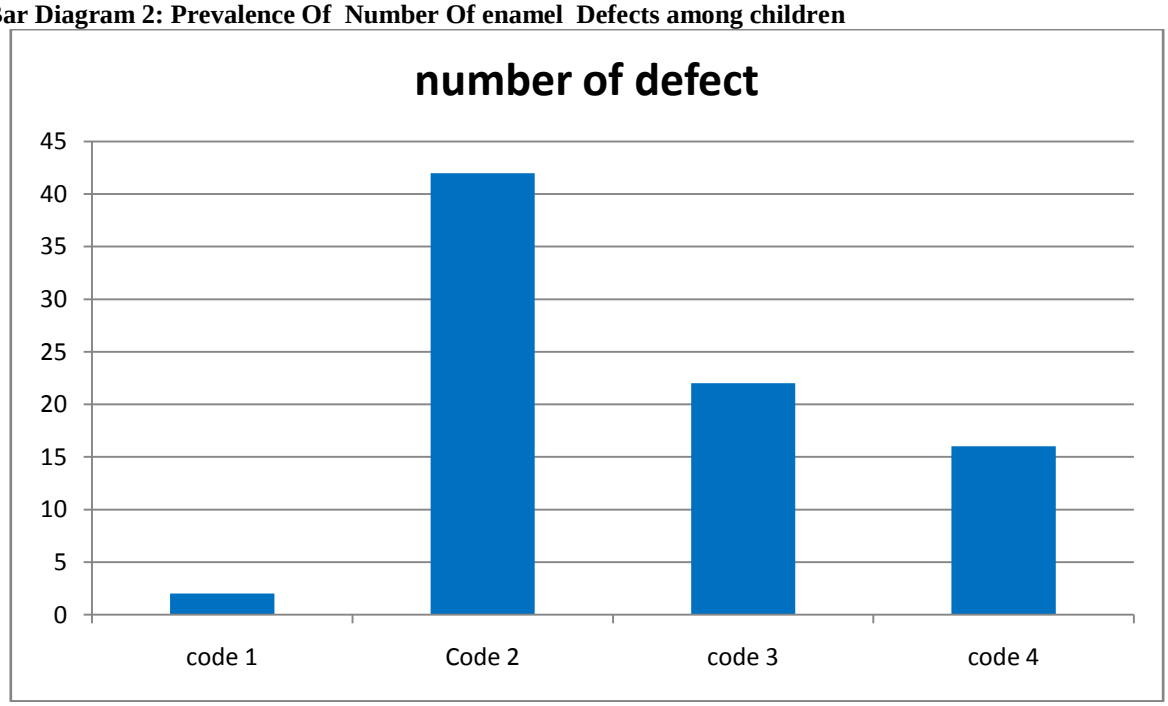
Table 3: distribution of type of enamel defects among study and control group.

Enamel defect	Study group	Control group
Code 0	18	95
Code 1	3	0
Code 2	41	5
Code 4	2	0
Code 7	36	0

Fisher's exact value=138.270, p<0.001*

Various types of enamel defect were seen among the study group. The most frequently seen defect was CODE 2 i.e yellow or brown opacities (41%) followed by CODE 7 i.e discolouration other than opacities (36%). When compared with the control group, all 5 adults showed CODE 2 enamel defects, i.e yellow or brown opacities. The result was statistically significant. P<=0.001*

Bar Diagram 2: Prevalence Of Number Of enamel Defects among children



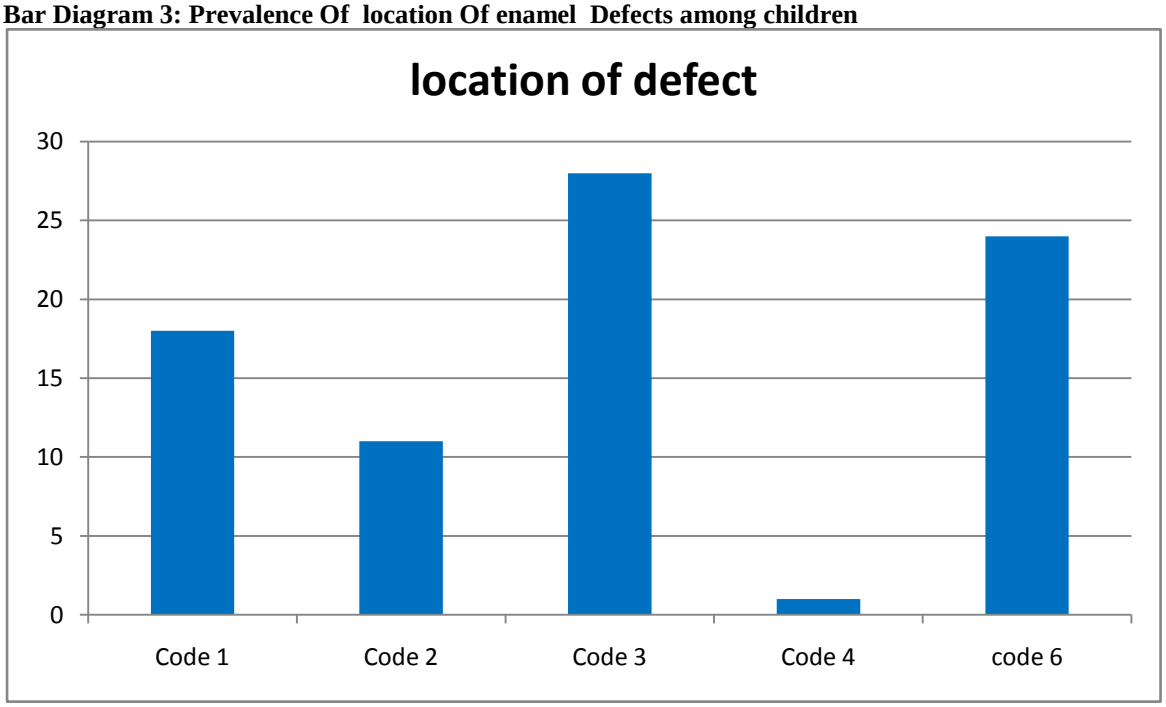
Code 1: single;Code 2: multiple;Code 3: diffuse (fine white lines);Code 4: diffuse (patchy)

Table 4: distribution of number of enamel defects among study and control group.

Number of defect	Study group	Control group
Code 1	2	0
Code 2	42	0
Code 3	22	5
Code 4	16	0

Number of defect seen among the study sample was categorized into single, multiple, diffuse (fine white lines) and diffuse (patchy).42% of children showed presence of enamel defects in multiple areas(CODE 2) of tooth followed by 22% showing diffuse fine white lines (CODE 3). Only 2% showed presence of single defect (CODE1). Among the control group all five adults showed diffuse fine white lines.

Bar Diagram 3: Prevalence Of location Of enamel Defects among children



Code1- Gingival ½;Code2- Incisal ½;Code 3- Gingival And Incisal Half;Code 4- Occlusal; Code 6- Whole Surface

Table 5:- distribution of location of enamel defect among children

Enamel defect	Study group	Control group
Code 0	18	95
Code 1	18	0
Code 2	11	2
Code 3	28	0
Code 4	1	0
Code 6	24	3

When distribution of enamel defect was noted, it was found that the most prevalent area of distribution was CODE 3 i.e gingival and incisal surface (28%) followed by CODE 6 presence of defect in the whole surface of tooth (24%), where as 3 individuals from the control group had the defect present in the entire tooth surface and two of them had in the incisal area.

Figure 2(a-h) : various enamel opacities seen among children in the study group.

IV. Discussion

Uranium and fluoride are often found together in the nuclear power industry, where uranium hexafluoride is used to enrich uranium mixtures and to increase their activity. After contact with moisture, including moisture in the air, uranium hexafluoride rapidly hydrolyzes to uranyl fluoride and hydrogen fluoride.[1] This could be a possible source of fluoride to the inhabitants of lands near uranium mines.

This study was undertaken to find out the prevalence of enamel defects among the children residing near uranium mines in a village named Gogi, in the Yadgir district of Karnataka, and also to mark if any remarkable changes are seen in the eruption timing of permanent teeth in those children. Results showed that 82% of the children showed enamel defects, out of which yellow brown opacities were predominant (41%). 100 Individuals above 20 years residing in the same area were taken as a control group and only 5 of them showed enamel opacities similar to the prevalent defect among children.

Any changes in the enamel is attributed to its susceptibility to an element or trauma at early stages of enamel formation. For example, teeth are more prone to fluorosis when they are in the early maturation stage of enamel development.[3] The permanent teeth (except third molars) are most susceptible to development of fluorosis during first 6-8 years of life.[4]Uranium mining was started in Gogi in 2007.Since enamel defects were not evident in elder age groups, there is a possibility that it could be due to the sudden availability of uranium in water, soil and food after commencement of uranium mining. The other possible reason could be the presence of fluoride as uranium hexafluoride is often found in the uranium mines to increase its efficacy. On dissolving in water, it can easily increase the availability of fluoride. Moreover the defects present in the study sample mimicked dental fluorosis which was present in all the teeth of affected individuals. But, 36% showed

discoloured enamel other than opacities, which decreases the chance of fluoride causing enamel defects in those children.

As given by Russel in 1961, mildest form of dental fluorosis and enamel opacities can be compared according to the area affected, shape of lesion, demarcation and colour.[5] Non fluoride enamel opacities are usually centered in smooth surface and may affect entire crown which was found in the conducted study. Moreover non fluoride enamel opacities are usually creamy yellow to dark reddish-orange in colour as found among children in Gogi village. These findings hints at uranium to be a possible target behind the opacities detected, but it cannot be confirmed as the shape of lesion were not discrete rounded or oval and they mostly mimicked line shading in pencil sketch as seen in dental fluorosis.

Few drawbacks or limitations which were faced during the study were, a small sample size could be involved owing to the lesser population and readiness of people to participate. Ever since the uranium mining was started in Gogi Village in 2007 various controversies regarding health hazards are being proposed, some of which might be just a myth. Uranium is an important source of energy and fuel and uranium mining could promote the economic development of the country and solve various other problems. This particular study was done not to demote the usefulness of mining but to create awareness about the prevailing effects, so that proper handling of waste materials can be done and people residing near those areas could take as much precautions possible.

V. Conclusion

From the study conducted, it can be concluded that 82% of study group showed presence of some form of enamel defects and the most common enamel defect seen was white or brown opacities.The enamel defects were present in multiple areas of the crown structure and The defects were mostly present on the gingival and incisal surface.

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