ORIGINAL RESEARCH PAPER
Volume - 14 | Issue - 01 | January - 2025 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

ASSESSMENT OF PREVALENCE AND SEVERITY OF FLUOROSIS AMONG THE TOBACCO USERS OF THE RURAL POPULATION OF NORTH KARNATAKA: A CROSS-SECTIONAL STUDY.

Community Medicine

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ABSTRACT

Background: More than 20 distinct forms or subtypes of cancer, heart and lung diseases, and a host of other debilitating illnesses are all significantly increased by tobacco use. Locally polluted drinking water is the primary source of fluoride. Gutkha (28–113 µg/g) and pan masala (16.5–306.5 µg/g) were shown to have high fluoride levels and to leach more fluoride when exposed to acidic environments, such as the stomach. In small doses, fluoride is believed to be a necessary chemical for human health. Exposure to excessive fluoride concentrations causes fluorosis, a deadly disorder. Dental and skeletal fluorosis are the two forms. The northern Karnataka district of Gadag is well-known for having a high prevalence of fluorosis. A study on the prevalence and severity of fluorosis among tobacco smokers has been chosen for the village of Lakkundi, where fluorosis is common and groundwater fluoride levels range from 1 to 4.4 mg/dl. **Methodology:** This community-based, cross-sectional study was carried out in Lakkundi village, Gadag district, over the course of a year, from June 2021 to June 2022. Data was gathered from a subset of households and targeted people who were at least eighteen years old. Using a 95% confidence level and a 5% margin of error, a sample size of 384 was determined based on a previous study that found a 52.3% prevalence of skeletal fluorosis among tobacco users. Following approval by the institutional ethical committee, a pilot study including 25 volunteers assisted in improving the instruments and procedures. Using systematic random sampling, 120 families were selected from 2,583 for the main study, choosing every 22nd household to meet the necessary sample size. Participants from these households who were older than 18 years were included. **Result:** According to research of 384 participants, the majority of participants (52.6%) were female, and the greatest age group (23.2%) was 28–37 years old. The majority of participants were either unemployed (38%), farmers (44%), or uneducated (28.9%). The majority belonged to Class 4 (38.3%) and Class 5 (38.8%) in terms of socioeconomic position. 37% of people used tobacco, especially men (21.6%) and people between the ages of 58 and 67 (15.4%). Clinically, 10.2% had an irregular gait, and 44% reported joint pain. Among tobacco smokers, there were statistically significant differences in the severity of dental (prevalence 31.1%) and skeletal fluorosis (prevalence 27.9%) ($p < 0.001$). **Conclusion:** The study found a strong statistical significance between a higher likelihood of moderate to severe skeletal and dental fluorosis and tobacco use. Because tobacco products contain fluoride, tobacco users had a higher correlation with severe fluorosis than non-users. These results highlight the necessity of focused public health initiatives to lower tobacco use, particularly in rural regions where fluoride exposure is high.

KEYWORDS

tobacco users, dental fluorosis, skeletal fluorosis, tobacco and pan masala, smokeless tobacco, Zarda, Ghutka, and Khaini, non-smokers, smokers.

INTRODUCTION

Tobacco use is a significant risk factor for over 20 different types or subtypes of cancer, cardiovascular and respiratory disorders, and numerous other crippling medical conditions. Nicotine is also highly addictive. Over 8 million individuals die from tobacco usage each year.[1]

The main source of fluoride is drinking water that has been contaminated locally. Yadav et al. observed that pan masala (16.5–306.5 µg/g) and gutkha (28–113 µg/g) had high fluoride levels and that these products leached more fluoride when exposed to acidic environments like the stomach. In addition to drinking water and food, the study demonstrates that other abundant sources of fluoride include tea, toothpaste, tobacco, and pan masala.[2]

The top limit of fluoride concentration in drinking water, as determined by the World Health Organization, is 1.5 mg/l. In contrast, the Bureau of Indian Standards points out that the maximum amount of fluoride that can be consumed is 1.0 mg/l.[4]

Fluoride, when present in small amounts, is thought to be an essential substance for human health. The dangerous condition known as fluorosis is brought on by exposure to high fluoride concentrations. There are two types of fluorosis: skeletal and dental.[3]

Dental fluorosis can result from prolonged exposure to high fluoride throughout infancy and children, when teeth are developing. This persistent ailment typically manifests as nearly invisible white streaks or lines or as brown or white discolorations on teeth. Pitting in tooth enamel can result from severe dental fluorosis. Skeletal fluorosis is also linked to long-term, high fluoride consumption. Its effects can include osteoporosis, muscular atrophy, neurological abnormalities, and infrequent joint discomfort or stiffness.[5]

According to the Indian government, fluoride prevalence was recorded in 230 districts across 19 states as of April 2014. However, 14 132 houses in the high-risk areas lacked access to safe drinking water. Official estimates place the population at risk at about 11.7 million, while non-governmental organizations caution that the threat is actually much more pervasive, affecting nearly 60 million people nationally.[6]

The districts of Mysore, Bellary, Chikkaballapur, Koppal, Davangere, Tumkur, Bagalkot, Bangalore (U), Bijapur, Raichur, Chitradurga, Gadag, Gulbarga, Hassan, Kolar, Mandya, Ramanagaram, and Shimoga have a high prevalence of fluorosis, according to NPPCF data.[7]

In India, the total prevalence of tobacco use is 10.38% for smokers and 21.38% for non-smokers, according to the Global Adult Tobacco Survey (GATS), which was conducted from 2016 to 2017. 28.6% of adults, 42.4% of males, and 14.2% of women now use tobacco, either in smoke or smokeless form.[8]

The Gadag district in Karnataka, situated in the northern region, is known for having high fluorosis prevalence. The village of Lakkundi, where fluorosis is prevalent and groundwater fluoride levels range from 1 to 4.4 mg/dl, has been selected for a study on the prevalence and severity of fluorosis among tobacco users.

Aims And Objectives

1. Assessment of prevalence of fluorosis among tobacco users.
2. Assessment of severity of fluorosis among tobacco users.

MATERIALS AND METHODS

Study Setting: The study was conducted in Lakkundi village of Gadag district.
Study Design: It is a cross-sectional, community-based study.
Study Duration: The study was conducted for a period of one year, from June 2021 to June 2022.
Study Population: It includes residents of the village who're older than 18 years.
Source Of Data: Data was collected from members of selected households..
Sample Size: Formula used for sample size calculation is,

$$n = \frac{z^2 \times p(1-p)}{e^2}$$

where
z is the z score = 95% confidence level

ε is the margin of error = 5%.
p is the population proportion = 52.
n is the final sample size calculated as 384.

Population proportion taken from previously conducted study by Saiprasad Get.al9, where the prevalence of skeletal fluorosis was 52.3% among tobacco users.

Ethical Consideration:
The study was initiated after obtaining approval from the institutional scientific committee and the institutional ethics committee of GIMS, Gadag.

Pilot study:
In the research area's Lakkundi village, a pilot study was conducted. 25 study participants were chosen, and information was gathered through an oral interview and a clinical examination. A single examiner administered each test. To reduce bias, the pilot study sample was left out of the final sample size.

Based on the result obtained from the pilot study questionnaire, methods of clinica

Sampling Technique:
A local primary health center survey indicates that there are 2583 homes and 12295 residents in the research area. A total of 384 study samples were selected from a total of 2583 households by systemic random methodology, 120 of which were selected based on a family size of 4.4 according to the 2011 Census, with 37.6% of the sample being under the age of 18 years (to exclude people under the age of 18 (37.6%), the overall sample size for the 120 houses under consideration is 528, i.e., 4.4×120=528.). Systemic random sampling was used to identify 120 households.

With Systemic sampling interval, $k = \frac{N}{n} = 21.5 \approx 22$
(Where N = total houses = 2583 n = total hoses selected = 120)

So, considering the sampling interval, every 22nd house of Lakkundi village was selected to collect a sample.

Family members of age more than 18 years were selected from 120 households.

Inclusion Criteria:
1. All selected study subjects of 18 years of age group and above & both genders that fulfilled the research criteria were included in the study.
2. Subjects who were willing to give consent to participate in the study.

Exclusion Criteria:
1. Subjects who are uncooperative for clinical examination during the study.
2. Subjects who are suffering from acute oral infections and severe general sickness, serious systemic diseases.
3. Study subjects who were less than 18 years of age.

Data Collection:
Data was collected after taking written informed consent from study subjects. Pre-designed, Pre-tested Performa is used for the collection of data by Interview and Clinical examination.

The first house was chosen by simple random method (**lottery method utilized to select first house)** then subsequent houses were selected by systematic random sampling (Sampling interval 22).

Dental Examination - Modified Dean's criteria used fora assessment of dental fluorosis.

Skeletal Examination - For Skeletal fluorosis was assessed using the three field tests,
a. Touching the toes without bending the knees,
b. Touching the chest with the chin,
c. Stretching the arms sideways and folding the arms to touch the back of the head.

Subjects who were unable to perform one test considered as mild form, those unable to perform two tests considered as moderate and those unable to perform all three tests considered as severe form of skeletal fluorosis.

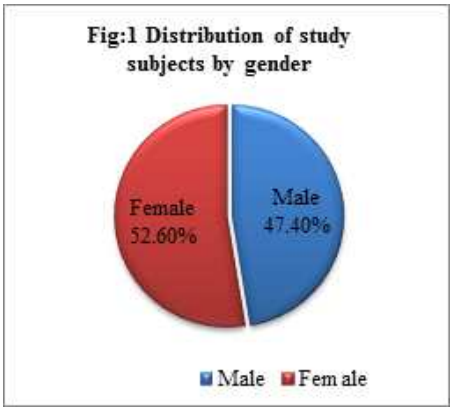
Statistical Analysis:
Data were entered into an Excel sheet, tabulated, and analyzed using the Chi-square test. The presentation of data was made using tables, graphs, and other figures. Jamovi software version 2.6.13, used for statistical analysis.

RESULTS
A total of 384 study participants were selected for the study. The distribution of all participants is as follows.

Table: 1 Distribution Of Study Subjects According To Age

Age	Number	Percentage
18-27	60	15.60%
28-37	89	23.20%
38-47	73	19.00%
48-57	64	16.70%
58-67	59	15.40%
68-77	35	9.10%
78-87	4	1.00%

The distribution of the study population by age groups is displayed in Table 1. The age group of 28–37 (23.20%) comprises the majority of the study individuals, followed by 38–47 (19.00%) and 48–57 (16.70%). 78–87 (1.00%) is the smallest age group in the population. The majority of the study population is younger.



The gender distribution of the study population is depicted in Fig. No. 1, with women constituting the majority (about 52.6%).

Table: 2 Distribution Of Study Subjects According To Education

Education status	Number	Percentage
Illiterate	111	28.90%
Primary school	74	19.30%
High school	73	19.00%
PUC/Diploma	95	24.70%
Graduate	28	7.30%
Post - graduate	3	0.80%

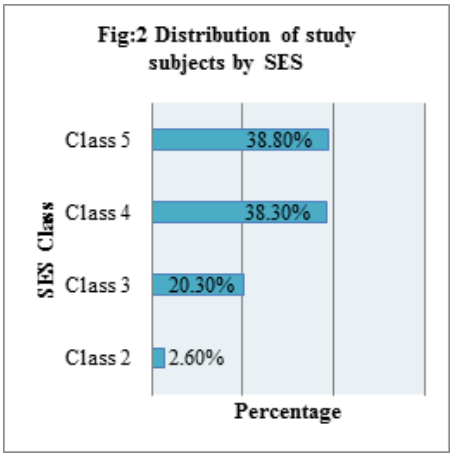
The distribution of study subjects by level of education is depicted in the above table. The highest percentage of study subjects are illiterate (28.9%), followed by those with a PUC or diploma (24.7%), primary school and high school (19.3% and 19%, respectively). Only 0.8% of people have postgraduate education.

Table: 3 Distribution Of Study Subjects According To Occupation

Occupation	Number	Percentage
Professional	19	4.90%
Semi professional	3	0.80%
Farmer	169	44.00%
Skilled worker	24	6.30%
Semiskilled worker	13	3.40%
Unskilled worker	10	2.60%
Unemployed	146	38.00%

Table 3 shows how the various occupations are distributed. The largest group is Farmers (44%), followed by the Unemployed(38%). Professional workers make up 4.9%, whereas skilled workers make up

up to (6.3%). Semiskilled workers make up 3.4% of the smaller group, while unskilled workers make up 2.6%.



According to the modified B G Prasad Scale, the above figure (no. 2) depicts the socioeconomic status distribution of the study population. Class 5 accounts for the majority of them (38.8%), followed by class 4 (38.3%), class 3 (20.3%), and class 2 (2.6%), which accounts for the least number of them.

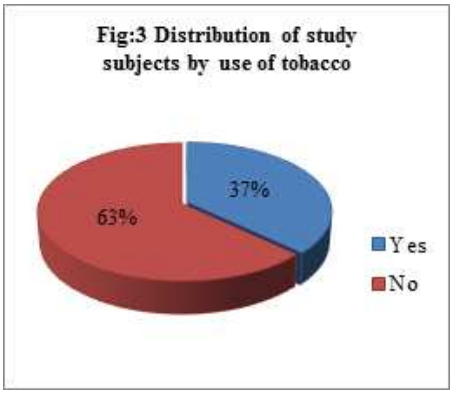


Figure No. 3 above shows the distribution of research participants based on tobacco usage. Of these, 37% smoke or use smokeless tobacco.

Table: 4 Distribution of study subjects according by tobacco users among various demographic factors

Factors		Number	Percentage
Age	18-27	1	0.30%
	28-37	5	1.30%
	38-47	18	4.70%
	48-57	23	6.00%
	58-67	59	15.40%
	68-77	32	8.30%
	78-87	4	1.00%
Gender	Male	83	21.60%
	Female	59	15.40%
Education status	Illiterate	64	16.70%
	Primary school	34	8.90%
	High school	16	4.20%
	PUC/Diploma	19	4.90%
	Graduate	8	2.10%
	Post - graduate	1	0.30%
Occupation	Professional	6	1.60%
	Semi professional	1	0.30%
	Farmer	76	19.80%
	Skilled worker	6	1.60%
	Semiskilled worker	2	0.50%
	Unskilled worker	2	0.50%
	Unemployed	49	12.80%
SES	Class 2	2	0.50%
	Class 3	28	7.30%
	Class 4	58	15.10%
	Class 5	54	14.10%

Based on a number of demographic variables, the distribution of study participants who use tobacco is shown in table (no. 4). The age range of 58–67 has the highest tobacco use (15.4%). Age groups 48–57 (6%), 68–77 (8.3%), and 38–47 (4.7%) were next. Males consume tobacco at a higher rate (21.6%) than females (15.4%). The majority of tobacco users (16.7%) are illiterate, followed by those with just completed primary school (8.9%), a university degree or diploma (4.9%), a graduate degree, and those who are the least educated among all (2.1%) and (0.3%). Among tobacco users, farmers make up the majority of this occupational category (19.8%), followed by unemployed people (12.8%). In terms of socioeconomic class, Class 4 tobacco users (15.1%) highest, followed by Class 5 (14.1%), Class 3 (7.3%), and Class 2 (0.5%).

Table: 5 Distribution Of Study Subjects According To Clinical Presentation

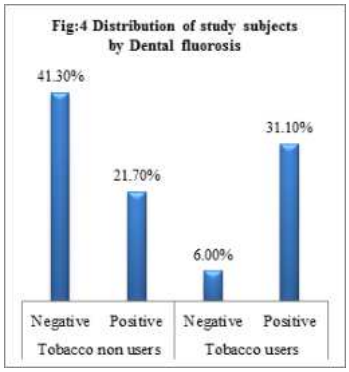
Clinical presentation	Sign/Symptoms	Number	Percentage
Joint mobility	Painful	169	44.01%
	Normal	215	55.99%
Joint deformity	Present	59	15.3%
	Absent	325	84.7%
Neck movement	Rigidity	5	1.3%
	Painful	93	24.2%
	Normal	286	74.5%
Gait/Posture	Normal	345	89.8%
	Abnormal	39	10.2%

The distribution of the study population based on the signs and symptoms is displayed in Table No. 5. Of the study subjects, 44.01% reported pain when moving a joint, 15.3% reported having a joint deformity, 1.3% reported experiencing neck stiffness when moving, and 24.3% reported pain when moving their neck. 10.2% of research participants had abnormal gait.

Table: 6 Distribution Of Study Subjects According To Dean's Index

Use of tobacco	Deans Index	Number	Percentage	Chi-square test
No	Normal	159	41.40%	
	Questionable	27	7.00%	
	Very mild	21	5.50%	
	Mild	29	7.60%	
	Moderate	3	0.80%	
	Severe	3	0.80%	
Yes	Normal	23	6.00%	$x^2 = 146$
	Questionable	18	4.70%	df = 5
	Very mild	13	3.40%	p = <0.001
	Mild	18	4.70%	
	Moderate	53	13.80%	
	Severe	17	4.40%	

The distribution of the study population by dental fluorosis (based on Dean's criteria) between tobacco users and non-users is shown in the above table (number 6). The majority of non-users (7.6%) have mild dental fluorosis, followed by 7% with questionable, 5.5% with very mild and 8% with both moderate and severe forms. On the other hand, the majority of tobacco users (13.8%) had moderate dental fluorosis, followed by 4.7% mild to questionable, 4.4% severe form, and 3.4% very mild. A statistical significance was found by the chi-square test (p = <.001).



The distribution of research participants by dental fluorosis is depicted in Fig. No. 4, with tobacco users having the highest dental fluorosis (31.1%) compared to non-users (21.7%).

Table:7 Distribution Of Study Subjects According To Skeletal Examination

Use of tobacco	Skeletal examination	Number	Percentage	Chi-square test
No	Normal	214	55.70%	
	Mild	22	5.70%	
	Moderate	3	0.80%	
	Sever	3	0.80%	
Yes	Normal	35	9.10%	$x^2 = 175$
	Mild	32	8.30%	df = 3
	Moderate	33	8.60%	p = <0.001
	Sever	42	10.90%	

The severity of skeletal fluorosis is shown in Table No. 7 above for both tobacco and non-tobacco users. Among non-users of tobacco, the prevalence of mild (5.7%) skeletal fluorosis was higher than that of moderate (0.8%) and severe (0.8%) forms. Compared to those uses tobacco Sever (10.9%) form high, followed by moderate (8.6%) and mild (8.3%). A statistical significance was revealed by the chi-square test (p = <.001).

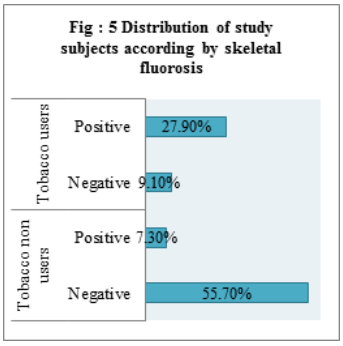


Figure No. 5 Illustrates the prevalence of skeletal fluorosis in tobacco users and non-users. Among tobacco users, the rate of positive cases is high (27.9%), while in non-users, it is 7.3%.

DISCUSSION

In the village of Lakkundi in the Gadag district in north Karnataka, where this study was done, we found that the total prevalence of tobacco use is 37%, with 21.6% of males and 15.4% of females using it. The 58–67 age group (15.4%), the illiterate (16.7%), farmers (19.8%), unemployed persons (12.8%), and people in class 4 economic status (15.1%) had the highest prevalence, according to our findings. However, a study by Chockalingam K et al.[10] in Chennai City found that the overall prevalence is 21%. A study by Sinha et al.[11] in rural Bihar found that the overall tobacco use rate is 45% for women and 74.1% for men, which is higher than the results of our study. A study by Hussain C et al.[12] found that 13.7% of women and 44.7% of men use tobacco products on a daily basis. According to NFHS 5, 38% of males and 9% of women in India who are over the age of 15 now use tobacco products. In rural areas, tobacco consumption is higher among both men and women (43% for men and 11% for women) than it is in urban areas (29% for men and 6% for women).[13]

The severity of skeletal fluorosis is shown by the fact that 15.3% of research participants had a joint deformity and 44.01% of individuals reported pain when moving a joint. Among them, 1.3% reported having stiff necks when they moved, and 24.3% reported neck pain. 10.2% of research participants exhibited an abnormal gait. According to a study by Joseph A. et al., there are indications of skeletal fluorosis in areas where drinking water has a high fluoride content. These symptoms include low back pain accompanied by muscle weakness, joint pain and stiffness, and a reduction in joint mobility. The dose of fluoride taken in its whole and the length of exposure are the primary determinants of the clinical trajectory of skeletal involvement.[14] The most prevalent symptom of skeletal fluorosis, according to another study by Saiprasad G et al., was pain or stiffness in the hip and backbone (16.2%), followed by pain or stiffness in the joints and backbone (15.5%).[9]

According to our research, the majority of non-tobacco users (7.6%) had mild dental fluorosis, followed by 7% with questionable, 5.5% with very mild, and 8% with both moderate and severe forms. On the other hand, the majority of tobacco users (13.8%) had moderate dental fluorosis, followed by 4.7% mild and questionable, 4.4% severe form, and 3.4% very mild. The chi-square test revealed a statistically significant difference (p = <.001) between tobacco users and non-users in terms of dental fluorosis severity and prevalence. Because tobacco contains a trace amount of fluoride, tobacco users may develop fluorosis more severe than non- users, According to a study by Wang M et al.[15] fluoride concentrations ranged from 16.73 to 111.3 mg/kg, with medium tobacco leaves having the highest concentration at 107.6 ± 3.21 mg/kg. In a different study, it was discovered that tobacco users had higher levels of dental fluorosis (54.54%) than non-users (25.79%), and there was a statistically significant correlation between the two.[16] According to our research, tobacco users had a greater prevalence of dental fluorosis (31.10%) than non-users (21.70%). The fluoride content of smokeless tobacco extracts ranged from 1.1 ppm to 2 ppm, with unprocessed tobacco having the greatest fluoride content, followed by Zarda, Ghutka, and Khaini, according to another investigation by Shetty P et al.[17]

In addition to drinking water and food, tobacco and pan masala (with and without tobacco) are abundant sources of fluoride, with 28.0–113.0, 16.5–306.5, and 23.5–185.0 µg of fluoride per gram of these items, respectively, according to another study by Yadav AK et al.[18]

We found that skeletal fluorosis was more common in mild (5.7%) than moderate (0.8%) and severe (0.8%) forms among non-tobacco users. Severe (10.9%) tobacco users rank highest, followed by moderate (8.6%) and mild (8.3%) among tobacco users. A statistically significant relationship (p = <.001) was found by the chi-square test between tobacco usage and skeletal fluorosis. As was previously mentioned, tobacco contains some fluoride, which could account for the severity of skeletal fluorosis among tobacco users in the region where fluorosis is endemic.

In our study, we found that tobacco users (27.90%) had higher total skeletal fluorosis than non-users (7.30%). In comparison to non-users (7.10%), frequent tobacco users had a higher prevalence of skeletal fluorosis (19.85% of cases), according to a study by Dhurvey V et al. (19). A distinct study by Choubisa L et al. (20) found that compared to non-users (13.8%), tobacco users (32.3%) had a higher prevalence of skeletal fluorosis. Skeletal fluorosis is more common in tobacco users (30%) and areca nut chewers (29%), compared to non-users of tobacco (15%) and areca nut chewers (12.9%), per a study by Kubakaddi A et al. (2021). Compared to the current investigation, all of these investigations showed a higher prevalence of skeletal fluorosis.[19,20,21]

CONCLUSIONS

The findings of the study showed some significant conclusions about the prevalence of tobacco usage and its connection to fluorosis. Additionally, a strong correlation between tobacco usage and the degree of dental and skeletal fluorosis was found in our study. There was a statistically significant association found between tobacco users and higher rates of moderate to severe forms of fluorosis compared to non-users. The presence of fluoride in tobacco products likely exacerbates the condition in this region. Our results highlight the necessity of focused public health initiatives that aim to lower tobacco use, especially in rural and fluoride-endemic areas.

Recommendation

It is advised to conduct more study to examine the long-term health effects of fluoride and tobacco exposure, as well as to create management and prevention plans for fluorosis.

Financial Support And Sponsorship

Nil.

Conflicts Of Interest

There are no conflicts of interest.

Acknowledgment

The authors acknowledge the cooperation of field health workers, who helped during data collection.

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