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PREVALENCE OF DENTAL CARIES AND DENTAL FLUOROSIS AMONG THE TRIBAL POPULATION OF GIR FOREST, GUJARAT: A CROSS-SECTIONAL STUDY

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ABSTRACT:
Background: Dental caries and dental fluorosis are among the most prevalent yet neglected oral health conditions in Indian tribal communities, where geographic isolation, limited dental care access, and endemic groundwater fluoride create a distinct disease profile. Data for the tribal communities of Gujarat's Gir Forest region remain scarce.
Aim: To determine the prevalence and severity of dental caries and dental fluorosis among the tribal population of the Gir Forest region, Gujarat.
Materials and Methods: A descriptive cross-sectional study was conducted among 390 tribal participants (Maldhari, Siddi, and Bharwad communities), with 130 each from three WHO index age groups (15 years, 35–44 years, and 65–74 years). Dental caries was recorded as the DMFT index and dental fluorosis was assessed using Dean's fluorosis index as specified in the WHO Oral Health Assessment Form for Adults (2013). Data were analysed using IBM SPSS version 20.0 and are presented as frequencies, percentages, and means with standard deviations.
Results: Overall caries prevalence was 97.7% (381/390). Mean DMFT rose with age, from 3.30 ± 1.87 at 15 years to 13.08 ± 4.41 at 65–74 years, driven predominantly by untreated decay (DT); the filled component (FT) was negligible across all age groups. Decayed teeth were higher in males (5.12 ± 3.17) than in females (3.92 ± 2.86). Dental fluorosis was present in 258 participants (66.2%), predominantly in the questionable (25.1%) and very mild (20.0%) categories; no participant exhibited severe fluorosis.
Conclusion: The Gir Forest tribal communities carry a very high burden of untreated dental caries alongside a considerable prevalence of dental fluorosis. These findings underscore the need for targeted mobile dental services, school-based preventive programmes, and water quality monitoring in this geographically isolated population.

KEYWORDS: Tribal population; Dental caries; DMFT; Dental fluorosis; Dean's index; Gir Forest; Gujarat.

INTRODUCTION

Dental caries and dental fluorosis are two of the most prevalent oral conditions worldwide, and both continue to impose a disproportionate burden on marginalised and tribal communities in India. Globally, dental caries affects an estimated 2.3 billion people in their permanent dentition, making it the most prevalent non-communicable disease among those tracked by the Global Burden of Disease Study.1 Dental fluorosis, caused by excessive fluoride intake during the period of tooth formation, affects millions in countries with endemic groundwater fluoride excess, India being one of the worst affected.2

India's tribal population, comprising over 104 million people or approximately 8.6% of the total population, is concentrated in forested, hilly, and geographically remote belts that typically lack adequate healthcare infrastructure.3 These communities face a combination of risk factors traditional dietary habits, limited oral hygiene practices, reliance on groundwater for drinking, and low healthcare utilisation that together produce an oral disease burden quite distinct from that of the general urban population.

The Gir Forest region of Gujarat, the last natural habitat of the Asiatic lion, is home to the Maldhari, Siddi, and Bharwad tribal communities who continue to live a largely pastoral and forest-dependent way of life.4 The Maldhari nesses (hamlets) situated within the Gir sanctuary house approximately 2,500 people across 361 families, many of whom have had minimal contact with government health services for generations. The Saurashtra-Junagadh geological belt, within which the Gir Forest falls, has documented groundwater fluoride concentrations that can exceed the WHO permissible limit of 1.5 mg/L,5 creating conditions favourable to endemic dental fluorosis. At the same time, the reliance of these communities on a diet rich in fermentable

carbohydrates, the near-total absence of fluoridated toothpaste use, and the complete lack of accessible dental services combine to sustain a high caries burden.
Despite this backdrop, no dedicated study has assessed the prevalence and severity of dental caries and dental fluorosis among these communities of Gir Forest. This study was therefore undertaken to fill that gap, using standardised WHO indices, so that findings can directly inform planning of targeted oral health interventions for this underserved population.

MATERIALS AND METHODS

Study design and setting

A descriptive cross-sectional study was conducted among the tribal population of the Gir Forest region spanning Junagadh and Amreli districts of Gujarat, home to the Maldhari, Siddi, and Bharwad communities. Data collection was carried out over eighteen months, from August 2024 to January 2026.

Sample size and sampling

Sample size was calculated using the standard formula $n = 4pq/L^2$ for cross-sectional surveys, based on a reported tribal caries prevalence of approximately 74.76%6 at 95% confidence and a 5% margin of error (n = 360). Adjusted upward for a 7% anticipated non-response rate, the final sample was set at 390 participants. Equal allocation of 130 participants to each of three WHO index age groups 15 years, 35–44 years, and 65–74 years was adopted as per WHO Oral Health Survey recommendations.7 A pilot study of 30 individuals, subsequently excluded from the main analysis, confirmed the feasibility of the protocol.

Inclusion and exclusion criteria

Cooperative individuals belonging to the three WHO index age groups who provided written informed consent (in English or Gujarati) were included. Individuals undergoing chemotherapy or radiotherapy, those with a history of head and neck surgery, drug users, and uncooperative participants were excluded.

Ethical approval

Ethical clearance was obtained from the Institutional Ethics Committee of Narsinhbhai Patel Dental College and Hospital, Sankalchand Patel University, Visnagar (Approval No. NPDCH/IEC/2024/164, dated 1 July 2024), before commencement of the study. Written informed consent was obtained from all participants.

Examiner calibration

Intra- and inter-examiner agreement was assessed on 20 subjects (excluded from the main analysis) using the Kappa statistic. Kappa values of 0.83 (intra-examiner) and 0.85 (inter-examiner) confirmed very good reproducibility prior to the commencement of fieldwork.

Recording of dental caries

Dental caries was recorded using the DMFT index (Decayed, Missing, and Filled Teeth at the tooth level) as specified in the WHO Oral Health Assessment Form for Adults (2013).7 Examinations were performed under natural or adjusted artificial light using a mouth mirror, dental explorer, and CPI probe. A tooth was recorded as decayed (D) when a lesion was clearly visible and the explorer caught in a pit or fissure, as missing (M) when absent due to caries, and as filled (F) when one or more surfaces bore a restoration. Third molars were excluded.

Recording of dental fluorosis

Dental fluorosis was assessed using Dean's fluorosis index,8 which classifies the degree of enamel mottling on a six-point scale: Normal (0), Questionable (?), Very mild (1), Mild (2), Moderate (3), and Severe (4), as incorporated in the WHO Oral Health Assessment Form (2013).7 The index score for each participant was assigned based on the two teeth most affected; if the two teeth differed in score, the lower score was recorded. Participants with a Dean's score ≥ 1 (questionable to severe) were considered to have dental fluorosis.

Statistical analysis

Data were entered in MS Excel and analysed using IBM SPSS Statistics version 20.0. As this was a descriptive study of prevalence, only descriptive statistics were computed: categorical variables (e.g. caries and fluorosis prevalence) are presented as frequencies and percentages, and continuous variables (e.g. DMFT and its components) as means with standard deviations.

RESULTS

Of the 390 participants, 270 (69.2%) were male and 120 (30.8%) were female, with equal distribution of 130 participants across each of the three WHO index age groups. The majority resided in rural areas (305, 78.2%), with the remainder from peri-urban settings (85, 21.8%); none came from urban areas. The mean age of male participants was 41.89 ± 21.65 years and that of female participants was 40.98 ± 22.91 years [Table 1].

Table 1: Sociodemographic characteristics of study participants (N = 390)

Characteristic	Category	Number (n)	Percentage (%)
Gender	Male	270	69.2
	Female	120	30.8
	Total	390	100.0

Characteristic	Category	Number (n)	Percentage (%)
Age group	15 years	130	33.3
	35–44 years	130	33.3
	65–74 years	130	33.3
	Total	390	100.0
Location	Rural	305	78.2
	Peri-urban	85	21.8
	Urban	0	0.0
	Total	390	100.0

Values expressed as frequency (n) and percentage (%).

Dental caries was nearly universal in this population. The overall caries prevalence (DMFT ≥ 1) was 97.7%, with only 9 participants (2.3%) recorded as caries-free. Active decay (DT ≥ 1) was present in 94.1% of participants, while missing teeth due to caries (MT ≥ 1) were recorded in 51.3%. Only 35.1% of participants had any restored teeth (FT ≥ 1), underscoring the near-total absence of restorative care in this population [Table 2].

Table 2: Prevalence of individual DMFT components among study participants (N = 390)

DMFT Component	Status	Number (n)	Percentage (%)
Decayed Teeth (DT)	Absent (DT = 0)	23	5.9
	Present (DT ≥ 1)	367	94.1
Missing Teeth (MT)	Absent (MT = 0)	190	48.7
	Present (MT ≥ 1)	200	51.3
Filled Teeth (FT)	Absent (FT = 0)	253	64.9
	Present (FT ≥ 1)	137	35.1
Overall Caries (DMFT)	Caries free (DMFT = 0)	9	2.3
	Caries experience (DMFT ≥ 1)	381	97.7

Values expressed as frequency (n) and percentage (%). Caries prevalence = percentage of participants with DMFT ≥ 1. DT = Decayed teeth; MT = Missing teeth; FT = Filled teeth; DMFT = Decayed-Missing-Filled Teeth index.

The mean DMFT by gender was 7.80 ± 5.31 in males and 6.82 ± 5.08 in females. By component, the decayed teeth (DT) score was 5.12 ± 3.17 in males and 3.92 ± 2.86 in females, the missing teeth (MT) score was 2.25 ± 3.05 in males and 2.36 ± 3.14 in females, and the filled teeth (FT) score was 0.43 ± 0.67 in males and 0.53 ± 0.77 in females [Table 3].

Table 3: Distribution of mean DMFT components by gender

DMFT Component	Group	Number (N)	Mean ± SD
DT	Male	270	5.12 ± 3.17
	Female	120	3.92 ± 2.86
MT	Male	270	2.25 ± 3.05
	Female	120	2.36 ± 3.14
FT	Male	270	0.43 ± 0.67
	Female	120	0.53 ± 0.77
DMFT	Male	270	7.80 ± 5.31
	Female	120	6.82 ± 5.08

DT = Decayed teeth; MT = Missing teeth; FT = Filled teeth; DMFT = Decayed-Missing-Filled Teeth index; SD = Standard deviation.

Mean DMFT increased with advancing age: 3.30 ± 1.87 at 15 years, 6.11 ± 3.00 at 35–44 years, and 13.08 ± 4.41 at 65–74 years. The same progressive rise was observed for the decayed (DT) and missing (MT) components. The filled teeth (FT) component remained negligible across all age groups, reaching a maximum mean of only 0.62 ± 0.85 in the 35–44-year group [Table 4].

Table 4: Distribution of mean DMFT components by age group

Component	Age Group	N	Mean ± SD
DT	15 years	130	2.89 ± 1.74
	35–44 years	130	4.35 ± 2.41
	65–74 years	130	7.02 ± 3.42
MT	15 years	130	0.05 ± 0.21
	35–44 years	130	1.14 ± 1.43
	65–74 years	130	5.66 ± 2.93
FT	15 years	130	0.36 ± 0.62
	35–44 years	130	0.62 ± 0.85
	65–74 years	130	0.40 ± 0.59
DMFT	15 years	130	3.30 ± 1.87
	35–44 years	130	6.11 ± 3.00
	65–74 years	130	13.08 ± 4.41

DT = Decayed teeth; MT = Missing teeth; FT = Filled teeth; SD = Standard deviation.

Dental fluorosis was present in 258 participants (66.2%). Among those with fluorosis, the most common category was questionable (98 participants, 25.1%), followed by very mild (78, 20.0%), mild (49, 12.6%), and moderate (33, 8.5%). No participant exhibited severe fluorosis. Accordingly, 33.8% of the sample had normal (fluorosis-free) enamel, while two-thirds had enamel changes consistent with endemic fluoride exposure [Table 5].

Table 5: Distribution of study participants based on dental fluorosis severity (Dean's Index) (N = 390)

Dean's Score	Category	Number (n)	Percentage (%)
0	Normal (No fluorosis)	132	33.8
?	Questionable	98	25.1
1	Very mild	78	20.0
2	Mild	49	12.6
3	Moderate	33	8.5
4	Severe	0	0.0
-	Total with any fluorosis (Dean's score ≥ 1)	258	66.2
-	Total	390	100.0

Dean's Index categories: Normal (0), Questionable (?), Very mild (1), Mild (2), Moderate (3), Severe (4). Fluorosis prevalence = participants with Dean's score ≥ 1 (questionable to severe). Values expressed as frequency (n) and percentage (%).

DISCUSSION

This study provides the first systematic, WHO-indexed assessment of dental caries and dental fluorosis among the tribal communities of the Gir Forest region of Gujarat. A caries prevalence of 97.7% places these communities among the most dentally burdened tribal groups reported in India, exceeding the 83.4% recorded among the Juang tribe of Odisha9 and the 74.76% found among tribal school children in Tamil Nadu.6 This gap likely reflects the extreme isolation of the Gir Forest communities and their near-total lack of access to dental care a picture consistent with the FT component, which averages just 0.46 across the whole sample. Care that

was never available in childhood appears to accumulate over a lifetime, producing a mean DMFT of 13.08 by the oldest age group.

The higher DT observed in males than females (5.12 ± 3.17 vs 3.92 ± 2.86) may reflect greater tobacco use, poorer oral hygiene, and occupational exposure among men in these communities, a pattern consistent with other tribal populations in India.10,11 The similar overall DMFT between genders despite this difference may reflect a compensating contribution from the MT component in women, whose pattern of tooth loss tends to differ from men's.

The steady rise in mean DMFT from 3.30 at 15 years to 13.08 at 65–74 years reflects disease accumulating across a lifetime without treatment, a pattern comparable to the DMFT of 18.47 ± 13.10 reported at 65–74 years among the Paniya community of Kerala.12 By contrast, the markedly lower DMFT (1.05 ± 2.59 among males) reported among the Birhor tribe of Jharkhand13 has been linked to a traditional low-sugar diet; a similar dietary transition toward refined carbohydrates has occurred in Gir Forest without any parallel improvement in dental care access, compounding the caries burden seen here.

The fluorosis prevalence of 66.2% is among the higher figures reported for Indian tribal communities, consistent with the well-documented groundwater fluoride excess of the Saurashtra-Junagadh belt, which in places exceeds the WHO permissible limit of 1.5 mg/L.5 Reliance on this groundwater during childhood tooth formation likely explains the degree of fluorosis observed. The distribution was skewed toward milder categories 25.1% questionable, 20.0% very mild, 12.6% mild, and 8.5% moderate, with no severe cases a profile consistent with the 63.65% fluorosis prevalence reported among the Iruliga tribe of Karnataka.14

This absence of severe fluorosis distinguishes Gir Forest from the very high fluorosis prevalence reported among the Rabari pastoral community of Rajasthan,15 and contrasts with the much lower prevalences of 11.9% and 22.9% found among tribal children elsewhere in India16 a difference likely reflecting geographic variation in groundwater fluoride rather than any secular trend, since our sample spans three age cohorts whose teeth formed decades apart. Most of the fluorosis observed (questionable and very mild, 45.1% of participants) is unlikely to cause visible or functional concern; only the mild and moderate categories (21.1%) may warrant cosmetic attention.

The coexistence of a high caries burden with considerable fluorosis is a notable public health finding: endemic fluoride exposure has not conferred meaningful caries protection here, a paradox well recognised where mild-to-moderate fluorosis coexists with high caries burden, and one that likely reflects the overriding influence of diet, oral hygiene, and healthcare access on caries risk in this setting.8,17

Limitations

As a cross-sectional study, this work cannot establish causal temporal relationships, and caries was recorded at the tooth level rather than the surface level, which may underestimate disease severity. Groundwater fluoride concentration was not measured directly in the study villages, and this would be a valuable addition in a future study. Information on dietary habits, tobacco use, and oral hygiene practices was not collected in the present analysis.

CONCLUSION

The tribal communities of the Gir Forest region, the Maldhari, Siddi, and Bharwad carry an extremely high burden of dental caries (prevalence 97.7%) alongside a considerable prevalence of dental fluorosis (66.2%). The caries burden is characterised by a near-complete absence of restorative care and a relentless increase in DMFT with advancing age, reflecting lifetime unmet dental need rather than any failure of host resistance. The fluorosis pattern predominantly questionable and mild, with no severe cases is consistent with moderate endemic fluoride exposure from the Saurashtra-Junagadh groundwater belt. Taken together, these findings define the baseline oral health situation for this underserved population and make an evidence-based case for three complementary policy responses: regular mobile dental camps to address the enormous backlog of untreated caries, school-based preventive education and fluoride monitoring to address fluorosis risk at its source, and the integration of oral health services into the existing Tribal Health Action Plan infrastructure in Gujarat. These measures, implemented with cultural sensitivity, have the potential to meaningfully reduce the oral disease burden in one of India's most isolated indigenous communities.

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Conflicts of interest: There are no conflicts of interest.

Ethical approval: Approved by the Institutional Ethics Committee, Narsinhbhai Patel Dental College and Hospital, Sankalchand Patel University, Visnagar (Approval No. NPDCH/IEC/2024/164, dated 1 July 2024). Written informed consent was obtained from all participants. A copy of the ethical approval certificate is provided in the Annexure.

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