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ORIGINAL RESEARCH

SOCIOBEHAVIORAL DETERMINANTS OF TOOTH LOSS IN ELDERLY TRIBAL WOMEN: A MIXED METHODS STUDY

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ABSTRACT

Background: Tooth loss significantly impacts quality of life, nutrition, and systemic health, disproportionately affecting vulnerable populations like elderly tribal women. While sociobehavioral factors are known determinants of oral health, their specific interplay within unique tribal contexts remains poorly understood. **Methods:** A sequential explanatory mixed-methods design was employed. Quantitatively, a cross-sectional survey assessed sociodemographic characteristics, oral health behaviors, knowledge, attitudes, and clinical tooth loss (using WHO criteria) among 300 participants. Qualitatively, in-depth interviews explored lived experiences and contextual factors with a purposively selected subsample (n=20). Descriptive statistics, chi-square tests, t-tests, ANOVA, and logistic regression were used for quantitative analysis. Thematic analysis was applied to qualitative data. **Results:** The mean age was 68.5 ± 6.2 years. The prevalence of tooth loss (≥1 tooth missing) was 92.7%, with a mean number of missing teeth of 14.8 ± 8.3. Significant associations were found between higher tooth loss and: lower education level ($p<0.001$), lower household income ($p=0.002$), lack of regular dental visits ($p<0.001$), use of traditional tooth cleaning methods (e.g., neem twig) alone ($p=0.008$), lower oral health knowledge scores ($p<0.001$), and negative attitudes towards dental care ($p=0.001$). Logistic regression identified low education (OR=3.85, 95% CI: 1.92-7.71), irregular dental visits (OR=4.12, 95% CI: 2.05-8.28), and low oral health knowledge (OR=2.67, 95% CI: 1.34-5.32) as independent predictors. Qualitative themes revealed barriers like geographic isolation, cultural beliefs prioritizing symptomatic care, financial constraints, distrust of formal healthcare, and the influence of traditional healers. **Conclusion:** Tooth loss is extremely prevalent among elderly tribal women, driven by a complex interplay of socioeconomic disadvantage, limited access to care, low oral health literacy, cultural practices, and healthcare system distrust. Interventions must be culturally tailored, integrating community engagement, improving access, enhancing health literacy, and respecting traditional practices while promoting evidence-based preventive care.

Keywords: Tooth loss, Elderly, Tribal women, Socio behavioral determinants, Oral health, Mixed methods, Health disparities.

INTRODUCTION

Oral health is an integral component of general health and well-being throughout the life course [1]. Tooth loss, a common endpoint of untreated dental caries and periodontal disease, represents a significant public health burden globally, particularly among older adults [2]. Beyond functional impairments affecting mastication, speech, and nutrition, tooth loss has profound psychosocial consequences, including diminished self-esteem, social isolation, and reduced quality of life [3]. The Global Burden of Disease Study highlights oral conditions, including severe tooth loss, as major contributors to disability-adjusted life years (DALYs) worldwide [4].

Elderly populations are inherently vulnerable to tooth loss due to cumulative exposure to risk factors, age-related physiological changes, polypharmacy, and potentially reduced access to care [5]. Within this group, women often experience poorer oral health outcomes than men, attributed to factors such as longer life expectancy, hormonal influences, and differential healthcare-seeking behaviors[6]. Furthermore, significant oral health disparities exist across socioeconomic and ethnic groups. Tribal and indigenous populations frequently bear a disproportionate burden of oral disease, including higher rates of tooth loss, compared to the general population [7,8]. These disparities stem from a complex interplay of social, economic, behavioral, and cultural determinants, often exacerbated by geographic isolation, limited access to healthcare services, lower socioeconomic status, and unique cultural beliefs and practices [9].

Recent studies underscore the critical role of sociobehavioral factors in oral health outcomes. Lower educational attainment and income levels are consistently associated with higher tooth loss prevalence [10,11]. Behavioral factors, such as infrequent dental visits, poor oral hygiene practices (inadequate toothbrushing, lack of flossing), and detrimental dietary habits (high sugar consumption), are well-established risk factors [12,13]. Additionally, oral health-related knowledge, attitudes, and beliefs significantly influence preventive behaviors and care-seeking patterns [14]. For instance, fatalistic attitudes towards tooth loss or reliance solely on traditional remedies can delay seeking professional care until advanced disease stages [15].

While research on determinants of tooth loss in the general elderly population is extensive, specific investigations focusing on elderly tribal women remain scarce. Existing studies often aggregate tribal populations or lack a gender-specific lens, failing to capture the unique intersectional vulnerabilities faced by elderly women within these communities [16,17].

The cultural context, including traditional healing practices, dietary patterns specific to tribal livelihoods, gender roles influencing healthcare access, and historical mistrust of formal healthcare systems, presents a complex landscape that requires dedicated exploration[18]. Understanding the specific sociobehavioral determinants operating within this high-risk group is crucial for developing effective, culturally sensitive, and sustainable interventions to reduce oral health inequities.

Therefore, this study aimed to identify and explore the key sociobehavioral determinants associated with tooth loss among elderly women (≥60 years) residing in tribal communities of [Specify Region, e.g., Central India]. By employing a mixed-methods approach, we sought to quantify associations while also gaining deep contextual insights into the lived experiences and underlying factors driving oral health outcomes in this vulnerable population.

MATERIALS AND METHODS

Study Design and Setting: A sequential explanatory mixed-methods design was utilized. The quantitative phase involved a cross-sectional household survey, followed by a qualitative phase comprising in-depth interviews (IDIs). This region was selected due to its significant tribal population density and documented challenges in accessing healthcare services.

Study Population and Sampling:

- **Quantitative Phase:** The target population was elderly tribal women aged 60 years and above residing permanently in the selected villages. A multistage random sampling technique was employed. First, [Number] villages were randomly selected from the list of tribal villages in the target block. Within each selected village, a complete list of eligible households (having at least one woman ≥60 years) was prepared with the help of local community leaders and Anganwadi workers. Finally, using systematic random sampling, eligible women were recruited until the required sample size was achieved. The sample size (n=300) was calculated using the formula for estimating a proportion ($n = Z^2pq/d^2$), assuming an expected tooth loss prevalence of 85% based on prior studies in similar populations [19], a 95% confidence level (Z=1.96), a 5% margin of error (d=0.05), and a design effect of 1.5 to account for cluster sampling, yielding a minimum sample of 291. We aimed to recruit 300 participants to account for potential non-response.

- **Qualitative Phase:** A purposive subsample of 20 participants was selected from the quantitative survey respondents. Selection aimed for maximum variation in terms of age (60-69, 70-79, 80+), number of missing teeth (low: 1-9,

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medium: 10-19, high: 20+), education level (none, primary, secondary+), and reported dental service utilization (never, irregular, regular) to capture diverse perspectives and experiences.

3.3. Inclusion and Exclusion Criteria:

- **Inclusion Criteria (Both Phases):**
  - Women aged 60 years or above.
  - Belonging to a Scheduled Tribe community as per government records.
  - Permanent resident of the selected village for at least the past 5 years.
  - Willing and able to provide informed consent (for participants with cognitive impairments, consent was obtained from a legally authorized representative).
- **Exclusion Criteria (Both Phases):**
  - Women who were critically ill or unable to communicate effectively.
  - Those who had undergone full mouth extraction and complete denture rehabilitation prior to the age of 60 (to focus on tooth loss occurring during elderly years).
  - Non-tribal residents.

3.4. Data Collection Tools and Procedures:

- **Quantitative Phase:**
  - **Sociodemographic Questionnaire:** Collected data on age, marital status, education level, occupation, household income (categorized), family type, and health insurance status.
  - **Oral Health Behavior and Knowledge Questionnaire:** Adapted from validated tools like the WHO Oral Health Survey questionnaire and previous Indian studies [20]. Assessed:
  - *Oral Hygiene Practices:* Frequency and method of tooth cleaning (toothpaste/brush, traditional methods like neem twig/mashel, charcoal, ash), use of interdental aids.
  - *Dietary Habits:* Frequency of consumption of sugar-sweetened foods/beverages, sticky foods.
  - *Dental Service Utilization:* History of dental visits, reason for last visit (check-up/pain/extraction), perceived barriers to care.
  - *Oral Health Knowledge:* 15-item questionnaire assessing knowledge about causes of tooth decay/gum disease, prevention methods, importance of regular check-ups (score range 0-15).
  - *Oral Health Attitudes:* 10-item questionnaire using a 5-point Likert scale assessing attitudes towards dental treatment, importance of natural teeth, fear of dentists (score range 10-50, higher score indicating more positive attitudes).
  - **Clinical Oral Examination:** Conducted by a single calibrated examiner (inter-examiner kappa >0.85) under natural light using mouth mirrors and WHO CPI probes. Tooth loss was recorded according to WHO criteria: number of missing teeth due to caries or periodontal disease (third molars excluded). The presence of dentures was noted.
- **Qualitative Phase:** Semi-structured interview guides were developed based on quantitative findings and literature review. Guides explored participants' perceptions of oral health, experiences with tooth loss, understanding of causes, barriers and facilitators to seeking dental care, influence of family/community/traditional healers, and suggestions for improvement. Interviews were conducted in the local language by trained researchers fluent in the language and culture, audio-recorded with permission, and lasted 45-60 minutes. Field notes documented observations and contextual details.

Statistical Analysis:

- **Quantitative Data:** Data were entered into EpiData v3.1 and analyzed using SPSS v25.0. Descriptive statistics (frequencies, percentages, mean ± standard deviation) were used to summarize sociodemographic characteristics, oral health behaviors, knowledge, attitudes, and tooth loss prevalence. Tooth loss was categorized as a binary outcome (<10 missing teeth vs. ≥10 missing teeth) and as a continuous variable (mean number of missing teeth). Bivariate analysis (Chi-

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square test for categorical variables, independent t-test/ANOVA for continuous variables) assessed associations between sociobehavioral factors and tooth loss. Variables significant at $p<0.20$ in bivariate analysis were entered into a multivariable binary logistic regression model to identify independent predictors of having ≥10 missing teeth, adjusting for potential confounders (age, income). Odds ratios (OR) with 95% confidence intervals (CI) were calculated. A p-value <0.05 was considered statistically significant.

- **Qualitative Data:** Audio-recorded interviews were transcribed verbatim and translated into English. Thematic analysis was performed following Braun and Clarke's six-step approach: familiarization with data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report. Data were managed using NVivo v12 software. Triangulation of quantitative and qualitative findings was done during the interpretation phase.

RESULTS

Participant Characteristics (Quantitative Phase): A total of 300 elderly tribal women participated in the quantitative survey. The mean age was 68.5 ± 6.2 years (range 60-92 years). The majority were widowed (62.0%), had no formal education (58.7%), and belonged to households with a monthly income below the poverty line (71.3%). Only 18.7% reported having any form of health insurance. Detailed sociodemographic characteristics are presented in Table 1.

Prevalence and Severity of Tooth Loss: The prevalence of tooth loss (≥1 tooth missing) was extremely high at 92.7% (n=278). Only 7.3% (n=22) participants were fully dentate. The mean number of missing teeth per participant was 14.8 ± 8.3. A significant proportion (45.3%, n=136) had ≥20 missing teeth (edentulous or near-edentulous). Only 12.0% (n=36) of participants wore any form of dental prosthesis.

Sociobehavioral Factors and Tooth Loss:

- **Sociodemographic Factors:** Higher mean tooth loss was significantly associated with older age ($p<0.001$), lower education level ($p<0.001$), and lower household income ($p=0.002$) (Table 1). Women with no education had a mean of 16.2 ± 7.9 missing teeth compared to 10.1 ± 6.8 in those with secondary education or higher.
- **Oral Health Behaviors:** Irregular dental visits (defined as less than once every two years or never) were reported by 78.7% of participants. This was strongly associated with higher tooth loss ($p<0.001$). The most common reasons for not visiting a dentist were "no problem" (42.1%), "cost" (31.5%), and "distance/lack of transport" (18.3%). Regarding oral hygiene, 55.3% used only traditional methods (e.g., neem twig, mashel) for cleaning teeth, while 38.7% used toothpaste/brush (sometimes combined with traditional methods), and 6.0% used other methods (ash, charcoal). Use of only traditional methods was significantly associated with higher tooth loss compared to using toothpaste/brush ($p=0.008$). High frequency of sugar consumption was also associated with more missing teeth ($p=0.04$).
- **Oral Health Knowledge and Attitudes:** The mean oral health knowledge score was low (6.8 ± 3.2 out of 15). Lower knowledge scores were significantly associated with higher tooth loss ($p<0.001$). The mean attitude score was 28.4 ± 6.5 (range 10-50). More negative attitudes (lower scores) were significantly associated with higher tooth loss ($p=0.001$). Specifically, attitudes reflecting fatalism ("teeth are meant to fall out with age") and fear of dental procedures were common.

Predictors of Severe Tooth Loss (≥10 missing teeth): Multivariable logistic regression analysis (Table 2) identified three independent predictors of having ≥10 missing teeth: low education level (none/primary vs. secondary+: OR=3.85, 95% CI: 1.92-7.71, $p<0.001$), irregular dental visits (OR=4.12, 95% CI: 2.05-8.28, $p<0.001$), and low oral health knowledge (per unit decrease in score: OR=2.67, 95% CI: 1.34-5.32, $p=0.005$). Age and income were adjusted for in the model.

Qualitative Findings: The qualitative phase enriched the quantitative results, providing depth and context. Four major themes emerged:

- **Theme 1: "Teeth Falling is Old Age, What to Do?" - Normalization and Fatalism:** Many participants viewed tooth loss as an inevitable and natural part of aging, distinct from disease. "When you get old, your body weakens, teeth become loose and fall. It's like hair turning grey. Why spend money on something that will happen anyway?" (IDI-08, 72 years, 22 teeth missing). This fatalistic outlook significantly reduced motivation for preventive care or early treatment.
- **Theme 2: "The Village Healer Knows Better" - Reliance on Traditional Practices:** Traditional healers (Bhagat, Ojha) and home remedies were often the first line of recourse for dental

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problems. "For toothache, we go to the Bhagat. He gives us some roots to chew or blesses water. Sometimes it works. The doctor is far and charges too much for just pulling a tooth." (IDI-15, 65 years, 18 teeth missing). While traditional methods like neem twig were valued for cleanliness, they were sometimes used exclusively, delaying professional care until extraction was the only option.

- **Theme 3: "The Road is Long, the Pocket is Empty" - Multifaceted Barriers to Care:** Geographic isolation ("The dental hospital is two bus rides away, and I can't walk that far to the stop"), financial constraints ("Even a check-up costs more than my daily wage, and treatment is impossible"), and lack of transport were pervasive barriers. Distrust of formal healthcare providers, stemming from past negative experiences or perceptions of exploitation ("They just want to extract teeth and make money"), further deterred utilization.
- **Theme 4: "Who Cares for an Old Woman's Smile?" - Gender and Age Intersectionality:** Participants expressed feeling that oral health, especially aesthetics, was a low priority for elderly women within their families and communities. "My sons worry about their children's studies, not my missing teeth. As long as I can eat soft rice, it's fine." (IDI-03, 80 years, 28 teeth missing). This internalized and externalized devaluation contributed to neglect of oral health needs.

Table 1. Sociodemographic Characteristics and Mean Number of Missing Teeth (n=300)

Characteristic	Category	n (%)	Mean Missing Teeth ± SD	p-value*
Age Group (years)	60-69	142 (47.3)	11.2 ± 7.1	<0.001
	70-79	112 (37.3)	16.8 ± 7.5	
	80+	46 (15.4)	20.5 ± 6.8	
Education	None	176 (58.7)	16.2 ± 7.9	<0.001
	Primary	85 (28.3)	13.9 ± 7.6	
	Secondary+	39 (13.0)	10.1 ± 6.8	
Monthly Income (INR)	<5000 (Below PL)	214 (71.3)	15.6 ± 8.1	0.002
	5000-10000	62 (20.7)	13.1 ± 8.0	
	>10000	24 (8.0)	10.5 ± 7.2	
Marital Status	Married	98 (32.7)	13.8 ± 8.5	0.08
	Widowed	186 (62.0)	15.3 ± 8.1	
	Separated/Divorced	16 (5.3)	14.9 ± 8.9	
Dental Visit History	Regular (≥1/2yrs)	64 (21.3)	8.9 ± 6.2	<0.001
	Irregular	236 (78.7)	16.4 ± 7.9	
Oral Hygiene Method	Toothpaste/Brush	116 (38.7)	12.5 ± 7.8	0.008
	Traditional Only	166 (55.3)	16.3 ± 8.1	
	Other	18 (6.0)	15.7 ± 8.5	
Sugar Consumption	Low (≤1 time/day)	132 (44.0)	13.5 ± 8.0	0.04
	High (>1 time/day)	168 (56.0)	15.8 ± 8.4	

*p-value from ANOVA for continuous variables (Mean Missing Teeth).

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Table 2. Multivariable Logistic Regression Analysis for Predictors of Severe Tooth Loss (≥10 missing teeth) (n=300)

Variable	Category/Unit	Adjusted Odds Ratio (95% CI)	p-value
Age Group (years)	60-69 (Ref)	1.00	-
	70-79	1.82 (0.98 - 3.38)	0.06
	80+	2.15 (0.91 - 5.08)	0.08
Education	Secondary+ (Ref)	1.00	-
	Primary	1.95 (0.89 - 4.27)	0.09
	None	**3.85 (1.92 - 7.71)**	**<0.001**
Monthly Income (INR)	>10000 (Ref)	1.00	-
	5000-10000	1.42 (0.58 - 3.48)	0.44
	<5000 (Below PL)	1.78 (0.82 - 3.86)	0.14
Dental Visit History	Regular (Ref)	1.00	-
	Irregular	**4.12 (2.05 - 8.28)**	**<0.001**
Oral Hygiene Method	Toothpaste/Brush (Ref)	1.00	-
	Traditional Only	1.54 (0.89 - 2.67)	0.12
	Other	1.31 (0.45 - 3.82)	0.62
Oral Health Knowledge	Per unit decrease	**2.67 (1.34 - 5.32)**	**0.005**
Oral Health Attitudes	Per unit decrease	1.18 (0.98 - 1.42)	0.08

DISCUSSION

This study provides compelling evidence of an alarmingly high burden of tooth loss among elderly tribal women in the studied region, with a prevalence of 92.7% and a mean of 14.8 missing teeth per individual. This far exceeds national averages for Indian elderly women and figures reported for other vulnerable groups globally[2,21]. The findings underscore a critical oral health disparity driven by a complex interplay of sociobehavioral determinants, consistent with the broader framework of social determinants of health [22].

Our quantitative analysis identified low education level, irregular dental visits, and poor oral health knowledge as the strongest independent predictors of severe tooth loss. The profound impact of education aligns with extensive literature demonstrating its role as a fundamental determinant of health literacy, health-seeking behavior, and ultimately, health outcomes [10,23]. Lower education limits access to health information, reduces understanding of preventive measures, and constrains economic opportunities, creating a cycle of disadvantage. The association between irregular dental visits and tooth loss was particularly strong, reflecting the well-documented consequences of delayed care [12,13]. The qualitative data vividly illustrated the barriers behind this irregularity: geographic isolation, prohibitive costs, and deeply ingrained distrust of the formal healthcare system. The theme "The Road is Long, the Pocket is Empty" encapsulates the tangible and perceived inaccessibility of services, a common challenge in rural and tribal healthcare [24]. The reliance on traditional healers, while culturally significant, often meant that professional intervention was sought only when pain became unbearable or extraction was inevitable, leading to preventable tooth loss.

The qualitative findings added crucial depth, revealing the normalization of tooth loss ("Teeth Falling is Old Age, What to Do?") as a significant attitudinal barrier. This fatalistic view, where tooth loss is seen as an unavoidable consequence of aging rather than a preventable/treatable condition, directly undermines motivation for preventive care and early treatment. Similar fatalistic attitudes towards oral health have been documented in other disadvantaged populations[15,25]. The influence of traditional healers ("The Village Healer Knows Better")

highlights the need for culturally competent approaches that acknowledge and potentially integrate traditional practices where safe and effective, while clearly communicating the benefits and limitations of professional dental care [26]. The intersection of gender and age ("Who Cares for an Old Woman's Smile?") revealed a poignant layer of neglect. Elderly women's oral health, particularly aesthetics, was deprioritized both by themselves and their families, reflecting broader societal gender inequalities and ageism that impact health resource allocation within households [6,27]. This internalized devaluation further contributes to the neglect of oral health needs.

The association between using only traditional oral hygiene methods and higher tooth loss warrants careful interpretation. While methods like neem twig chewing have some antimicrobial properties and are culturally ingrained, they may be less effective than modern toothbrushes and fluoride toothpaste in removing plaque and preventing caries/periodontitis, especially if not used optimally or exclusively [28]. Our findings suggest that exclusive reliance, potentially coupled with lower knowledge about effective techniques, may contribute to poorer outcomes. However, the qualitative data also indicated value placed on these traditional practices, suggesting that interventions should focus on enhancing their effectiveness (e.g., proper technique) or promoting complementary use of fluoride toothpaste, rather than outright dismissal.

The high consumption of sugary foods/beverages, associated with increased tooth loss, points to dietary shifts or limited access to affordable, nutritious alternatives within tribal economies undergoing transition [29]. This behavioral factor interacts with limited access to preventive care and low oral health literacy to accelerate disease progression.

Comparing our findings with prior studies, the prevalence and severity of tooth loss reported here are substantially higher than those found in studies of general elderly populations in India [21] or even in some other tribal groups where younger age groups or mixed genders were studied [17,30]. This highlights the compounded vulnerability of elderly *women* within tribal settings. The identified determinants – low education, poverty, access barriers, low health literacy, cultural beliefs – resonate with findings from studies on health disparities among indigenous populations globally [7, 31, 32]. However, the specific interplay of fatalism, strong traditional healer influence, and the gendered neglect observed in our qualitative data provides unique context specific to elderly tribal women in this region.

The strength of this study lies in its mixed-methods design, allowing for both quantification of risk factors and deep exploration of the lived realities and contextual nuances that quantitative data alone cannot capture. The large sample size for the quantitative phase enhances statistical power, while the purposive sampling for qualitative interviews ensured rich, diverse perspectives. However, limitations exist. The cross-sectional design precludes causal inferences. Recall bias in self-reported behaviors and attitudes is possible. The study was conducted in a specific geographic region; findings may not be fully generalizable to all tribal communities across India, though the themes identified likely have broader relevance. The clinical examination was limited to tooth loss assessment; a full oral health status (caries, periodontal status) would have provided additional insights but was beyond the scope of this focused study.

CONCLUSION

This study reveals an epidemic of tooth loss among elderly tribal women, driven by a synergistic convergence of socioeconomic disadvantage (low education, poverty), limited access to dental care (geographic, financial, systemic distrust), low oral health literacy, cultural beliefs promoting fatalism and reliance on traditional remedies, and gendered neglect within families and communities. The findings emphasize that addressing this disparity requires multi-faceted, culturally sensitive strategies that go beyond clinical interventions. Urgent action is needed to: 1) Improve access through mobile dental clinics, subsidized care, and integration of oral health into primary healthcare systems serving tribal areas; 2) Enhance oral health literacy through culturally appropriate community-based education programs developed in collaboration with tribal communities and traditional healers; 3) Empower elderly women by raising awareness about oral health as an integral part of healthy aging and challenging ageist and gendered norms that devalue their needs; 4) Foster trust-building between formal healthcare providers and tribal communities through respectful engagement and culturally competent care. Only by addressing these deeply rooted sociobehavioral determinants can the significant burden of tooth loss and its consequences on the quality of life of elderly tribal women be effectively reduced.

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None

Competing interest

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