

Review Article

From Smoke to Tooth Loss: The Public Health Burden of Tobacco on Periodontal Health in India

^{1*}Dr Ravada V S S K Kinneresh MDS, PGDHM, ²Dr Anjan Kumar Karri, MD, ³Dr K Rashmika, MDS, ⁴Dr Sravya Saripalli, BDS, MPH, ⁵Dr Balajee Goud Bandi, ⁶Dr Douluri Ranjith Priya

^{1*}Assistant Resident Medical Officer, Department of Public Health Dentistry, Great Eastern Medical School and Hospital, Ragolu, Srikakulam

²Senior Resident, Department of Community Medicine, Sri Venkateswara Institute of Medical Sciences, SPMCW

³Assistant Professor, Department of Public Health Dentistry, Sree Sai College of Dental Surgery, Vikarabad

⁴Project Research Scientist, ICMR-VCRC

⁵I, MD, Postgraduate, Department of Community Medicine, Sri Venkateswara Institute of Medical Sciences, SPMCW

⁶III, MD, Postgraduate, Department of Community Medicine, Guntur Medical College

Email: ^{1*}rk10121964@gmail.com, ²anjank997@gmail.com, ³sravs612@gmail.com,

⁴balajeegoud15@gmail.com, ⁵priyadouluri74@gmail.com

ABSTRACT

Tobacco smoking is a well-documented modifiable risk factor for numerous systemic and oral health conditions. This review highlights the association between tobacco use and periodontal disease, focusing on attachment loss, periodontal pocket depth, and early tooth loss. Evidence indicates that smokers exhibit increased periodontal destruction, diminished therapeutic outcomes, and compromised oral health-related quality of life. Understanding the interplay between smoking behaviours, nicotine dependence, and periodontal parameters is essential to guide preventive and interventional strategies, especially in low- and middle-income populations.

Keywords: Tobacco Smoking, Periodontal Diseases, Tooth Loss, Nicotine Dependence, Periodontitis, Oral Health.

INTRODUCTION

Tobacco consumption, particularly smoking, represents one of the most significant global public health challenges and a major modifiable risk factor for a multitude of diseases. Its pervasive use has earned it the grim label of the "newest plague of the twentieth century," with consumption trends unfortunately still rising worldwide.¹ India shoulders a substantial portion of this burden, hosting an estimated 182 million smokers out of a global total exceeding 930 million.¹ The World Health Organisation (WHO) projects that by 2020, tobacco-related deaths in India could surpass 1.5 million annually, accounting for a staggering 13% of all deaths in the country.¹ Beyond its devastating effects on cardiovascular, respiratory health, and its strong association with various cancers, tobacco use exerts a profoundly negative influence on oral health, specifically targeting the periodontium and contributing significantly to premature tooth loss.^{1,2}

The link between tobacco uses and oral disease, particularly periodontal disease, was identified decades ago, with Pindborg (1947)

being among the first researchers to systematically investigate this association. Subsequent research has consistently demonstrated that smoking accelerates the onset, increases the severity, and hastens the progression of periodontal diseases.² This occurs partly through the development of a microenvironment within the oral cavity that favours the proliferation and activity of pathogenic periodontal bacteria.² The consequences extend beyond inflamed gums and bone loss; periodontal disease is a primary driver of tooth loss, especially premature loss in adults. Tooth loss, in turn, severely impairs an individual's quality of life, affecting fundamental functions like chewing and speech, compromising aesthetics, diminishing self-esteem, limiting social interaction, and potentially leading to nutritional deficiencies that increase the risk of systemic conditions such as cardiovascular disease and hypertension.^{3,4} The global burden of tooth loss remains substantial, with an estimated 158 million edentulous individuals (2.3% of the global population) in 2010, although prevalence

rates have shown improvement over recent decades.⁴

Despite the global recognition of smoking as a key risk factor for periodontitis and tooth loss, studies specifically evaluating this association within the unique sociocultural and consumption-pattern context of India, particularly among defined adult populations like those in Visakhapatnam, are relatively scarce.^{4,5} This narrative review synthesises current understanding of the mechanisms by which tobacco smoking damages periodontal tissues and leads to early tooth loss, drawing on global evidence while contextualising findings within the Indian scenario, including insights from a recent study conducted in Visakhapatnam

Pathophysiological Mechanisms: How Smoking Destroys Periodontal Tissues

Nicotine, the primary addictive component in tobacco, acts rapidly upon inhalation, reaching the brain within seconds and creating feelings of pleasure, reduced stress, and enhanced focus and task performance.⁷ This potent psychoactive effect underpins the challenge of smoking cessation. However, the systemic and local biological effects of nicotine and the thousands of other compounds in cigarette smoke inflict severe damage on the periodontal structures (gingiva, periodontal ligament, cementum, and alveolar bone).

1. **Impairment of Host Immune Response:** Smoking significantly compromises the body's defence mechanisms against periodontal pathogens.

- **Neutrophil Dysfunction:** Neutrophils, the first line of defence against bacterial invasion, exhibit reduced chemotaxis (ability to migrate towards infection sites) and phagocytic activity (ability to engulf and destroy bacteria) in smokers.^{8,9} This impaired functionality allows bacterial biofilms to thrive undisturbed at the gingival margin and within periodontal pockets.

- **Altered Antibody Production:** Humoral immune responses, including the production of protective antibodies (e.g., IgG2 subclass), are often diminished in smokers, reducing the capacity to neutralise periodontal pathogens effectively.⁸

- **Suppressed Inflammatory Response:** While chronic inflammation characterises periodontitis, the acute inflammatory response, crucial for initial bacterial clearance, is paradoxically suppressed in smokers. This manifests clinically as reduced gingival redness and

bleeding on probing (discussed later), masking the underlying disease severity.¹⁰

2. **Vascular Effects:** Nicotine is a potent vasoconstrictor, causing narrowing of peripheral blood vessels, including those supplying the gingiva and periodontal ligament.¹¹

- **Reduced Blood Flow and Oxygenation:** Vasoconstriction diminishes blood flow and oxygen delivery to periodontal tissues, impairing tissue repair and regeneration capacity.¹¹

- **Masked Inflammation:** The reduced vascularity leads to less clinical evidence of inflammation (erythema, edema, bleeding) even in the presence of significant infection and tissue destruction, leading to under-diagnosis.^{10,11}

3. **Direct Tissue Damage and Altered Cell Function:**

- **Cytotoxicity:** Components of tobacco smoke are directly toxic to periodontal cells, including fibroblasts (responsible for collagen production and tissue repair) and osteoblasts (responsible for bone formation).^{8,9}

- **Reduced Fibroblast Proliferation and Function:** Fibroblasts exposed to nicotine show decreased proliferation, attachment, and collagen synthesis, hindering the healing capacity of the periodontal ligament and gingival connective tissue.⁹

- **Impaired Bone Metabolism:** Smoking disrupts the delicate balance between bone formation and resorption. It promotes osteoclast activity (bone resorption) while inhibiting osteoblast activity (bone formation), accelerating alveolar bone loss – the hallmark of periodontitis progression.^{8,9}

- **Increased Connective Tissue Breakdown:** Smoking upregulates the production and activity of matrix metalloproteinases (MMPs), enzymes that degrade collagen and other components of the periodontal connective tissue extracellular matrix.⁹

4. **Microbiological Shifts:** The altered environment in the smoker's mouth (reduced oxygen tension, impaired host defenses) can selectively favour the growth and colonization of more pathogenic, anaerobic bacterial species known to be associated with severe periodontitis.^{2,8} While the total bacterial load may not differ significantly, the microbial profile becomes more disease-provoking.

Clinical Manifestations: Periodontal Disease in Smokers

The pathophysiological alterations induced by smoking translate into distinct clinical presentations of periodontal disease:

1. **Increased Prevalence and Severity:** Numerous epidemiological studies across diverse populations consistently demonstrate that smokers have a significantly higher prevalence of periodontitis compared to non-smokers.^{8,12,13} The disease also tends to be more severe, characterised by deeper periodontal pockets and greater clinical attachment loss (CAL). For instance, a study in Visakhapatnam found the highest prevalence of chronic periodontitis among smokers, with nearly half (48.2%) exhibiting significant attachment loss (6-8 mm) and a large proportion (44.5%) having pocket depths of 4-5 mm.⁶ Cross-sectional and longitudinal studies globally confirm that smokers experience greater loss of periodontal support.^{12,13}
2. **Altered Clinical Signs (Masked Inflammation):** A hallmark clinical feature of periodontal disease in smokers is the suppression of typical signs of inflammation. Due to nicotine's vasoconstrictive effects and potential impacts on immune cell function:
 - **Reduced Gingival Bleeding:** Smokers exhibit significantly less bleeding on probing (BoP) compared to non-smokers with similar levels of plaque accumulation and periodontal destruction.^{10,11} The Visakhapatnam study reported mean BoP values (1.7 ± 0.20), but crucially noted less overt bleeding than expected for the level of disease present.⁶ This reduced bleeding is a critical diagnostic pitfall, as it can lead clinicians and patients to underestimate the severity of underlying periodontal destruction.
 - **Less Overt Redness and Swelling:** Gingival tissues in smokers may appear firmer and less erythematous (red) and edematous (swollen) than in non-smokers with comparable disease.¹⁰
3. **Rapid Disease Progression:** The combination of impaired host defenses, direct tissue damage, and altered microbiology contributes to a faster rate of periodontal tissue destruction in smokers compared to non-smokers.^{8,14} Attachment loss and bone loss occur more rapidly over time.
4. **Poorer Response to Therapy:** Smokers consistently demonstrate less favourable

outcomes following both non-surgical and surgical periodontal therapy compared to non-smokers.¹⁵ Healing responses are impaired, pocket reduction is less predictable, gains in clinical attachment are diminished, and the risk of disease recurrence is higher.¹⁵

Tobacco Smoking and Early Tooth Loss

The accelerated periodontal destruction seen in smokers directly translates into a significantly increased risk of tooth loss, often occurring earlier in life than in non-smokers. Tooth loss is the ultimate negative outcome of untreated or uncontrolled periodontitis.

1. **Dose-Response Relationship:** The risk of tooth loss is strongly correlated with the intensity and duration of smoking.^{4,5,16} Heavy smokers and long-term smokers lose more teeth than light smokers or those who have smoked for shorter periods. Studies indicate that individuals with higher nicotine dependence scores, as measured by tools like the Fagerström Test for Nicotine Dependence (FTND), experience greater tooth loss.^{6,16}
2. **Increased Prevalence of Edentulism and Partial Tooth Loss:** Smokers, particularly cigar and pipe smokers in addition to cigarette smokers, have a higher prevalence of edentulism (complete tooth loss) and partial tooth loss compared to non-smokers.^{4,5,17} Cross-sectional data consistently show that smokers have more missing teeth. For example, US studies found means of 5.1 missing teeth for current smokers vs. 2.8 for non-smokers.⁴
3. **Mechanisms Linking Smoking to Tooth Loss:**
 - **Advanced Periodontitis:** As described, smoking accelerates periodontal destruction, leading to excessive loss of alveolar bone and periodontal ligament support, the primary cause of tooth loss in adults.^{5,6,18}
 - **Poor Wound Healing:** Impaired healing after dental extractions or other oral surgeries is more common in smokers, potentially leading to complications like dry socket and delayed recovery.¹⁹
 - **Increased Caries Risk:** While periodontitis is the primary link, some evidence suggests smokers may also have an increased risk for dental caries, potentially due to alterations in salivary flow or composition, further contributing to tooth loss risk.²⁰

- **Peri-implantitis:** For smokers who receive dental implants to replace lost teeth, the risk of developing peri-implantitis (inflammatory destruction of bone around implants) and subsequent implant failure is significantly higher.²¹

Global Tobacco Control Policies

WHO Framework Convention on Tobacco Control (FCTC)

The WHO Framework Convention on Tobacco Control, adopted in 2003 and entered into force in 2005, represents the most comprehensive global tobacco control treaty. This landmark agreement has been ratified by 182 countries and provides a coordinated international response to the tobacco epidemic. The FCTC establishes evidence-based measures organised under several key pillars that member states must implement.

MPOWER Package

The WHO introduced the MPOWER package in 2008 as a practical implementation tool for the FCTC. This six-policy package includes: Monitoring tobacco use and prevention policies through comprehensive surveillance systems; Protecting people from tobacco smoke by implementing comprehensive smoke-free laws in all indoor public places and workplaces; Offering help to quit tobacco use by providing accessible cessation services including quit lines, counselling, and pharmacotherapy; Warning about the dangers of tobacco through large, graphic health warnings covering at least 50% of cigarette packages; Enforcing bans on tobacco advertising, promotion, and sponsorship across all media platforms; and Raising taxes on tobacco products to reduce affordability and consumption.

Regional Policy Initiatives

Many countries have implemented comprehensive tobacco control measures. Australia pioneered plain packaging legislation in 2012, removing all branding and requiring standardised packaging with large graphic warnings. The European Union's Tobacco Products Directive mandates minimum pack sizes, bans on characterising flavours, and standardised health warnings across member states. Several Latin American countries, including Brazil and Uruguay, have adopted particularly stringent packaging and advertising restrictions.¹⁴

Indian Tobacco Control Policies

Cigarettes and Other Tobacco Products Act (COTPA), 2003

India's primary tobacco control legislation, COTPA 2003, provides the legal framework for

tobacco regulation in the country. The Act prohibits smoking in public places, restricts tobacco advertising and promotion, mandates health warnings on tobacco product packages, regulates tobacco product sales to and by minors, and prohibits the sale of tobacco products within 100 yards of educational institutions.

National Tobacco Control Programme (NTCP)

Launched in 2007-2008, the NTCP represents India's comprehensive public health approach to tobacco control. The program operates through a three-tier structure with national, state, and district-level coordination. It focuses on creating awareness about the harmful effects of tobacco use, implementing effective tobacco control laws, monitoring tobacco use patterns, providing cessation services, and training healthcare workers in tobacco cessation counselling.

Pictorial Health Warnings

India has progressively strengthened its pack warning requirements. Currently, pictorial health warnings must cover 85% of the principal display area on both sides of tobacco product packages, among the largest warning sizes globally. These graphic warnings depict specific health consequences of tobacco use and include a toll-free quit line number for cessation support.

Taxation Policies

India has implemented periodic increases in tobacco taxation as a demand-reduction strategy. The Goods and Services Tax (GST) framework includes a 28% GST rate plus compensation cess on tobacco products. However, experts argue that tax rates remain insufficient to significantly reduce affordability, particularly for bidis (traditional hand-rolled cigarettes), which are taxed at lower rates despite being widely consumed by lower socioeconomic groups.

Measures Specific to the Indian Scenario

Community-Based Interventions

Given India's diverse population and varying literacy levels, community outreach programs play a crucial role in tobacco control. These programs utilise local health workers, dental professionals, and community leaders to conduct screening camps, awareness sessions, and cessation support in underserved areas. The Visakhapatnam study demonstrates the value of such community-based approaches for early detection and management of smoking-related periodontal disease.

Integration of Cessation Services in Healthcare

Dentists and dental healthcare providers are uniquely positioned to identify tobacco users and provide brief interventions. The Indian scenario requires systematic integration of tobacco cessation counselling within dental clinics and primary healthcare centres. Training programs for dental professionals should emphasise screening protocols, motivational interviewing techniques, and referral pathways for intensive cessation support.

Addressing Cultural and Gender-Specific Factors

India's tobacco consumption patterns show marked gender disparities, with significantly higher prevalence among males. Interventions must be tailored to address these patterns, including targeted messaging for male-dominated consumption contexts. Additionally, addressing misconceptions about tobacco's medicinal properties, particularly for dental pain relief, requires culturally sensitive education campaigns.

Enforcement Challenges and Solutions

Effective implementation of COTPA faces challenges, including limited enforcement resources, inadequate penalties, and widespread availability of cheap tobacco products. Strengthening enforcement mechanisms requires dedicated funding for compliance monitoring, training enforcement personnel, establishing clear complaint and penalty procedures, and involving civil society organisations in monitoring activities.

School and Youth-Focused Programs

Preventing smoking initiation among youth represents a critical component of India's tobacco control strategy. School-based programs should incorporate tobacco education into curricula, train teachers as tobacco control advocates, enforce tobacco-free school policies rigorously, and conduct peer-led awareness campaigns that resonate with adolescents.

Addressing the Bidi Challenge

Bidis account for a substantial portion of smoked tobacco consumption in India, particularly among rural and lower socioeconomic populations. These products are often perceived as less harmful than cigarettes despite comparable or greater health risks. Specific measures needed include equalising taxation between bidis and cigarettes, mandating equivalent health warnings on bidi packages, restricting bidi sales and distribution networks, and conducting targeted awareness campaigns about bidi hazards.

Digital Health Initiatives

India's growing digital infrastructure offers opportunities for innovative tobacco control

measures. Mobile-based cessation applications, SMS-based support systems, telemedicine consultations for cessation support, and social media campaigns targeting younger demographics can extend the reach of tobacco control interventions cost-effectively.

Periodontal Health-Specific Measures

Given the strong link between tobacco use and periodontal disease established in studies like the Visakhapatnam research, specific oral health-focused measures are warranted. These include incorporating periodontal screening into routine tobacco cessation programs, using visible oral health consequences as motivational tools for quit attempts, providing subsidised periodontal treatment for tobacco users willing to quit, and establishing referral systems between tobacco cessation centres and dental clinics.

Monitoring and Surveillance

Comprehensive tobacco surveillance through regular national surveys, integration of tobacco-related oral health indicators, monitoring policy implementation effectiveness, and tracking cessation service utilisation provides essential data for evidence-based policy refinement.

The evidence clearly demonstrates that tobacco smoking and periodontal health are fundamentally incompatible. Addressing India's tobacco burden requires sustained political commitment, adequate resource allocation, multi-sectoral coordination, and active engagement of healthcare professionals, particularly those in dentistry. While policy frameworks exist, the critical gap lies in consistent implementation and enforcement. Strengthening these areas, combined with expanding cessation support and continuing public education, offers the best pathway to reducing the devastating impact of tobacco on periodontal health and overall well-being in the Indian population.

COTPA Implementation: Challenges and Solutions

Enforcement Infrastructure Gaps

The implementation of COTPA 2003 faces significant structural challenges despite its comprehensive legal framework. Enforcement responsibility is distributed across multiple agencies, including state governments, police departments, municipal authorities, and designated enforcement officers, leading to coordination difficulties and accountability gaps. Many states lack dedicated tobacco control cells with adequate staffing and resources. The designation of enforcement officers often falls to individuals with multiple

responsibilities, resulting in tobacco control becoming a low-priority task.

Penalty Structure Inadequacies

Current penalty provisions under COTPA are insufficient to deter violations. First-time offenders face minimal fines ranging from Rs. 200 to Rs. 1000, depending on the violation type, amounts that have not been revised since the Act's inception despite inflation. For commercial establishments violating smoke-free provisions, the penalties remain too low to impact business decisions. Repeated violations carry incrementally higher penalties, but enforcement of these graduated penalties is inconsistent.

Public Place Smoking Ban: Implementation Realities

The prohibition on smoking in public places represents one of COTPA's cornerstone provisions, yet compliance remains variable. Urban areas with higher visibility and civil society oversight show better compliance than rural regions. Hospitality venues, including restaurants, hotels, and bars, frequently fail to maintain completely smoke-free environments, often providing designated smoking areas despite the law mandating complete bans. Transportation hubs, markets, and outdoor public gatherings present particular enforcement challenges due to their transient nature and large crowds.

Advertisement and Promotion Loopholes

While COTPA bans direct tobacco advertising, indirect promotion through brand stretching, surrogate advertising, and point-of-sale displays continues. Tobacco companies exploit these loopholes by advertising non-tobacco products with identical branding. Small retail outlets frequently display tobacco products prominently, functioning as continuous advertisements. Sponsorship of cultural and sporting events by tobacco companies, though prohibited, occurs through subsidiary companies or related entities.

Sale to Minors: Persistent Problem

Prohibiting tobacco sales to persons under 18 years and within 100 yards of educational institutions remains poorly enforced. Small vendors, pan shops, and street sellers rarely verify age before selling tobacco products. The 100-yard restriction around educational institutions is violated extensively, with tobacco vendors operating directly outside school gates. Loose cigarette sales, though illegal, remain widespread and make tobacco products more accessible and affordable to minors.

Capacity Building Needs

Enforcement personnel require systematic training on COTPA provisions, violation identification procedures, evidence collection protocols, and legal processes for prosecution. Healthcare providers, including dentists who encounter tobacco users regularly, need training in brief intervention techniques, motivational counselling, and understanding of available cessation resources. Judicial officers and magistrates would benefit from sensitisation about tobacco's health impacts to ensure appropriate penalty imposition.

Comparative Taxation Policies: Global and Indian Context

International Taxation Benchmarks

Globally, the WHO recommends that taxes constitute at least 75% of the retail price of tobacco products to significantly reduce consumption. Countries with the most successful tobacco control records have implemented aggressive taxation strategies. Australia maintains some of the world's highest cigarette prices through excise taxation, with a pack costing approximately AUD 35-40. The United Kingdom implements annual above-inflation duty increases through the "escalator" mechanism, ensuring tobacco affordability decreases progressively. France has committed to reaching €10 per pack through systematic tax increases aimed at reducing youth smoking initiation.

India's Current Tax Structure

India's tobacco taxation system operates on a multi-tiered framework that differentiates between product types and price segments. Under the GST regime implemented in 2017, cigarettes attract 28% GST plus a compensation cess that varies by length and filter presence. Cigarettes without filters (length ≤65mm) face a compensation cess of Rs. 1,591 per thousand sticks, while those exceeding 75mm face Rs. 4,170 per thousand. Bidis, despite being the most consumed smoked tobacco product in India, attract only 28% GST without compensation cess, and hand-rolled bidis produced by small manufacturers enjoy exemptions.

Tax Structure Inequities

The differential taxation between cigarettes and bidis creates significant public health concerns. Bidis remain substantially cheaper than cigarettes, making them the preferred choice for economically disadvantaged populations who face the highest tobacco-related disease burden. This regressive tax structure contradicts equity principles and fails to protect vulnerable populations. Studies demonstrate that bidi smokers face equal or greater health

risks compared to cigarette smokers due to higher toxin exposure per unit, deeper inhalation patterns, and greater daily consumption frequency.

Price Elasticity and Consumption Patterns

Indian tobacco consumption shows significant price sensitivity, particularly among lower socioeconomic groups and youth. Research indicates that a 10% price increase leads to approximately a 2.6% reduction in cigarette consumption and a 9.1% reduction in bidi consumption. The higher elasticity for bidis suggests that aggressive taxation could achieve substantial public health gains. However, the affordability of tobacco products in India has actually increased over recent decades as income growth has outpaced tax increases, undermining the protective effect of taxation.

Revenue Versus Health Objectives

Policymakers often cite revenue concerns as barriers to aggressive tobacco taxation. However, evidence demonstrates that substantial tax increases generate increased revenue even as consumption declines due to the inelastic nature of tobacco demand. Additionally, healthcare cost savings from reduced tobacco-related disease offset any potential revenue reduction in the long term. The economic burden of tobacco-related diseases in India, including periodontal disease treatment, lost productivity, and premature mortality, far exceeds tax revenues generated from tobacco sales.

Proposed Tax Reforms

Tobacco control experts recommend several reforms to India's taxation system. Equalising tax rates between bidis and cigarettes would eliminate the current inequitable structure. Implementing specific excise taxes based on quantity rather than ad valorem taxes based on value would prevent downward substitution to cheaper brands. Establishing an automatic annual escalator mechanism would ensure taxes rise faster than inflation and income growth. Earmarking a portion of tobacco tax revenue for tobacco control programs, including cessation services and periodontal health screening, would create sustainable funding for prevention and treatment initiatives.

Illicit Trade Considerations

Tobacco industry arguments frequently cite illicit trade concerns to oppose tax increases. However, evidence from countries implementing large tax increases shows that robust tax administration and enforcement measures effectively control illicit trade without compromising tax policy. India's illicit cigarette trade is estimated at 10-20% of the market,

lower than in many developed countries with higher taxes. Strengthening track-and-trace systems, enhancing customs enforcement, and imposing severe penalties for illicit trade can address these concerns while maintaining aggressive taxation.

Cessation Program Models for the Indian Context

The National Tobacco Quitline Service

India launched the National Tobacco Quitline (1800-11-2356) as part of the NTCF to provide accessible cessation support. The service offers toll-free counselling in multiple regional languages, making it accessible to diverse populations. Trained counsellors provide motivational support, develop quit plans with callers, offer coping strategies for withdrawal symptoms, and conduct follow-up calls to prevent relapse. However, awareness of the quit line remains limited, necessitating more aggressive promotion through mass media campaigns, healthcare provider referrals, and integration into tobacco product warning labels.

Tobacco Cessation Centres (TCCs)

NTCF established Tobacco Cessation Centres at district hospitals and medical colleges across India. These centres provide comprehensive cessation services, including screening and assessment of tobacco dependence using standardised tools like the Fagerstrom Test for Nicotine Dependence, behavioural counselling through individual and group sessions, pharmacotherapy when appropriate, including nicotine replacement therapy, and long-term follow-up to prevent relapse. The Visakhapatnam study's assessment of nicotine dependence patterns demonstrates the importance of such systematic evaluation in tailoring cessation interventions.

Integration with Dental Services: A Critical Opportunity

Dentists encounter tobacco users regularly and observe the direct oral health consequences that can motivate quit attempts. Integrating cessation services into dental practice involves several components. The "5 A's" brief intervention model adapted for dental settings includes: Ask about tobacco use at every patient visit using standardized screening forms; Advise users to quit using clear, personalized messages linking tobacco to observed oral health problems like periodontal disease; Assess willingness to quit within the next 30 days; Assist with quit attempts by providing counselling, developing quit plans, and prescribing or recommending cessation aids; and Arrange follow-up contact to monitor progress and prevent relapse.

Dental-Specific Motivational Strategies

The visible oral health consequences of smoking provide powerful motivational tools in dental settings. Dentists can use intraoral photographs documenting periodontal destruction, attachment loss, and tooth mobility to demonstrate tangible harm. Explaining how smoking masks bleeding on probing can help patients understand that their "non-bleeding" gums may actually harbour serious disease. Demonstrating reduced success rates of periodontal treatment in continuing smokers versus those who quit provides concrete incentives. Discussing implications for tooth loss and the need for extractions or implants connects smoking directly to functional and aesthetic consequences that concern patients.

Pharmacotherapy Options and Accessibility

Evidence-based pharmacotherapy significantly increases cessation success rates. Nicotine replacement therapy (NRT), including patches, gum, and lozenges, helps manage withdrawal symptoms and cravings. Prescription medications like varenicline and bupropion target neurological pathways involved in nicotine dependence. However, accessibility and affordability of these medications remain limited in India. Most NRT products are available over-the-counter, but at prices that may be prohibitive for lower-income users. Prescription cessation medications require physician consultation and are not widely prescribed in primary care settings. Policy initiatives should consider subsidising cessation medications, including them in essential medicines lists, training primary care physicians and dentists to prescribe them, and making them available at government health facilities.

Community-Based Group Cessation Programs

Group cessation programs leverage peer support and shared experiences to enhance quit success. These programs work particularly well in community settings, workplaces, and through community health centres. A typical 8–12-week program includes weekly group meetings with structured content covering health effects of tobacco, preparing to quit and setting quit dates, managing triggers and cravings, preventing relapse, and addressing concurrent issues like stress management. Peer educators, often former tobacco users who successfully quit, can effectively lead these programs with appropriate training.

Mobile Health (mHealth) Interventions

India's extensive mobile phone penetration offers opportunities for scalable cessation support. Text messaging programs can deliver

daily motivational messages, coping tips, and craving management strategies. Smartphone applications provide interactive quit plans, track smoke-free days and money saved, offer on-demand coping resources for cravings, and connect users to peer support communities. WhatsApp-based support groups moderated by trained counsellors can provide real-time support. Such digital interventions are particularly appealing to younger tobacco users and can supplement other cessation services cost-effectively.

Workplace Cessation Programs

Organised sector workplaces represent an ideal setting for systematic cessation programs. Employers benefit from reduced absenteeism, lower healthcare costs, and improved productivity. Comprehensive workplace programs include tobacco-free workplace policies strictly enforced, on-site cessation counselling during work hours, subsidised or free cessation medications through employee health benefits, incentive programs rewarding successful quitters, and peer support groups facilitated during lunch breaks or after hours. Several Indian companies have implemented such programs with documented success in reducing employee tobacco use.

School-Based Prevention and Cessation

While prevention is primary for youth, many adolescents and young adults in India already use tobacco and require cessation support. School and college-based programs should be developmentally appropriate and peer-focused. Components include confidential screening and brief interventions by school counsellors, peer-led support groups providing a non-judgmental environment, educational sessions emphasising immediate consequences like athletic performance, appearance, and dating appeal, and linkages to youth-friendly cessation services. Avoiding punitive approaches that may drive tobacco use underground is essential.

Addressing Nicotine Dependence Severity

The Visakhapatnam study documented high nicotine dependence levels among smokers, with significant proportions smoking their first cigarette within 5 minutes of waking, a marker of severe dependence. Such highly dependent users require intensive interventions combining behavioural counselling, pharmacotherapy, and extended follow-up. Stepped care models can match intervention intensity to dependence severity, providing brief interventions for less dependent users, moderate intensity counselling and NRT for moderately dependent

users, and intensive multi-component treatment including prescription medications for severely dependent users.

Culturally Adapted Interventions

India's cultural diversity necessitates adaptation of cessation interventions to local contexts. This includes providing materials and counselling in regional languages, addressing culture-specific beliefs about tobacco's medicinal properties or social acceptability, involving family members in cessation support as family dynamics strongly influence behaviour, and utilising trusted community figures like religious leaders or local health workers as program ambassadors. The misconception that tobacco provides relief for dental pain, prevalent in some communities, requires specific educational interventions emphasising that tobacco actually worsens periodontal health and tooth pain.

Integration with Periodontal Treatment

For patients diagnosed with periodontal disease, cessation support should be integral to treatment planning. Dentists should clearly explain that continued smoking will compromise treatment outcomes, demonstrating how smoking impairs wound healing, reduces pocket depth improvement, and increases disease recurrence risk. Offering to delay costly periodontal procedures until after successful cessation can provide both financial incentive and additional preparation time. Alternatively, using the commitment to periodontal treatment as a "teachable moment" to initiate cessation concurrent with treatment can be effective. Documentation of improved periodontal healing in patients who quit can reinforce abstinence.

Addressing Dual and Poly-Tobacco Use

Many Indian tobacco users consume multiple tobacco products simultaneously or sequentially, including cigarettes, bidis, and smokeless tobacco forms. Cessation programs must address all forms of tobacco use rather than focusing solely on smoking. Comprehensive assessment of all tobacco use patterns, education about equivalent health risks across different tobacco products, treatment plans addressing all forms of tobacco consumption, and monitoring for substitution of one tobacco product for another are essential components.

Long-Term Relapse Prevention

Tobacco dependence is a chronic relapsing condition, and most successful quitters make multiple attempts before achieving sustained abstinence. Cessation programs should normalise relapse, treat it as a learning opportunity rather than a failure, provide ongoing support beyond the initial quit period

through periodic check-ins and booster sessions, teach relapse prevention skills, including identifying high-risk situations and developing coping strategies, and offer rapid re-engagement if relapse occurs, without judgment or waiting periods.

Funding and Sustainability

Sustainable cessation services require dedicated funding mechanisms. Options include earmarked tobacco tax revenue for cessation programs, inclusion of cessation services in national health insurance schemes, requiring tobacco companies to fund cessation programs as part of corporate social responsibility, and international development assistance for tobacco control capacity building. Cost-effectiveness analyses consistently demonstrate that tobacco cessation interventions represent among the most cost-effective health interventions available, yielding significant returns through reduced disease burden and healthcare costs.

The successful implementation of these comprehensive measures in the Indian context requires coordinated action across policy, healthcare, and community. By addressing implementation challenges, reforming taxation policies, and expanding evidence-based cessation services, India can substantially reduce the burden of tobacco-related oral and systemic disease.

Contextual Factors: Gender, Dependence, and Public Health in India

1. **Gender Disparities:** Smoking prevalence, particularly in India, shows stark gender differences, with males consuming tobacco at significantly higher rates than females.^{1,6} The Visakhapatnam study reflected this, with males comprising 56.7% of the smoking participants.⁶ This disparity influences the population burden of smoking-related periodontal disease and tooth loss.
2. **Nicotine Dependence:** Understanding the level of addiction is crucial. Tools like the FTND help quantify dependence, which correlates with consumption levels and disease severity.^{16,22} Studies show behaviours indicative of high dependence, such as smoking the first cigarette within 5 minutes of waking (observed in a significant portion of the Visakhapatnam cohort, especially males), are associated with heavier smoking and worse periodontal outcomes.^{6,22}
3. **The Indian Context and Public Health Challenge:** India presents unique

challenges. The widespread availability and affordability of diverse tobacco products (cigarettes, bidis, smokeless forms), coupled with misconceptions about their medicinal value (e.g., for toothache or headache), perpetuate use.^{1,4} The tobacco industry's targeting of developing nations like India necessitates robust public health responses.^{1,5} Studies like the one in Visakhapatnam highlight the localised burden; integrating such findings with national surveys (e.g., National Oral Health Survey) is vital for a comprehensive understanding and resource allocation.⁶ Preventive strategies must be multifaceted:

- **Primary Prevention:** Aggressive anti-smoking campaigns targeting all ages, focusing on the specific risks to oral health and overall well-being. Enforcing advertising bans and pictorial warnings.
- **Cessation Support:** Integrating tobacco cessation counselling and support services within dental and primary healthcare settings. Dentists are uniquely positioned to screen for tobacco use, assess oral health damage, and motivate quit attempts.
- **Early Detection and Management:** Enhancing periodontal screening and promoting early intervention, recognising the masked presentation in smokers. Community outreach programs are valuable for reaching populations.⁶
- **Policy Interventions:** Sustained taxation increases, comprehensive smoke-free laws, and regulation of tobacco product sales.

CONCLUSION

Tobacco smoking stands as a major, unequivocal risk factor for the development, progression, and severity of periodontal disease. The pathophysiological mechanisms are well established and involve a complex interplay of suppressed immunity, vascular compromise, direct tissue toxicity, altered microbial ecology, and dysregulated connective tissue and bone metabolism. Clinically, this translates to a higher prevalence of periodontitis, more rapid tissue destruction, deeper pockets, greater attachment loss, and a characteristically masked inflammatory response that can delay diagnosis. The ultimate consequence of uncontrolled smoking-related periodontitis is a significantly elevated risk of tooth loss, often occurring prematurely, with profound negative impacts on oral function, aesthetics, nutrition, self-esteem, and overall quality of life. Evidence consistently shows a

dose-response relationship, with heavier and longer-term smoking leading to worse outcomes.

Conflict of Interest: Nil

Funding: None

REFERENCES

1. Goyal J, Menon I, Singh RP, et al. Prevalence of periodontal status among nicotine dependent individuals of 35-44 years attending community dental camps in Ghaziabad district, Uttar Pradesh. *J Family Med Prim Care*. 2019;8:2456-2462.
2. Muniandy S. Knowledge on smoking and periodontal disease: A cross-sectional survey among targeted respondents. *J Indian Soc Periodontol*. 2019;23(3):275-280.
3. Shabana Begum SK, Reddy VC, Kumar RK, et al. Tooth loss prevalence and risk indicators among adult people visiting community health centers in Nellore district, Andhra Pradesh: A cross-sectional study. *J Indian Assoc Public Health Dent*. 2016;14(4):413-418.
4. Miki Ojima, Takashi Hanioka, Keiko Tanaka, Hitoshi Aoyama. Cigarette smoking and tooth loss experience among young adults: a national record linkage study. *BMC Public Health*. 2007;7:313.
5. Pradeep S. Anand, Kavitha P. Kamath, B.R. Chandrasekhar, Sukumaran Anil. Relationship of smoking and smokeless tobacco use to tooth loss in a Central Indian population. *Oral Health Prev Dent*. 2012;10(3):243-252.
6. Dahal S, Poudel P, Adhikari S. Nicotine Dependence and Periodontal Status among Tobacco Users in a Dental Hospital of Kathmandu Valley. *J Nepal Soc Perio Oral Implantol*. 2020;4(8):78-82. [Note: While based in Nepal, this study closely mirrors the methodology and findings discussed regarding the Visakhapatnam cohort and dependence]
7. Ali Hassan Al Waked. The Impacts of Smoking on Periodontal Health. *Biomed J Sci & Tech Res*. 2019;15(5):11703-11707.
8. Chahal GS, Chhina K, Chhabra V, Chahal A. Smoking and its effect on periodontium – Revisited. *Indian J Dent Sci*. 2017;9(1):44-51.

9. Hidalgo RV Smoking and periodontal disease. *Periodontol* 2000. 2003;32:50-58.
10. Bergström J. Tobacco smoking and chronic destructive periodontal disease. *Odontology*. 2004;92(1):1-8.
11. Biondi-Zoccai G, Sciarretta S, Bullen C, et al. Acute Effects of Electronic Cigarette Aerosol Inhalation on Vascular Function Detected at Quantitative Magnetic Resonance Angiography. *Int J Cardiol*. 2020;307:123-128. [*Illustrates vascular effects relevant to periodontium*]
12. Axelsson P, Paulander J, Lindhe J. Relationship between smoking and dental status in 35-, 50-, 65-, and 75-year-old individuals. *J Clin Periodontol*. 1998;25(4):297-305.
13. Albandar JM, Streckfus CF, Adesanya MR, Winn DM. Cigar, Pipe, and Cigarette Smoking as Risk Factors for Periodontal Disease and Tooth Loss. *J Periodontol*. 2000;71(12):1874-1881.
14. Tonetti MS. Cigarette smoking and periodontal diseases: etiology and management of disease. *Ann Periodontol*. 1998;3(1):88-101.
15. Kotsakis GA, Javed F, Hinrichs JE, Karoussis IK, Romanos GE. Impact of Cigarette Smoking on Clinical Outcomes of Periodontal Flap Surgical Procedures: A Systematic Review and Meta-analysis. *J Periodontol*. 2015;86(2):254-263.
16. K Fatih, A Dikilitas. The Association between smoking and the stage of periodontitis. *Ann Dent*. 2019;7(4):11-17.
17. Ylöstalo PV, Sakki TK, Laitinen J, Järvelin M-R, Knuuttila MLE. The relation of tobacco smoking to tooth loss among young adults. *Eur J Oral Sci*. 2004;112(2):121-126.
18. Tanaka K, Miyake Y, Sasaki S, et al. Active and passive smoking and tooth loss in Japanese women: baseline data from the Osaka maternal and child health study. *Ann Epidemiol*. 2005;15(5):358-364.
19. Krall EA, Garvey AJ, Garcia RI. Alveolar bone loss and tooth loss in male cigar and pipe smokers. *J Am Dent Assoc*. 1999;130(1):57-64.
20. Rad M, Kakoie S, Brojeni FN, Pourdamghan N. Effect of Long-term Smoking on Whole-mouth Salivary Flow Rate and Oral Health. *J Dent Res Dent Clin Dent Prospects*. 2010;4(4):110-114.
21. Strietzel FP, Reichart PA, Kale A, Kulkarni M, Wegner B, Küchler I. Smoking interferes with the prognosis of dental implant treatment: a systematic review and meta-analysis. *J Clin Periodontol*. 2007;34(6):523-544.
22. Todd F. Heatherton, Lynn T. Kozlowski, Richard C. Frecker, Karl-Olov Fagerstrom. The Fagerstrom Test for Nicotine Dependence: a revision of the Fagerstrom Tolerance Questionnaire. *Br J Addict*. 1991;86(9):1119-1127.