

From Peer Pressure to Point-of-Sale: A Narrative Review of Adolescent Tobacco and Arecanut Use in North India and the Gap Between Policy and Practice

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Abstract

Adolescent tobacco and arecanut use remains an important and preventable public health concern in North India, where initiation frequently occurs during adolescence and is influenced by peer and family exposure, marketing practices, product availability, and the implementation of tobacco-control measures. This narrative review synthesizes findings from three recent school-based studies conducted among adolescents in the Mathura region of Uttar Pradesh. The studies examined the prevalence of tobacco and arecanut use and associated oral mucosal lesions; adolescents' exposure to tobacco marketing in relation to exposure to preventive health messages; and peer- and family-related factors associated with the initiation of arecanut and smokeless tobacco use. These findings are considered alongside evidence from the broader Indian literature concerning point-of-sale compliance, school-based tobacco-prevention programs, and the use of tobacco-containing dentifrices as a potential route of early tobacco exposure. Collectively, the available evidence indicates a persistent gap between the formal protections provided by India's tobacco-control legislation and adolescents' reported exposure to tobacco products and related influences. Marketing exposure, product accessibility, and social normalization within peer and family environments may limit the effectiveness of preventive messaging and existing regulatory measures. Important gaps remain in the evidence base, including the limited availability of longitudinal studies, variation in the operational definitions of smokeless tobacco use, insufficient region-specific data on vendor compliance, and the limited evaluation of culturally and contextually adapted school-based interventions. Future research should prioritize longitudinal investigation of initiation pathways, standardized definitions and measurement tools, systematic assessment of point-of-sale compliance, and rigorous evaluation of locally adapted prevention strategies.

Keywords: Adolescent tobacco use, arecanut, smokeless tobacco, point-of-sale compliance

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Methods

This study was conducted as a narrative review rather than a systematic review or meta-analysis. The review was structured around three primary studies conducted by our research group among school-going adolescents in the Mathura region of Uttar Pradesh, India [1-3]. These studies were supplemented by a targeted, non-exhaustive search of the Indian and international literature addressing adolescent tobacco and arecanut use, tobacco-control policy implementation, point-of-sale (POS) compliance, tobacco marketing exposure, and school-based prevention programs.

The objective of the review was to synthesize findings across these complementary sources, contextualize the Mathura findings within the existing evidence base, and identify important gaps requiring further investigation. Because the review was not designed as a systematic review, no formal risk-of-bias assessment, study-quality scoring, or quantitative pooling of effect estimates was undertaken. The interpretation therefore emphasizes consistency and divergence across studies and considers the methodological and contextual limitations of the available evidence.

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Prevalence and Oral Health Burden

The first study conducted by our group assessed the prevalence of tobacco and arecanut use among school-going adolescents in Mathura city and examined associated oral mucosal findings [1]. The study documented the presence of both smoked and smokeless tobacco use among adolescents and identified oral mucosal changes in a proportion of users. These findings are consistent with evidence from other Indian settings indicating that smokeless tobacco products, including gutka, khaini, and zarda, are used by adolescents and young people and are associated with adverse oral health outcomes, including oral potentially malignant disorders and an increased long-term risk of oral cancer [4].

The observed pattern is not restricted to Mathura. National and regional evidence indicates that adolescents may be exposed to a range of smokeless tobacco and arecanut-containing products, including paan, zarda, gutka, and other commercially prepared products. Tobacco-containing dentifrices may represent an additional and less readily recognized source of exposure [5, 6]. However, direct comparisons of prevalence estimates across studies should be interpreted cautiously because studies differ in sampling strategies, age groups, definitions of tobacco and arecanut use, and methods of assessing exposure.

The contribution of the Mathura study is therefore primarily regional. It provides evidence from an area of Uttar Pradesh that has received comparatively less research attention than several major metropolitan settings in India. Such region-specific data are important because patterns of product availability, social norms, marketing exposure, and tobacco-control implementation may vary substantially across geographic and socioeconomic contexts.

Marketing Exposure and Preventive Messaging

The second study examined adolescents' exposure to tobacco-related marketing and cues in comparison with exposure to preventive health messaging within the same school-based population [2]. The findings indicated that tobacco-related marketing cues were relatively more salient to adolescents than preventive health messages. Although this finding does not establish a causal relationship between marketing exposure and tobacco initiation, it highlights a potential imbalance between commercial exposure and prevention-oriented communication in adolescents' everyday environments.

This observation is broadly consistent with evidence from other Indian settings. For example, a study conducted in Mumbai involving 675 tobacco retailers documented substantial tobacco-related point-of-sale advertising, despite regulatory provisions intended to restrict tobacco promotion and protect young people from exposure [7]. Taken together, these findings suggest that adolescents may encounter tobacco-related cues through community retail environments as well as through social and interpersonal networks, while preventive messages may have more limited or intermittent exposure.

The comparison should nevertheless be interpreted

in its appropriate context. The Mathura study assessed adolescents' reported or cognitive exposure to tobacco-related and preventive messages, whereas POS studies generally evaluate characteristics of retail environments. These measures are not directly equivalent. Further research combining adolescent-level exposure assessments with systematic observation of retail environments could provide stronger evidence regarding the relationship between marketing exposure, product availability, and tobacco initiation.

Peer- and Family-Related Pathways to Uptake

The third study investigated the social pathways associated with the initiation of arecanut and smokeless tobacco use among schoolchildren in the study population, with particular attention to peer influence [3]. Peer-related influences were identified as an important factor in the circumstances surrounding initial use. This finding is consistent with the broader literature on adolescent risk behaviors, in which peer norms, perceived social acceptance, and opportunities for experimentation have been identified as important influences on substance-use initiation.

Family exposure also represented a relevant pathway in this population. Previous research in India has similarly described associations between tobacco use among household members and adolescents' exposure to tobacco products within the home environment. In some settings, children may also be asked to purchase tobacco products for adult family members, potentially increasing their familiarity with tobacco products and contributing to their normalization within everyday family life.

These findings suggest that adolescent tobacco prevention should not focus exclusively on individual knowledge or decision-making. Peer norms and family practices may influence the social acceptability and accessibility of tobacco and arecanut products. However, because the available evidence is predominantly cross-sectional, the direction and magnitude of these relationships cannot be established definitively. Longitudinal studies are needed to distinguish factors that precede initiation from those that emerge after tobacco use has already begun.

Regulatory Framework and the Enforcement Gap

India's tobacco-control framework includes specific measures intended to reduce adolescent access to tobacco products. Section 6 of the Cigarettes and Other Tobacco Products Act (COTPA) prohibits the sale of tobacco products to persons below 18 years of age and includes restrictions concerning tobacco sales in proximity to educational institutions. However, evidence from multiple Indian settings indicates substantial variation in compliance with these provisions.

An observational study of tobacco retailers in urban Puducherry found that none of the assessed outlets achieved full compliance with the relevant COTPA point-of-sale requirements [7]. In Mumbai, research involving high school students and tobacco vendors reported an association between tobacco use, perceived

ease of access, and vendor-level compliance with COTPA provisions, suggesting that weaknesses in regulatory implementation may affect adolescents' ability to obtain tobacco products [5]. Similarly, a multi-state observational study covering Bihar, Karnataka, Kerala, Maharashtra, and Rajasthan documented inconsistent compliance with provisions related to youth access and tobacco advertising [8].

Collectively, these studies indicate that the existence of tobacco-control legislation does not necessarily translate into uniform implementation at the point of sale. Nevertheless, the available evidence should not be interpreted as demonstrating that enforcement failure is the sole determinant of adolescent tobacco use. Product availability interacts with social influences, family practices, marketing exposure, individual attitudes, and other contextual factors.

Our group's subsequent work, currently in preparation, is intended to examine this issue from the adolescent perspective by assessing whether young people report experiencing the protections established by tobacco-control legislation [3]. Because these findings have not yet undergone formal peer review, they should be considered preliminary and are not presented as definitive evidence. If confirmed in a completed and independently evaluated study, such findings could complement vendor-based compliance assessments by providing information on whether regulatory protections are reflected in adolescents' actual experiences.

Tobacco-Containing Dentifrices: An Under-Recognized Exposure Pathway

Tobacco-containing dentifrices represent a potentially important but insufficiently recognized pathway of tobacco exposure in parts of India. Tobacco-containing tooth powders and related oral-care products have historically been marketed or perceived as dental-care products, despite the presence of tobacco or nicotine in some formulations. Previous chemical analyses have reported nicotine in commercially available toothpowder products, while public misconceptions regarding the perceived dental benefits of tobacco may contribute to their continued use [6].

This issue has important implications for epidemiological assessment. Adolescents or parents may not recognize dentifrice use as tobacco exposure when tobacco-containing products are perceived primarily as oral-hygiene products. Consequently, questionnaires that assess tobacco use only through conventional categories such as smoking, chewing tobacco, or smokeless tobacco may fail to identify some forms of exposure.

This potential misclassification is particularly relevant to studies conducted in regions where tobacco-containing dentifrices remain available. In our own research, variation in the classification of dentifrice-only use across questionnaire items represented a methodological limitation. Future prevalence studies should therefore provide explicit definitions and separate questionnaire items for tobacco-containing dentifrices, arecanut-containing products, and other forms of smokeless tobacco.

Standardized definitions would improve comparability across studies and reduce the potential for underestimation of adolescent tobacco exposure.

School-Based Interventions: Evidence and Research Gaps

School-based prevention represents an important component of adolescent tobacco control because schools provide access to large groups of young people before tobacco-use patterns become firmly established. However, the India-specific evidence base for school-based tobacco-prevention programs remains limited. A systematic review of school-based tobacco-prevention programs among adolescents in India identified only 13 eligible studies published between 2000 and 2020 from approximately 8,000 records screened [9]. This relatively small evidence base limits the ability to determine which intervention components are most effective across different Indian settings.

Available evidence suggests that school-based interventions can improve tobacco-related knowledge and attitudes and may reduce tobacco use, particularly when programs involve repeated exposure, follow-up sessions, and multiple points of contact rather than relying on a single educational session [9]. These findings support the development of sustained, school-based approaches that combine health education with skills related to refusal, decision-making, and resistance to peer influence.

The findings from the Mathura studies further indicate that school-based prevention should be considered within the broader social and commercial environment in which adolescents make decisions about tobacco and arecanut use. Educational interventions may have limited impact when adolescents simultaneously encounter tobacco products through peers, family members, and retail environments. Accordingly, prevention programs may benefit from integrating classroom education with family engagement, peer-led approaches, community-level awareness, and stronger implementation of tobacco-control regulations.

Our group's school-based tobacco-prevention activities in the Mathura region were developed within this context but have not yet been formally evaluated using a controlled or prospective design. Future research should therefore assess such programs using standardized outcomes and appropriate comparison groups, with follow-up periods sufficient to determine whether improvements in knowledge and attitudes translate into measurable reductions in tobacco and arecanut initiation or use.

Synthesis

Taken together, the three studies conducted in the Mathura region, considered alongside the broader Indian literature, suggest a multifactorial pattern of adolescent tobacco and arecanut exposure. Initiation appears to occur within interconnected social and environmental contexts, including peer and family influences, exposure to tobacco-related marketing, and access to tobacco products. The available evidence also indicates a potential mismatch between the formal protections

provided by tobacco-control legislation and adolescents' experiences of tobacco availability and exposure. Similar implementation challenges have been reported in other Indian settings, although the magnitude and determinants of these challenges may vary geographically.

An additional concern is the potential under-recognition of tobacco exposure through products that are not consistently classified as conventional tobacco products, particularly tobacco-containing dentifrices. Variation in questionnaire definitions and product categorization may contribute to differences in reported prevalence and limit comparisons between studies. This issue highlights the importance of developing standardized measures that capture the range of tobacco and arecanut products encountered by adolescents.

School-based prevention represents a potentially practical component of a comprehensive tobacco-control strategy because schools provide an established setting for reaching adolescents at a critical stage of behavioral development. However, the limited number of rigorously evaluated school-based interventions in India makes it difficult to determine which approaches are most effective across different cultural and geographic settings. In the Mathura region specifically, there is a need for locally adapted interventions that address not only knowledge and attitudes but also peer influence, family exposure, product accessibility, and exposure to tobacco marketing.

Overall, the available evidence supports a multidimensional approach in which adolescent education is complemented by family and community engagement and effective implementation of tobacco-control regulations. However, the cross-sectional nature of much of the existing evidence limits causal interpretation, and further research is required to establish the temporal relationships among exposure, initiation, and continued use.

Identified Gaps in the Current Evidence

Several important gaps emerge from the available literature and the findings of the studies reviewed:

- **Limited longitudinal evidence:** The three studies conducted by our group, as well as much of the cited Indian literature, use cross-sectional designs. Consequently, the temporal relationships among marketing exposure, peer and family influences, tobacco initiation, and subsequent patterns of use cannot be established reliably.
- **Inconsistent definitions of smokeless tobacco exposure:** Studies vary in how they define and classify smokeless tobacco use, particularly with respect to tobacco-containing dentifrices and products containing both tobacco and arecanut. Such variation reduces comparability between studies and may result in underestimation of exposure when specific products are not explicitly assessed.
- **Insufficient region-specific point-of-sale compliance data:** Although point-of-sale compliance has been investigated in settings such as Mumbai and Puducherry and in multi-state studies, comparable vendor-level data from the Mathura–Agra region remain limited. Region-specific observational studies are therefore needed

to determine the extent to which COTPA provisions are implemented in local retail environments.

- **Limited evaluation of locally adapted school-based interventions:** Although school-based tobacco-prevention programs have demonstrated potential benefits in India, evidence regarding their effectiveness remains limited. Existing prevention activities in the Mathura region, including those undertaken by our group, require formal evaluation using prospective or controlled study designs before their effectiveness can be established.

- **Insufficient understanding of gender-related differences in access:** Preliminary observations suggest that access to tobacco products and experiences of refusal may differ by gender. However, the mechanisms underlying such differences remain unclear and may involve both vendor practices and differences in adolescents' purchasing behavior. These factors should be investigated using appropriately designed observational and analytical studies.

- **Limited assessment of nicotine dependence:** Few studies in this population have incorporated validated measures of nicotine dependence or biological markers of tobacco exposure. The absence of standardized dependence assessments limits comparisons with clinical and epidemiological studies of tobacco addiction and makes it difficult to characterize the transition from experimentation to established dependence.

Directions for Future Research

The evidence gaps identified in this review provide a basis for a focused research agenda for North India. Priority areas include:

- **Longitudinal cohort studies:** Adolescents should be followed from early secondary school through late adolescence to establish the temporal sequence between exposure to tobacco marketing, peer and family influences, initiation, and progression to regular use.
- **Standardized assessment of tobacco exposure:** Future studies should use a clearly defined and comprehensive classification system for smokeless tobacco and arecanut products, including tobacco-containing dentifrices. Explicit product-level questions would improve prevalence estimates and facilitate comparisons across regions and studies.
- **Region-specific point-of-sale surveillance:** Observational studies of tobacco retailers in the Mathura–Agra region should assess compliance with relevant COTPA provisions using standardized criteria comparable with those used in studies from other Indian settings. Repeated assessments could additionally determine whether compliance changes over time following enforcement or educational initiatives.
- **Rigorous evaluation of school-based interventions:** Existing prevention activities should be evaluated using prospective pre–post designs, controlled studies, or cluster-randomized approaches where feasible. Outcomes should extend beyond knowledge and attitudes to include tobacco initiation, current use, exposure to tobacco products, and relevant behavioral indicators.
- **Gender-stratified research on tobacco access:**

Future studies should examine whether observed gender differences in refusal and purchase success arise primarily from vendor behavior, adolescent purchasing behavior, differences in product use, or interactions among these factors.

- Early identification of tobacco-related oral health outcomes: There is potential value in evaluating low-cost digital screening and decision-support approaches that could assist school health personnel or community health workers in identifying suspicious oral mucosal changes and referring adolescents for appropriate clinical assessment. Any artificial intelligence (AI)-assisted approach should undergo prospective validation against qualified clinical assessment before implementation and should be evaluated for diagnostic accuracy, feasibility, and potential bias.

These priorities should be pursued within a coordinated regional research framework that combines epidemiological surveillance, policy implementation research, school-based prevention, and oral health assessment.

Limitations of This Review

This narrative review has several limitations. First, it was not conducted according to a preregistered systematic-review protocol and did not involve an exhaustive database search or formal assessment of the methodological quality or risk of bias of all included studies. Consequently, relevant studies may have been missed, and the selection of supporting literature may reflect the authors' research focus.

Second, three of the principal studies discussed were conducted by the same research group and involved overlapping geographic and, potentially, participant populations. Although integrating these studies provides a coherent regional perspective, it may also introduce investigator-related and geographic concentration bias. The findings should therefore not be considered representative of all adolescents in Uttar Pradesh or North India without confirmation from independent studies and more diverse populations.

Third, much of the available evidence is cross-sectional, limiting the ability to infer causal relationships between social influences, marketing exposure, product accessibility, and tobacco initiation. Fourth, differences in study populations, product definitions, measurement instruments, and outcome classifications limit direct comparison across studies.

Finally, some observations discussed in relation to ongoing or unpublished research are preliminary and have not undergone independent peer review. These findings have therefore been presented as areas for future investigation rather than as established evidence. Further studies conducted by independent research groups using standardized methods are needed to confirm the regional patterns identified in this review.

In conclusion, the available evidence suggests that adolescent tobacco and arecanut use in the Mathura region of North India is influenced by interconnected social, commercial, and regulatory factors. Peer and

family environments may contribute to early exposure and initiation, while tobacco-related marketing and product accessibility may reinforce tobacco-related behaviors. At the same time, evidence from several Indian settings indicates that the implementation of existing tobacco-control provisions remains inconsistent.

The review also highlights important methodological challenges, particularly variation in the definition and measurement of smokeless tobacco exposure and the potential under-recognition of tobacco-containing dentifrices. These issues, together with the predominance of cross-sectional studies, limit the comparability and causal interpretation of the current evidence.

A focused regional research agenda should therefore prioritize longitudinal studies, standardized assessment of tobacco and arecanut products, systematic evaluation of point-of-sale compliance, and rigorous testing of locally adapted school-based prevention programs. Strengthening the evidence in these areas could help determine whether existing tobacco-control policies are effectively reaching adolescents and identify practical strategies for reducing tobacco and arecanut initiation in North India.

Conflict of Interest

The authors declare that they have no conflict of interest.

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Statement of Transparency and Principles

- The authors declare no conflict of interest.
- All authors contributed to the implementation of this research.

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