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Original Article

Tobacco use Patterns and their Contribution to NCD Risk Among Adolescents In Dhubri District – A Community-Based Cross-Sectional Study

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ABSTRACT

Background: Tobacco use initiated during adolescence contributes to long-term non-communicable disease (NCD) risk and remains a key preventable public health problem in India. This study assessed tobacco use patterns and examined their contribution to selected NCD risk indicators among adolescents in Dhubri district.
Methods: A community-based cross-sectional study was conducted from June to November 2025 in the field practice area of Dhubri Medical College, Assam. A total of 200 adolescents (10–19 years) were selected using multistage sampling and interviewed using a pre-tested questionnaire. Current tobacco use was defined as any tobacco use in the past 30 days. Anthropometry and blood pressure were measured using standard procedures. Associations were assessed using chi-square tests and multivariable logistic regression, reporting adjusted odds ratios (aOR) with 95% confidence intervals (CI).
Results: Ever tobacco use was 27.0% (54/200; 95% CI 21.3–33.5) and current tobacco use was 13.5% (27/200; 95% CI 9.4–18.9). Among current users, smokeless tobacco (44.4%) was most common, followed by smoked tobacco (40.7%) and dual use (14.8%); 66.7% reported daily use. Mean age at initiation was 13.8 ± 1.9 years, and 68.5% initiated before 15 years. In multivariable analysis, current tobacco use was independently associated with male sex (aOR 4.19, 95% CI 1.43–12.31), out-of-school status (aOR 4.44, 95% CI 1.53–12.94), and parental tobacco use (aOR 2.70, 95% CI 1.06–6.92). Current users had a higher prevalence of composite NCD risk (≥2 indicators) than non-users (40.7% vs 23.7%), but the adjusted association was not statistically significant (aOR 1.69, 95% CI 0.69–4.11).
Conclusion: Approximately one in seven adolescents in Dhubri were current tobacco users, with early initiation and predominance of smokeless/dual patterns. Male adolescents, out-of-school youth, and those with parental tobacco exposure represent priority groups for early, community-oriented tobacco prevention integrated with adolescent NCD risk reduction..

Keywords*: Adolescents; tobacco use; smokeless tobacco; dual use; determinants; NCD risk factors; blood pressure; India; Assam; cross-sectional study.*

INTRODUCTION

Tobacco use typically begins during adolescence, and early initiation increases the likelihood of sustained use into adulthood, strengthening the lifetime risk of major non-communicable diseases (NCDs) such as cardiovascular disease, chronic respiratory disease, and cancers. In India, adolescent tobacco use has been recognized for decades as a growing public health concern, with early reports documenting experimentation and regular use patterns among school-aged youth and highlighting the need for prevention strategies before habits become established. [1] From a Community Medicine perspective, adolescent tobacco use is especially important because it is shaped by modifiable environmental and social determinants—family and peer influence, accessibility of products, and exposure to marketing—and therefore lends itself to population-level interventions.

Evidence from India shows that adolescent tobacco use is not only prevalent but also behaviourally dynamic, with initiation and progression influenced by context and policy environment. Longitudinal evidence has demonstrated that adolescent tobacco use patterns change over time and are responsive to the broader tobacco control landscape, emphasizing the importance of monitoring trends and local determinants in order to guide prevention programs. [2] Studies from Indian states further show that prevalence and correlates can vary substantially across regions, reflecting differences in social norms, product availability (smoked and smokeless forms), and household exposures. For example, community-based evidence from Kerala reported measurable prevalence of adolescent tobacco use and identified correlates that can inform targeted risk communication and school/community action. [3]

Marketing and social influence remain major drivers of uptake in adolescents. In urban Indian cohorts, exposure to tobacco advertisements has been shown to increase the likelihood of tobacco use over time, underscoring the role of commercial determinants and the need for effective enforcement of advertising restrictions. [4] In addition, reviews focusing on school-going adolescents in India have consistently highlighted that tobacco use is multifactorial, influenced by individual susceptibility, peer networks, and the surrounding environment—suggesting that single-point interventions are unlikely to be sufficient without complementary community and policy measures. [5]

Dhubri district presents a relevant public health context to examine adolescent tobacco use because of its diverse socio-demographic composition and potential variations in access, household exposure, and community norms. Generating local evidence on patterns of tobacco use (smoked, smokeless, and dual use) and quantifying their contribution to NCD risk indicators among adolescents can support district-level planning for tobacco control and adolescent health services. Accordingly, this community-based cross-sectional study in Dhubri district was undertaken to assess (i) the prevalence and patterns of tobacco use among adolescents and (ii) the association between tobacco use and selected NCD risk indicators, to plan locally appropriate prevention strategies.

OBJECTIVES

General objective:

To assess tobacco use patterns and their contribution to NCD risk among adolescents in Dhubri district.

Specific objectives:

1. To estimate the prevalence of tobacco use (ever use and current use) among adolescents.
2. To describe patterns of tobacco use (smoked/smokeless/dual use, frequency, age of initiation).
3. To examine the association between tobacco use and selected NCD risk indicators among adolescents.

Materials and Methods

Study design, setting, and duration

A community-based cross-sectional study was conducted in Dhubri district, Assam, in the field practice/community area affiliated with Dhubri Medical College. The study was carried out over six months from June 2025 to November 2025.

Study population and eligibility

The study population comprised adolescents residing in the selected communities of Dhubri district during the study period. Adolescents aged 10–19 years who had been residing in the area for at least six months and who provided assent (and parental/guardian consent for minors) were included. Adolescents who were seriously ill at the time of survey, unable to participate in interview/measurements, or who declined assent/consent were excluded.

Sample size and sampling technique

A total of 200 adolescents were enrolled. A multistage sampling approach was used. In the first stage, villages from the field practice area were selected by simple random sampling. In the second stage, households within selected clusters were visited using a systematic approach until the required sample was achieved. If more than one eligible adolescent was present in a household, one was selected using a simple random method (e.g., lottery).

Data collection tool and procedure

Data were collected using a pre-tested structured questionnaire administered through face-to-face interviews, along with anthropometric and blood pressure measurements. The questionnaire captured socio-demographic details (including age, sex, and schooling status), tobacco exposure and use patterns (ever use, current use in the past 30 days, type of tobacco used, frequency of use, age of initiation, source of procurement, exposure to second-hand smoke, exposure to tobacco advertising/promotions, and peer/family tobacco use), and selected behavioural NCD risk indicators such as physical activity and diet-related practices as recorded in the tool. Field investigators were trained prior to data collection, and the questionnaire was piloted to ensure clarity and feasibility.

Operational definitions
Ever tobacco use was defined as use of any tobacco product (smoked or smokeless) at least once in the participant's lifetime. Current tobacco use was defined as use of any tobacco product on one or more days during the past 30 days. Smoked tobacco included cigarettes, bidis, hookah, or other smoked forms, while smokeless tobacco included gutkha, khaini, zarda, pan with tobacco, or similar products. Dual use was defined as the use of both smoked and smokeless tobacco. Early initiation was considered initiation of tobacco use before 15 years of age for descriptive subgroup analysis. Physical inactivity and unhealthy diet indicators were categorized using the cut-offs applied in the questionnaire for this study.

Anthropometry and blood pressure measurement
Weight was measured to the nearest 0.1 kg using a calibrated digital weighing scale, with participants in light clothing and without shoes. Height was measured to the nearest 0.1 cm using a stadiometer with standard positioning. BMI was calculated as weight (kg) divided by height squared (m^2) and categorised for analysis using age-appropriate adolescent references; for regression, BMI was grouped into practical categories (e.g., non-overweight vs overweight/obese). Blood pressure was measured using an appropriately sized cuff after at least five minutes of rest. Two readings were taken, and the average was used for analysis. BP status was categorised into normal/elevated based on adolescent cut-offs used in the study protocol.

Outcome variables
The primary outcomes were the prevalence of ever tobacco use and current tobacco use among adolescents. Secondary outcomes included description of tobacco use patterns (type, frequency, and age of initiation) and assessment of associations between tobacco use and selected NCD risk indicators (such as BMI category, BP category, and behavioural risk markers recorded in the tool).

Statistical analysis
Data were entered and analysed using standard statistical software. Categorical variables were summarised as frequencies and percentages, and continuous variables as mean ± SD (or median with IQR where appropriate). Prevalence estimates were reported with 95% confidence intervals. Associations between tobacco use and explanatory variables/NCD risk indicators were assessed using chi-square test (or Fisher's exact test where applicable). Binary logistic regression was performed to examine independent predictors of current tobacco use, and adjusted odds ratios with 95% confidence intervals were reported. A p-value <0.05 was considered statistically significant.

Ethical considerations
Ethical approval was obtained from the Institutional Ethics Committee of Dhubri Medical College prior to initiation. Written informed consent was obtained from parents/guardians for minors along with adolescent assent; participants aged 18 years and above provided consent directly. Confidentiality was ensured through anonymized coding and restricted data access. Participants identified as current tobacco users were provided brief counselling and appropriate referral information for cessation support in accordance with local service availability.

RESULTS
1) Participant profile (baseline characteristics)
A total of 200 adolescents were enrolled from the community field practice area. Over half were aged 15–19 years (53.5%), and 54.5% were male. Most participants were school-going (82.5%), while 17.5% were out-of-school. With respect to contextual exposures, 40.0% reported parental tobacco use, 41.0% reported peer tobacco use, and 63.5% reported exposure to tobacco advertisements/promotions in the recent period. Second-hand smoke exposure was common (44.0% at home; 54.5% in public places). As shown in Table 1, and figure1 current tobacco use differed significantly by sex (higher among males) and school status (higher among out-of-school adolescents). In contrast, most other baseline characteristics and exposure variables did not show statistically significant differences.

Table 1. Baseline characteristics by current tobacco use (N = 200)

Variable	Category	Total (N=200)	Non-users (n=173)	Current users (n=27)	Test	p value
Age group (years)	10–14	93/200 (46.5%)	84/173 (48.6%)	9/27 (33.3%)	Chi-square	0.205
	15–19	107/200 (53.5%)	89/173 (51.4%)	18/27 (66.7%)		
Sex	Male	109/200 (54.5%)	87/173 (50.3%)	22/27 (81.5%)	Chi-square	0.005
	Female	91/200 (45.5%)	86/173 (49.7%)	5/27 (18.5%)		
School status	School-going	165/200	147/173	18/27 (66.7%)	Chi-square	0.040

		(82.5%)	(85.0%)			
	Out-of-school	35/200 (17.5%)	26/173 (15.0%)	9/27 (33.3%)		
Socioeconomic status	Low	92/200 (46.0%)	79/173 (45.7%)	13/27 (48.1%)	Chi-square	0.457
	Middle	84/200 (42.0%)	72/173 (41.6%)	12/27 (44.4%)		
	High	24/200 (12.0%)	22/173 (12.7%)	2/27 (7.4%)		
Parental tobacco use	No	120/200 (60.0%)	108/173 (62.4%)	12/27 (44.4%)	Chi-square	0.118
	Yes	80/200 (40.0%)	65/173 (37.6%)	15/27 (55.6%)		
Peer tobacco use	No	118/200 (59.0%)	106/173 (61.3%)	12/27 (44.4%)	Chi-square	0.149
	Yes	82/200 (41.0%)	67/173 (38.7%)	15/27 (55.6%)		
Advertisement exposure (past 30 days)	No	73/200 (36.5%)	68/173 (39.3%)	5/27 (18.5%)	Chi-square	0.061
	Yes	127/200 (63.5%)	105/173 (60.7%)	22/27 (81.5%)		
Second-hand smoke exposure at home	No	112/200 (56.0%)	93/173 (53.8%)	19/27 (70.4%)	Chi-square	0.159
	Yes	88/200 (44.0%)	80/173 (46.2%)	8/27 (29.6%)		
Second-hand smoke exposure in public places	No	91/200 (45.5%)	76/173 (43.9%)	15/27 (55.6%)	Chi-square	0.357
	Yes	109/200 (54.5%)	97/173 (56.1%)	12/27 (44.4%)		
Physical activity level	High	50/200 (25.0%)	43/173 (24.9%)	7/27 (25.9%)	Chi-square	0.979
	Moderate	98/200 (49.0%)	86/173 (49.7%)	12/27 (44.4%)		
	Low	52/200 (26.0%)	44/173 (25.4%)	8/27 (29.6%)		
BMI category	Underweight	76/200 (38.0%)	69/173 (39.9%)	7/27 (25.9%)	Chi-square	0.241
	Normal	109/200 (54.5%)	90/173 (52.0%)	19/27 (70.4%)		
	Overweight	12/200 (6.0%)	11/173 (6.4%)	1/27 (3.7%)		
	Obese	3/200 (1.5%)	3/173 (1.7%)	0/27 (0.0%)		
Blood pressure category	Normal	148/200 (74.0%)	128/173 (74.0%)	20/27 (74.1%)	Chi-square	0.595
	Elevated	45/200 (22.5%)	38/173 (22.0%)	7/27 (25.9%)		
	Hypertension	7/200 (3.5%)	7/173 (4.0%)	0/27 (0.0%)		

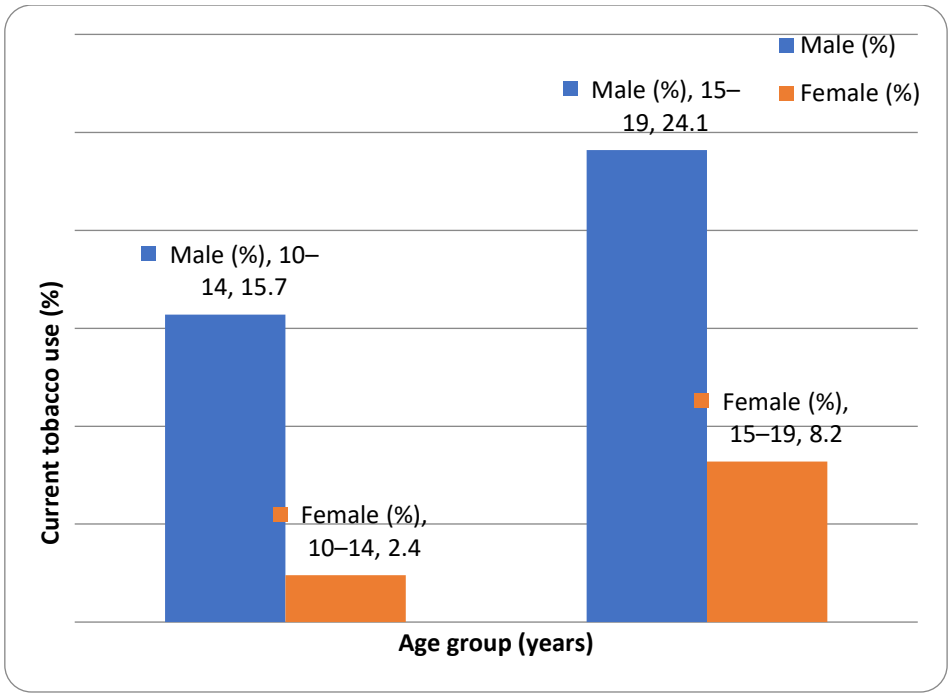

Figure 1. Current tobacco use by age sex

2) Prevalence of tobacco use

Overall, 27.0% (54/200) of adolescents reported ever tobacco use, while 13.5% (27/200) reported current tobacco use (use in the past 30 days). The confidence intervals around these estimates are presented in Table 2A.

Table 2A. Prevalence of tobacco use (N = 200)

Measure	n/N (%)	95% CI (%)
Ever tobacco use	54/200 (27.0%)	21.3–33.5
Current tobacco use (past 30 days)	27/200 (13.5%)	9.4–18.9

3) Patterns of current tobacco use

Among current tobacco users (n = 27), smokeless tobacco was the most common pattern (44.4%), followed by smoked tobacco (40.7%), while dual use accounted for 14.8%. Nearly two-thirds of current users reported daily use (66.7%), with the remainder reporting occasional use (Table 2B,figure2).

Table 2B. Patterns of tobacco use among current users (n = 27)

Pattern (among current users)	n/N (%)
Smoked tobacco	11/27 (40.7%)
Smokeless tobacco	12/27 (44.4%)
Dual use	4/27 (14.8%)
Occasional use	9/27 (33.3%)
Daily use	18/27 (66.7%)

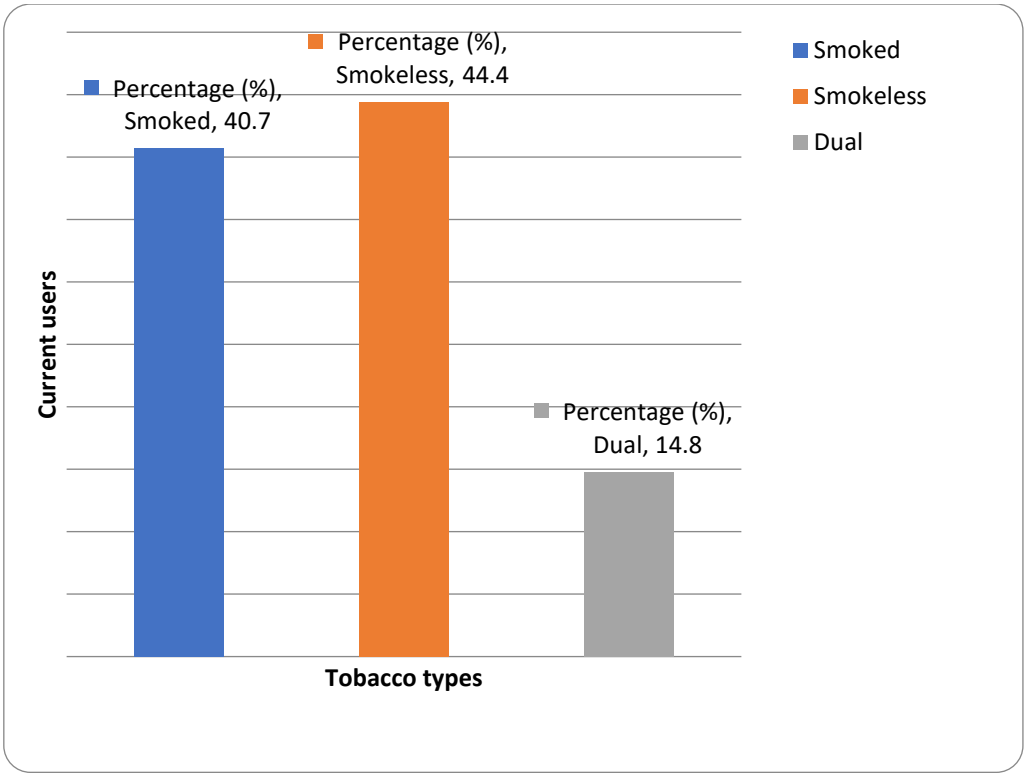

Figure2.Tobacco type among current users

Initiation profile (among ever users)

Among adolescents who had ever used tobacco (n = 54), the mean age at initiation was 13.8 ± 1.9 years, and 68.5% initiated tobacco use before 15 years of age (Table 2C).

Table 2C. Initiation profile among ever tobacco users (n = 54)

Initiation profile (among ever users)	Value
Age at initiation (years), mean ± SD	13.8 ± 1.9
Initiation <15 years	37/54 (68.5%)

4) Determinants of current tobacco use

In bivariate analysis, current tobacco use was significantly higher among males and out-of-school adolescents, while differences by age group, socioeconomic status, and exposure variables were not statistically significant at the 5% level (Table 1; Table 3A). In multivariable logistic regression, male sex (aOR 4.19, 95% CI 1.43–12.31), out-of-school status (aOR 4.44, 95% CI 1.53–12.94), and parental tobacco use (aOR 2.70, 95% CI 1.06–6.92) remained independently associated with current tobacco use. Associations for older age group, peer tobacco use, and advertisement exposure showed borderline statistical significance, while second-hand smoke exposure at home and socioeconomic status were not independently associated (Table 3B).

Table 3A. Bivariate tests for determinants of current tobacco use (N = 200)

Predictor (bivariate)	Test	p value
Age group (years)	Chi-square	0.205
Sex	Chi-square	0.005
School status	Chi-square	0.040
Socioeconomic status	Chi-square	0.457
Parental tobacco use	Chi-square	0.118
Peer tobacco use	Chi-square	0.149
Advertisement exposure (past 30 days)	Chi-square	0.061
Second-hand smoke exposure at home	Chi-square	0.159

Table 3B. Multivariable logistic regression for determinants of current tobacco use (N = 200)
(Reference categories: age 10–14, female, school-going, high SES)

Predictor	aOR	95% CI	p value
Age 15–19 (vs 10–14)	2.47	0.94–6.47	0.066
Male (vs Female)	4.19	1.43–12.31	0.009
Out-of-school (vs School-going)	4.44	1.53–12.94	0.006
Low SES (vs High)	1.04	0.20–5.40	0.962
Middle SES (vs High)	1.55	0.31–7.68	0.593
Peer tobacco use (Yes vs No)	2.44	0.96–6.22	0.061
Parental tobacco use (Yes vs No)	2.70	1.06–6.92	0.038
Advertisement exposure (Yes vs No)	2.75	0.91–8.36	0.074
Second-hand smoke at home (Yes vs No)	0.53	0.20–1.42	0.208

5) Tobacco use and NCD risk indicators

Current tobacco use showed higher prevalence of several NCD risk indicators compared with non-use, although most differences were not statistically significant. Elevated or hypertensive blood pressure was observed in 33.3% of current users versus 26.0% of non-users. The proportion with overweight/obesity was low overall and did not differ meaningfully between groups. A higher proportion of current users reported frequent sugary drink intake and had a higher prevalence of the composite NCD risk flag (≥2 indicators), but these associations did not reach statistical significance on bivariate testing (Table 4A). In the adjusted model controlling for age group, sex, school status and socioeconomic status, current tobacco use was not independently associated with composite NCD risk ≥2 (Table 4B).

Table 4A. Association of current tobacco use with selected NCD risk indicators (N = 200)

NCD risk indicator	Non-users n/N (%)	Current users n/N (%)	Test	p value
Hypertension	45/173 (26.0%)	9/27 (33.3%)	Chi-square	0.485
Overweight/obesity	14/173 (8.1%)	1/27 (3.7%)	Fisher	0.698
Low physical activity	44/173 (25.4%)	8/27 (29.6%)	Chi-square	0.821
Junk/fast food ≥4 days/week	39/173 (22.5%)	7/27 (25.9%)	Chi-square	0.887
Sugary drinks ≥4 days/week	22/173 (12.7%)	7/27 (25.9%)	Chi-square	0.129
Composite NCD risk (≥2 indicators)	41/173 (23.7%)	11/27 (40.7%)	Chi-square	0.101

Table 4B. Adjusted association between current tobacco use and composite NCD risk (≥2 indicators)

Exposure	Outcome	aOR	95% CI	p value
Current tobacco use (past 30 days)	Composite NCD risk (≥2 indicators)	1.69	0.69–4.11	0.250

DISCUSSION

In Dhubri district, we found 13.5% current tobacco use and 27.0% ever use among adolescents, with a marked sex gradient (male current use 22/109 = 20.2% vs female 5/91 = 5.5%) and higher use among out-of-school adolescents. In a school-based survey from north Kerala, Muttappallymyalil et al. (2012) reported an overall tobacco-use prevalence of 5.5%, with 12% among boys and 0% among girls. [6] The higher overall current-use prevalence in our community sample (13.5%) compared with their school sample (5.5%) is numerically plausible given methodological differences: our design likely captured higher-risk out-of-school adolescents (who had ~4-fold higher adjusted odds in our model) and included a slightly older distribution, while definitions and reporting windows can also shift estimates upward or downward across studies.

Product patterns in our current users showed smokeless (44.4%) marginally exceeding smoked (40.7%), with dual use (14.8%), underscoring that smokeless tobacco is not a "benign substitute." Gupta and Ray (2003) summarized strong health risks for smokeless products, including age-adjusted relative risks for premature mortality of 1.2–1.96 in men and 1.3 in women, and substantially elevated relative risks for oral cancer (1.8–5.8) and oesophageal cancer (2.1–3.2) among male chewers of betel quid with tobacco. [7] This risk profile is directly relevant to Dhubri because nearly half of current users were using smokeless products; even at adolescent ages, the predominance of smokeless use warrants prevention messaging that explicitly addresses misperceptions about "safer" non-smoked forms.

Our dual-use prevalence depends strongly on the denominator: 14.8% among current users translates to 2.0% (4/200) in the full adolescent sample. Singh et al. (2020) reported that adult dual use in India declined from 5.3% (2009–2010) to 3.4% (2016–2017) and noted that dual users represented 12% of all tobacco users, with persistent rural burden and rising urban burden in some contexts. [8] Against those national adult figures, our population-level dual-use estimate (2.0%) is directionally consistent (lower in adolescents than adults), while our within-user share (14.8%) is also plausible because multi-product use tends to concentrate within the smaller group already using tobacco.

Initiation in our cohort was early (mean 13.8 ± 1.9 years; 68.5% initiated before 15 years), suggesting prevention must begin well before late secondary school. Using GATS data, Verma et al. (2023) reported mean recalled initiation ages that were much later at the national adult level—20.9 ± 8.5 years for smoked tobacco and 22.3 ± 10.6 years for smokeless tobacco in GATS-2—yet their same analysis showed that younger respondents (15–24 years) reported earlier smokeless initiation of 15.5 ± 4.2 years, and highlighted associations between awareness and earlier reported initiation for smokeless (aOR 1.4, 95% CI 1.3–1.7) and dual use (aOR 1.8, 1.6–2.0). [9] Numerically, our younger initiation age is compatible with the "younger cohort initiates earlier" signal in Verma et al., and the difference is expected because our sample captures adolescents closer to the initiation window (less recall lag) and includes many who start before 15.

Our determinants analysis is consistent with established social-influence pathways: parental tobacco use remained independently associated with current use (aOR 2.70), and peer tobacco use showed a borderline association (aOR 2.44, p≈0.06). Biglan et al. (1995), in a longitudinal model of adolescents aged 14–17 years, concluded that inadequate parental monitoring and association with deviant peers predicted later tobacco use, and that parental/peer smoking explained additional variance while monitoring and deviant-peer association still contributed. [10] In Dhubri, the combination of a sizeable parental tobacco-use prevalence (40%) and a strong structural marker of reduced supervision (out-of-school status; aOR 4.44) provides a numerically coherent interpretation: household and peer environments likely reinforce initiation and persistence, and interventions need to target families and peer networks rather than only individual knowledge.

Marketing exposure was high in our cohort (63.5%) and showed a borderline adjusted association with current tobacco use (aOR 2.75, p≈0.07). In a longitudinal school-based cohort of adolescents who were e-cigarette–naïve at baseline, Camenga et al. (2018) reported that 9.6% initiated e-cigarette use by follow-up and that Facebook advertising exposure at baseline significantly increased the odds of subsequent use (OR 2.12, p<0.02). [11] While their outcome was e-cigarette initiation and ours was any tobacco use, the magnitudes are strikingly comparable (OR ~2.1 vs aOR ~2.8), supporting the plausibility that advertising/promotion contributes meaningfully to adolescent uptake in Dhubri—though our cross-sectional design and smaller number of current users (n=27) likely reduced precision enough to push the association toward borderline significance.

When we compare prevalence and patterns to other Indian adolescent studies, our results appear internally consistent and regionally plausible. In Delhi, Kumar et al. (2014) reported ever tobacco use of 16.4% and current use of 13.1%, with current smoking 10.2% and current chewing 9.4%, and noted higher risk among males. [12] Our current use (13.5%) is remarkably close to their 13.1%, despite different contexts (community-based Dhubri vs school-based Delhi), while our ever use (27.0%) is higher than their 16.4%, plausibly reflecting differences in product access, social acceptability, and inclusion of out-of-school adolescents. The similarity in current-use prevalence despite these differences also underlines how "current use" can converge across settings even when lifetime experimentation ("ever use") diverges due to measurement and contextual factors.

Second-hand smoke exposure was frequent in Dhubri (44.0% at home; 54.5% in public places), even though SHS-at-home was not independently associated with current use after adjustment. Using GATS youth data, Chopra et al. (2025) reported declines in SHS exposure among non-smoking youth from GATS-I to GATS-II—home exposure 50% → 37.6% (15–24 years) and 49.2% → 35% (25–29 years), and public-place exposure 44% → 37.8% (15–24 years) and 42.1% → 36.8% (25–29 years). [13] Our home SHS exposure (44%) sits squarely within that national range (between ~38% and 50%), but our public-place exposure (54.5%) is notably higher than the GATS youth estimates (~38–44%), which is a plausible regional/measurement difference: adolescents in a border district may spend time in settings with weaker enforcement or higher ambient exposure, and our question framing/time window may not match GATS exactly.

We also explored whether tobacco use clustered with NCD risk indicators. In Dhubri, elevated/hypertensive BP was 33.3% in current users versus 26.0% in non-users, and the composite NCD-risk flag (≥2 indicators) was 40.7% versus 23.7%, but the adjusted association with composite risk was not statistically significant (aOR 1.69, p=0.25). Ford et al. (2008), in a large prospective cohort (Add Health), found that among young adults aged 18–26, 5.37% reported high BP and 4.28% high cholesterol, and that adolescent overweight/obesity predicted later risk (e.g., obese adolescents: aOR 1.96 for high BP), while adolescent tobacco use and physical activity/inactivity did not independently predict reported high BP or cholesterol. [14] This provides a useful contrast: our cross-sectional BP signal trends upward among tobacco users but is modest and imprecise—consistent with Ford et al.'s conclusion that BMI-related pathways may dominate cardiometabolic outcomes, and that tobacco's independent effect on BP may be harder to detect without longitudinal follow-up, heavier exposure measurement, or older age outcomes.

Our behavioral profile also fits broader Indian school-student evidence of early experimentation and co-occurring lifestyle risks. Bassi et al. (2021) reported that among sixth-grade students, 42.5% achieved <1 hour/day of moderate-to-vigorous physical activity, and approximately one-third had ever tried smoking (30.1%) or smokeless tobacco (30.5%). [15] Our ever-tobacco prevalence (27.0%) is numerically close to their ~30% "ever tried" estimates, despite differences

in age (older adolescents in our study) and measurement; meanwhile, our low-activity prevalence (26%) is lower than their MVPA<1 hour/day (42.5%), plausibly reflecting different constructs (activity categories vs MVPA threshold) rather than a true protective difference.

Finally, the tendency toward risk clustering in our data (composite risk ≥2: 26.0% overall, higher in tobacco users) should be interpreted alongside global clustering evidence and the limits of indicator selection. Uddin et al. (2020), analysing 304,779 adolescents from 89 countries, reported that 82.4% had ≥2 lifestyle risk factors and 34.9% had ≥3, and demonstrated clustering beyond chance in combinations such as physical inactivity with low fruit/vegetable intake (O/E 1.10 in males; 1.08 in females). [16] Our much lower prevalence of "≥2 risks" is expected because we measured a narrower, context-specific set of indicators (and not the full six-risk-factor framework used by Uddin et al.), but the direction—higher multi-risk burden among tobacco users—remains consistent with the clustering paradigm. Taken together, these comparisons support the interpretation that Dhubri adolescents experience a meaningful burden of tobacco use with early initiation and strong social determinants, and that prevention strategies should be community-oriented (families, peers, out-of-school youth), marketing-aware, and integrated with broader adolescent NCD risk reduction—while explicitly acknowledging that prevalence and effect sizes vary with region, sampling frame, and measurement choices.

Limitations

This cross-sectional study cannot establish temporality or causality between exposures and tobacco use/NCD risk. Findings are based on a single district with N=200, limiting generalizability and statistical power (especially for subgroup and NCD-risk associations). Tobacco-use measures relied on self-report, introducing potential under-reporting and misclassification. The NCD risk assessment used selected proxy indicators rather than comprehensive biochemical measurements.

CONCLUSION

In Dhubri district, 13.5% of adolescents were current tobacco users and 27.0% had ever used tobacco, with smokeless tobacco slightly more common than smoking and early initiation frequent (mean initiation 13.8 years; 68.5% initiating before 15 years). Current use was independently associated with male sex, out-of-school status, and parental tobacco use, highlighting the importance of family- and community-level determinants. These findings support early, integrated adolescent health interventions that combine tobacco prevention, enforcement against youth access and promotion, and targeted outreach to out-of-school adolescents and households with tobacco use, alongside broader NCD risk reduction strategies.

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