Epidemiological features of nicotine and environmental dependence grading among urban adult smokers: A cross-sectional study

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ABSTRACT

INTRODUCTION Smoking remains a major public health challenge in China, but environmental smoking dependence is under-investigated among urban community adult smokers. This study aimed to examine nicotine and environmental smoking dependence and associated factors.

METHODS This cross-sectional study consecutively enrolled 500 adult smokers who were usual residents of the Kaiyuan Community, Licheng District, Quanzhou, China, from August 2025 to April 2026, using one-to-one face-to-face interviews recorded in a WeChat mini-program questionnaire. Nicotine dependence was assessed with the Fagerström test for nicotine dependence (FTND) and environmental-situational dependence with the smoking-related test for environmental dependence (STED). FTND and STED scores were compared across participant characteristics, and factors associated with FTND, STED, and smoking dependence severity were identified using multivariable linear regression models and multivariable ordinal logistic regression, respectively.

RESULTS Mean FTND and STED scores were 2.88 ± 2.19 and 7.20 ± 2.84, respectively. FTND was associated with STED (ρ=0.242) and smoking index (ρ=0.497); STED was associated with smoking index (ρ=0.184) and age (ρ= -0.152). In multivariable linear regression, FTND and STED scores remained mutually associated; higher ln (smoking index) was associated with higher FTND score (B=0.797; 95% CI: 0.626–0.967) and STED (B=0.578; 95% CI: 0.331–0.826), whereas tea consumption was associated with lower FTND score (B= -0.519; 95% CI: -0.973 – -0.065) and older age with lower STED score (B= -0.059; 95% CI: -0.081 – -0.037). For smoking dependence subtypes, older age was associated with lower severity (AOR=0.956; 95% CI: 0.938–0.973), and higher ln (smoking index) predicted greater severity (AOR=1.634; 95% CI: 1.374–1.942).

CONCLUSIONS Community smokers showed a predominantly severe dependence pattern, with environmental-situational dependence and nicotine dependence mutually associated. Dependence severity was affected by age and smoking index. Future research is warranted to validate these findings and inform smoking-cessation-related studies.

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INTRODUCTION

Tobacco epidemic remains one of the greatest public health threats worldwide, causing more than 7 million deaths annually, as well as disability and long-term tobacco-related illnesses[1]. Tobacco use is a major risk factor for cardiovascular and respiratory diseases, cancers, and numerous other debilitating health conditions[2]. As a major country in tobacco production and consumption, China faces prominent tobacco-related public-health burdens. Nationally representative data from the 2024 National Adult Tobacco Survey demonstrate that the current smoking prevalence among adults aged ≥15 years was 23.2%, while the smoking-cessation rate among smokers was 22.6%, with marked gender and urban–rural disparities remaining unresolved[3,4]. Evidence has indicated that smoking exerts adverse impacts on all-cause mortality and premature death among Chinese smokers aged >45 years, and pack-years of smoking show a linear association with the risk of premature death in the general population and females[5]. Nicotine dependence serves as the biological mechanism sustaining smoking behavior and hindering successful smoking cessation. Neurobiological studies have revealed that nicotine in tobacco affects the brain reward system and leads to addiction[6]. By contrast, environmental smoking dependence is a psychological-contextual reliance subdivided into internal (intrapersonal affective triggers) and external (social-situational cues) dimensions. Triggered-by-context craving characterizes this dependence, which arises from contextual-psychological conditioning rather than physiological nicotine adaptation[7,8]. Together, these two dimensions may jointly contribute to the severity of smoking behavior and the difficulty of quitting.

Given the large size of community smokers, communities constitute a key setting for smoking cessation intervention[9,10]. Clarifying the dependence characteristics, influencing factors and behavioral triggers of community smokers is a prerequisite for formulating targeted and effective smoking cessation strategies. It has been reported that over 90% of Chinese smokers have experiences of cigarette sharing and gifting[11]. China features abundant traditional festivals and folk activities, where occasions such as weddings, funerals, festivals and sacrifices become high-risk scenarios for smoking. Such social-custom-driven situations act as external environmental cues that may trigger smoking cravings and reinforce smoking-dependent behaviors. However, the association between regional lifestyles and the degree of smoking dependence remains unclear. Existing studies mostly focus solely on nicotine dependence assessment, with insufficient attention to environmental dependence and the impact of regional lifestyles. As a characteristic regional lifestyle in southeast coastal China, tea drinking commonly occurs in social smoking contexts; however, its association with smoking dependence severity remains unclear. Accordingly, this study aimed to assess community smokers' smoking dependence from both nicotine and environmental dimensions. We explored the associations of demographic characteristics, chronic disease status, daily lifestyle habits such as tea consumption, and folk activity participation with smoking dependence indicators, established smoking dependence severity grading, and compared clinical features across different dependence subtypes, to provide evidence for community smoking cessation management.

METHODS

Study design and setting

This cross-sectional epidemiological survey was conducted among adult usual resident smokers in the Kaiyuan Community, Licheng District, Quanzhou, China. Usual residents were defined as adults who had lived in the community for ≥12 consecutive months. The study was approved by the Ethics Committee of Kaiyuan Street Community Health Service Center on 2 April 2025 (Approval No.: 2025-KY-002-01). All procedures were performed in accordance with the ethical principles of the Declaration of Helsinki (1975). All participants provided informed consent prior to enrollment.

Study population and participant recruitment

Data collection was conducted through household surveys and among attendees at community health service centers. Eligible participants were

identified during home visits or routine medical consultations. After obtaining informed consent, participants were consecutively enrolled between 4 August 2025 and 16 April 2026, and a total of 500 valid questionnaires were obtained. The sample size of 500 was adequate for both the multivariable linear regression models (approximately 50 subjects per independent variable, exceeding the conventional threshold of 10–20) and the ordinal logistic regression (meeting the empirical rule of 10–15 outcome events per factor).

Inclusion criteria were: 1) aged ≥18 years; 2) long-term residents in the surveyed community; and 3) clear consciousness and normal communication ability to independently complete the questionnaire. Exclusion criteria were: 1) presence of severe organic diseases, e.g. advanced dementia, severe aphasia, end-stage critical illness; and 2) questionnaires with substantial missing information and invalid data (≥20% of total items unanswered or missing core tobacco-use items including smoking status and daily cigarette consumption).

Data collection and study instruments

Data collection procedures

Prior to the survey, all investigators received standardized training covering questionnaire completion requirements, scale scoring criteria, variable definitions, and on-site survey protocols. No personal identifiers (e.g. name, identity-card number) were collected; all questionnaires were assigned unique identification codes to ensure data confidentiality.

Data were collected through one-to-one face-to-face interviews. Participants' responses were concurrently recorded into the WeChat mini-program questionnaire during interviews, and investigators checked the completeness of all questionnaire contents. For elderly participants and those with limited comprehension ability, investigators provided enhanced explanation and interpretation of survey items to facilitate accurate understanding. All valid questionnaires were uniformly coded, and data entry was performed with standardized procedures and quality checks to ensure accuracy. The mini-program was configured such that the questionnaire could only be saved after all items were completed; no incomplete questionnaires existed.

Study instruments and variable definitions

The questionnaire included demographics, the Fagerström test for nicotine dependence (FTND), the smoking-related test for environmental dependence (STED), smoking index, marital status, education level, retirement status, job status, and chronic disease. Data on alcohol and tea consumption habits, as well as participation in traditional festivals and folk activities, were also collected.

The FTND consists of six weighted-response items. The total FTND score was calculated as the simple sum of scores across all six items, with a possible range of 0–10; higher total scores indicate greater severity of nicotine dependence[12].

The STED consisted of external and internal environmental dimensions. The external environment included social gatherings, folk activities, staying with other smokers, drinking alcohol, and drinking tea. The internal environment included situations of tension, depression, anger, anxiety, and encountering difficulties. One point was assigned for the answer 'yes' and zero points for 'no' according to smoking behavior in each situation. The total STED score ranges from 0 to 10, with higher scores indicating greater environmental-situational smoking dependence.

The smoking index (cigarette-year) calculated as: smoking index = average number of cigarettes smoked per day × duration of smoking in years. Natural-log transformation was applied: ln (smoking index), and the transformed variable was used in regression models.

Study variables

Outcome variable

The composite ordinal smoking dependence subtypes (mild, moderate, severe) were defined by combining FTND and STED scores. For FTND, severity cutoffs (mild 0–3, moderate 4–6, severe ≥7) were adopted from the Guidelines for Treating Tobacco Dependence 2020 published by the European Network for Smoking

and Tobacco Prevention (ENSP)[12]. For the novel STED, formal threshold standards are unavailable. We prespecified a stratification strategy based on the proportion of endorsed items – a pragmatic approach commonly used in exploratory analyses. A STED score ≥7 (reflecting positive responses to >70% of situational items) was designated as high environmental reactivity, while a score <4 was designated as low environmental reactivity.

A compensatory risk algorithm was applied to construct composite subtypes: severe dependence subtype was defined as FTND ≥7 or STED ≥7 to maximize sensitivity for high-risk screening; mild dependence subtype was defined as FTND <4 and STED <4 to ensure a homogeneous low-risk group; all remaining participants were categorized as moderate dependence subtype.

Independent variables

Two separate multivariable linear regression models were built for FTND and STED, respectively. Both adjusted for age, BMI, marital status, education level, job status, chronic disease, and ln (smoking index), and mutually adjusted for each other's score. Additionally, alcohol-consumption habits, tea-consumption habits, and folk-activity frequency were included as potential confounders in the FTND model but excluded from the STED and ordinal models. These variables may predispose individuals to smoke in the very situations assessed by the STED. Including them could therefore compete with the STED in explaining the same variance, leading to multicollinearity and unstable effect-size estimates; they were thus omitted. Ordinal logistic regression model was applied to explore factors associated with composite smoking-dependence subtypes (mild, moderate, and severe), with adjustment for age, BMI, marital status, education level, retirement status, job status, chronic disease status, and ln (smoking index). Sex was excluded from all regression analyses because of its extremely imbalanced distribution (female participants, n=5; 1.0%), which could lead to unstable parameter estimates and model overfitting.

All categorical covariates were dichotomized before regression analysis, with the exception of folk-activity frequency, which was treated as a categorical variable with three levels. Education level was grouped into high (senior high school/technical secondary school and above, coded as 0, reference group) and low (below senior high school or technical secondary school, coded as 1). Chronic disease status was defined as present (coded as 1) or absent (coded as 0, reference group). Stable job status was categorized as stable occupation (retired status, public-institution staff, teachers, and medical workers, coded as 0, reference group) or unstable occupation (unemployed, students, farmers, and other occupations, coded as 1). Marital status was classified as married (coded as 0, reference group) or unmarried (coded as 1). For the three-category folk-activity participation variable, two dummy variables were created in both regression models, with participants reporting folk activities less than once per year as the reference group.

Statistical analysis

Continuous data with normal distribution were expressed as mean ± SD, otherwise as median with interquartile range (IQR). Categorical variables are presented as frequencies and percentages. Between-group comparisons were performed using independent-samples t-test or one-way ANOVA for normally distributed data, and Mann-Whitney U or Kruskal-Wallis H test for non-normally distributed data. To characterize the dominant pattern of tobacco dependence among this community population and inform regionally tailored prevention strategies, a paired-sample t-test was used to compare raw FTND and STED scores. For correlations between two continuous variables, Spearman's rank correlation coefficient (ρ) was used.

Univariate ordinal logistic regression was performed for between-group comparisons of potential predictors. Multicollinearity of independent variables was evaluated via variance inflation factor (VIF). VIF values were 1.030–3.023 for the FTND linear regression model, 1.019–3.002 for the STED linear regression model (no substantial multicollinearity), and 1.017–3.001 (all VIF <5) for the ordinal logistic regression model, demonstrating acceptable collinearity. Model fit for ordinal logistic regression was evaluated by likelihood ratio

test, deviance goodness of fit test and pseudo R^2. Effect estimates were reported as odds ratios with 95% confidence intervals. All analyses were performed in SPSS 25.0. Two tailed tests were used with α=0.05; p<0.05 was considered statistically significant.

RESULTS

Demographic and behavioral characteristics

A total of 500 valid questionnaires were obtained from 495 males and 5 females. The mean age was 60.79 ± 14.22 years, ranging from 19–92 years. Among the participants, 196 (39.2%) suffered from chronic diseases, consisting of 150 cases (30.0%) with a single chronic disease and 46 cases (9.2%) with two or more chronic diseases. The distributions of age, marital status, education level, occupation and BMI are presented in Table 1. The FTND and STED scores were 2.88 ± 2.19 and 7.20 ± 2.84, respectively. The difference between the two score distributions was statistically significant (t= -30.602, p<0.001). By cigarette-year categories, 37.0% (185/500) were mild (0–399 cigarette-years), 31.8% (159/500) moderate (400–799 cigarette-years), and 31.2% (156/500) heavy (≥800 cigarette-years) smokers. In addition, 202 participants (40.4%) had alcohol-drinking habits and 411 (82.2%) had tea-drinking habits. Regarding folk activity participation, 297 participants (59.4%) took part less than once a year, 177 (35.4%) 1 to 4 times a year, and 26 (5.2%) no less than 5 times a year.

Univariate analyses of FTND and STED scores

Univariate correlation analysis revealed a weak positive correlation between age and smoking index (ρ=0.388, p<0.001). FTND score was positively associated with STED score (ρ=0.242, p<0.001) and smoking index (ρ=0.497, p<0.001). STED score was positively associated with smoking index (ρ=0.184, p<0.001) and weakly negatively associated with age (ρ= -0.152, p=0.001).

Smoking intensity (F=73.82, p<0.001), education level (t= -2.821, p=0.005), chronic disease status (t= -3.015, p=0.003), and alcohol-consumption habits (t= -2.329, p=0.021) were associated with FTND scores.

Age (F=9.352, p<0.001), smoking intensity (F=8.579, p<0.001), and tea-consumption (t= -2.017, all p=0.044) exhibited associations with STED scores (Table 1).

Multivariable linear regression analyses of FTND and STED scores

The overall model of FTND was statistically significant (F=12.818, df=12, p<0.001), with R^2=0.2406, and adjusted R^2=0.221. After adjusting for all covariates, a higher ln (smoking index) was independently associated with a higher FTND nicotine dependence score (B=0.797; 95% CI: 0.626–0.967, p<0.001). Similarly, an increased STED score was positively associated with FTND score (B=0.126; 95% CI: 0.061–0.190, p<0.001). Tea consumption was not significantly associated with FTND score in univariate analysis but became significant after adjustment for covariates, suggesting possible suppression of the association. In the multivariable model, tea consumption was independently associated with a lower FTND score (B= -0.519; 95% CI: -0.973 – -0.065, p=0.025). Lower level of education was independently associated with a higher FTND score (B=0.403; 95% CI: 0.039–0.766, p=0.030). Chronic disease status was marginally associated with FTND score (B=0.341; 95% CI: -0.039–0.720, p=0.078), with participants having chronic diseases tending to have slightly higher FTND scores. Alcohol consumption habits showed no independent association with FTND score (B= -0.178; 95% CI: -0.532–0.175, p=0.322). No significant associations were observed between FTND score and other variables (all p>0.05).

The overall model of STED was statistically significant (F=8.584, p<0.001), with R^2=0.136, and adjusted R^2=0.120. After adjustment for covariates, higher FTND score (B=0.206; 95% CI: 0.086–0.326, p=0.001) and higher ln (smoking index) (B=0.578; 95% CI: 0.331–0.826, p<0.001) were independently associated with higher STED scores, whereas older age was independently associated with lower STED scores (B= -0.059; 95% CI: -0.081 – -0.037, p<0.001). No other variables reached statistical significance.

Table 1. Differences in FTND and STED scores among community smokers according to characteristics, a cross-sectional study, Quanzhou, China, August 2025 – April 2026, (N=500)

Variables	*Total n*	*FTND score Mean ± SD*	*FTND F/t*	*FTND p*	*STED score Mean ± SD*	*STED F/t*	*STED p*
Age (years)			F=2.883	0.057		F=9.352	<0.001
<60	180	2.62 ± 1.92			7.54 ± 2.70		
60–74	245	3.12 ± 2.30			7.34 ± 2.66		
≥75	75	2.79 ± 2.38			5.93 ± 3.38		
Smoking index (cigarette-years)			F=73.82	0.001		F=8.579	<0.001
1–399	185	1.65 ± 1.65			6.52 ± 3.10		
400–799	159	3.06 ± 1.99			7.60 ± 2.50		
≥800	156	4.19 ± 2.15			7.59 ± 2.70		
BMI (kg/m²)			t=0.401	0.688		t= -0.783	0.434
<24	297	2.92 ± 2.23			7.12 ± 2.83		
≥24	203	2.84 ± 2.14			7.32 ± 2.85		
Marital status			t=0.878	0.380		t=0.135	0.892
Married	482	2.91 ± 2.21			7.20 ± 2.83		
Unmarried	18	2.44 ± 1.79			7.11 ± 3.05		
Education level			t= -2.821	0.005		t=1.526	0.128
High	258	2.62 ± 2.13			7.38 ± 2.78		
Low	242	3.17 ± 2.22			7.00 ± 2.89		
Retirement status			t=0.919	0.359		t= -1.309	0.191
Retired	198	3.00 ± 2.40			6.99 ± 2.89		
Non-retired	302	2.81 ± 2.04			7.33 ± 2.80		
Job status			t= -0.243	0.808		t= -1.357	0.175
Stable	255	2.87 ± 2.38			7.03 ± 2.91		
Unstable	245	2.91 ± 1.98			7.38 ± 2.76		
Chronic disease			t= -3.015	0.003		t= -0.252	0.801
Absent	304	2.65 ± 2.10			7.17 ± 2.91		
Present	196	3.26 ± 2.29			7.24 ± 2.72		
Alcohol consumption			t= -2.329	0.021		t=1.003	0.317
No	298	2.87 ± 2.22			6.81 ± 2.81		
Yes	202	2.93 ± 2.15			7.78 ± 2.79		
Tea consumption			t=0.575	0.565		t= -2.017	0.044
No	89	3.01 ± 2.16			6.65 ± 2.51		
Yes	411	2.86 ± 2.20			7.32 ± 2.89		
Folk activity frequency (times/year)			F=0.850	0.428		F=0.185	0.831
<1	297	2.91 ± 2.11			7.24 ± 2.79		
1–4	177	2.79 ± 2.25			7.19 ± 2.91		
≥5	26	3.38 ± 2.72			6.88 ± 2.90		

FTND: Fagerström test for nicotine dependence. STED: smoking-related test for environmental dependence. Group comparisons: t-test for two groups, one-way ANOVA for three groups. A two-tailed p<0.05 was considered statistically significant.

Association of festivals and folk customs on smoking behavior

In terms of folk activities that tend to induce smoking, 72.2% of participants reported no definite relevant activities or held uncertain attitudes. A total of 23.0% regarded wedding and funeral ceremonies as major inducing scenarios, while religious sacrifices, festival performances and temple fairs accounted for 2.4%, 1.2% and 0.8%, respectively, with other activities taking up 0.4%. Regarding changes in smoking volume influenced by folk activities, 130 participants (26.0%) reported increased smoking amount, 355 participants (71.0%) reported no obvious change, and merely 15 cases (3.0%) reported decreased smoking volume. Further analysis of influencing factors showed that personal preference (77.2%), social etiquette demands (64.2%), inheritance of traditional customs (59.6%) and activity atmosphere (55.0%) were the leading causes of smoking during folk activities. While less frequently reported reasons included lack of relevant regulatory constraints (2.40%) and other factors (4.60%). As for festivals associated with higher smoking tendency, 77.4% of smokers had no clear answer or held ambiguous views, and 20.6% took the Spring Festival as the primary festival for smoking. Qingming Festival, Mid-Autumn Festival, Chongyang Festival and other festivals accounted for 2.0% in total.

Stratified analysis of smoking dependence

Differences in clinical characteristics

Among all participants, 329 cases were classified into severe smoking dependence, 120 into moderate dependence and 51 into mild dependence.

The three subtypes differed significantly in FTND score (H=44.398, p<0.001), STED score (H=352.541, p<0.001), smoking index (H=18.827, p<0.001), and age (H=10.641, p=0.005). FTND, STED, and smoking index increased progressively from mild to severe subtypes, whereas age decreased progressively. No statistically significant inter-group differences were found in BMI, marital status, education level, stable job status and chronic disease history (all p>0.05) (Table 2).

Multivariable ordinal logistic regression analysis of composite smoking dependence subtypes

The overall ordinal logistic regression model for composite smoking-dependence subtypes was statistically significant (χ^2=50.942, df=8, p<0.001)), with a Nagelkerke pseudo-R^2 of 0.118. The proportional odds assumption was satisfied (χ^2=5.049, df=8, p=0.752).

After adjustment for all covariates, older age was independently associated with lower smoking dependence severity (Wald χ^2=25.096, df=1, AOR=0.956, 95% CI: 0.938–0.973, p<0.001), while higher ln (smoking index) independently predicted greater dependence severity (Wald χ^2=30.854, df=1, AOR=1.634; 95% CI: 1.374–1.942, p<0.001). BMI showed a marginal association (p=0.082), whereas marital status, education level, retirement status, occupational status, and chronic disease status showed no significant associations (all p>0.05). Regression coefficients, AORs, 95% CIs, p-values, and reference categories for all variables in the model, are presented in Table 3.

Smoking behavior during festivals and folk activities by dependence subtype

Stratified analyses further revealed significant differences in smoking behavior during festivals and folk activities across dependence subtypes (χ^2=94.867; p<0.001). Among participants with mild dependence subtype, 43.1% (22/51) reported smoking during festivals or folk-custom events; the corresponding proportion was 79.2% (95/120) for moderate dependence participants, and 93.9% (309/329) for severe dependence participants. The proportion of smoking during folk-custom events followed the order: severe dependence> moderate dependence> mild dependence (p<0.001). No significant correlation was found between smoking amount and participation in festivals or folk activities across dependence levels (rs= -0.047; p=0.295). Regarding changes in cigarette consumption triggered by folk-custom events, increased consumption was reported by 25.5% (13/51) of mild-dependence participants, 31.7% (38/120) of moderate-dependence participants, and 24.0% (79/329) of severe-dependence participants; no change in smoking amount was observed in 72.5%

Table 2. Differences in participant characteristics among community smokers with different grades of smoking dependence, a cross-sectional study, Quanzhou, China, August 2025 – April 2026 (N=500)

Variables	Mild (N=51)	Moderate (N=120)	Severe (N=120)	Statistic	p
	Mean ± SD	Mean ± SD	Mean ± SD	H	
FTND score	1.16 ± 1.25	2.64 ± 1.98	3.25 ± 2.24	44.398	<0.001
STED score	1.90 ± 1.14	4.48 ± 0.98	9.02 ± 1.15	352.541	<0.001
Smoking index (cigarette-years), median (IQR)	250 (100–550)	405 (200–800)	540 (270–800)	18.827	<0.001
Age (years)	65.70 ± 14.55	62.42 ± 13.23	59.41 ± 14.28	10.641	0.005
BMI (kg/m²), median (IQR)	23.39 (21.45–24.84)	23.17 (21.10–25.40)	23.41 (21.47–25.38)	0.211	0.900
	n	n	n	χ^2	
Marital status				1.135	0.648*
Married	50	114	318		
Unmarried	1	6	11		
Education level				3.071	0.215
High	23	56	179		
Low	28	64	150		
Retirement status				3.654	0.161
Retired	21	56	121		
Non-retired	30	64	208		
Job status				3.505	0.173
Stable	28	69	158		
Unstable	23	51	171		
Chronic disease				0.884	0.643
Absent	34	71	199		
Present	17	49	130		

FTND: Fagerström test for nicotine dependence. STED: smoking-related environmental test for dependence. H: Kruskal-Wallis H-statistic. Group comparisons: Kruskal-Wallis H test for continuous variables, chi-squared test for categorical variables. A two-tailed p<0.05 was considered statistically significant. *Fisher's exact test was used instead of chi-squared test when expected cell counts were <5.

(37/51), 64.2% (77/120), and 73.3% (241/329) of the three subgroups, respectively, whereas decreased consumption was rare across all subtypes.

DISCUSSION

Based on an epidemiological survey among community smokers, this study clarified the distribution characteristics and associated factors of nicotine dependence and environmental dependence, and identified potential factors associated with smoking dependence stratification. The results revealed that community smokers presented low-level nicotine dependence but high-level environmental dependence, indicating that environmental factors exert prominent impacts on smoking behaviors. These findings are consistent with previous evidence and conform to the interpersonal communication characteristics in Chinese society[13], suggesting that community-based environmental smoking cessation guidance may be of value for future tobacco control initiatives.

Both univariate and multivariate analyses verified that smoking index was a positive influencing factor for FTND and STED scores, namely higher smoking index corresponded to elevated FTND and STED scores. In univariate analysis, chronic disease status was associated with FTND score, with smokers with chronic diseases having higher FTND scores than those without. After adjustment for covariates, however, this association was attenuated

Table 3. Results of the multivariable ordinal logistic regression analysis for factors associated with smoking dependence severity, a cross-sectional study, Quanzhou, China, August 2025 – April 2026 (N=500)

Variables	β	SE	AOR	95% CI	p
Age	-0.045	0.009	0.956	0.938–0.973	<0.001
BMI	0.049	0.028	1.050	0.994–1.108	0.082
ln (smoking index)	0.491	0.088	1.634	1.374–1.942	<0.001
Marital status (not married vs married)	-0.428	0.501	0.652	0.244–1.742	0.393
Education level (low vs high)	-0.185	0.202	0.831	0.559–1.235	0.360
Retirement status (not retired vs retired)	-0.323	0.344	0.724	0.369–1.420	0.348
Job status (unstable vs stable)	0.365	0.316	1.440	0.776–2.675	0.248
Chronic disease (present vs absent)	0.212	0.210	1.236	0.818–1.866	0.315

β: regression coefficient (log-odds). SE: standard error. AOR: adjusted odds ratio. CI: confidence interval. BMI: body mass index. ln: natural logarithm. This ordinal logistic regression model was adjusted for age, BMI, marital status, education level, retirement status, job status, chronic disease status, and ln (smoking index). Reference categories were married, high level of education, retired, stable job, and absent chronic disease. A two-tailed p<0.05 was considered statistically significant.

and no longer statistically significant, suggesting that the crude association may be partly explained by other factors included in the model. This pattern may reflect bidirectional and reverse-causal relationships between nicotine dependence and chronic disease among this community population. Previous studies have confirmed that individuals with nicotine dependence have a significantly higher risk of developing chronic non-communicable inflammatory diseases compared with those without dependence[14]. Conversely, a chronic disease diagnosis may act as a teachable moment, prompting older smokers to reduce cigarette consumption[15,16]. This health-related behavioral adaptation may partly dilute the crude unadjusted association between chronic disease and FTND.

Smoking-related behaviors among the Chinese population are subject to marked sociocultural influences. Cigarette sharing persists in China with occupational and geographical disparities. Social bonds and mutual cigarette offering create an environment in which smoking is sustained and readily triggered in social settings[17].

In our study, age was negatively associated with STED scores. After incorporating STED indicators into the comprehensive assessment, the proportion of severe smoking dependence increased as age decreased, suggesting that younger smokers may have greater environmental smoking dependence and may be at higher risk of severe smoking dependence, particularly under environmental triggers. This may be because younger smokers participate more in social gatherings and group activities, making them more susceptible to smoking environments, social norms, and psychosocial factors. Consistent with this, previous studies on adolescent smoking in China have shown that interpersonal factors – including peer smoking, parental supervision, cultural attitudes, and individual traits – jointly shape smoking susceptibility among young people[18]. These findings highlight the need for targeted intervention strategies for younger smokers. Nevertheless, we did not identify an independent association between age and nicotine dependence as measured by the FTND in the present study. Heterogeneous results across published reports may be explained by differences in age sampling. This null finding is consistent with Vink et al.[19] but differs from a Chinese study of smokers aged ≥40 years[16]. The discrepancy may be due to differences in age sampling, smoking status, FTND outcome definition, and covariate adjustment.

In view of regional living customs, >80% of enrolled participants had regular tea-drinking habits. In univariable analysis, tea consumption habit was not significantly associated with FTND score. However, after adjustment for demographic and smoking-related covariates, participants with a tea consumption habit exhibited a significantly lower FTND score. This discrepancy may reflect a suppression association, whereby confounding

factors such as age, education level, and smoking index masked the crude association in univariable analysis.

In addition, participants with alcohol consumption habits showed higher FTND scores in univariable analysis, but no significant association with FTND score remained after adjustment for demographic and smoking-related covariates. This finding could stem from selection bias related to sampling sources and local lifestyle characteristics. In contrast to the findings of our study, some previous studies have reported that alcohol consumption is associated with greater severity of nicotine dependence[20,21]. Potential explanations also include limited statistical power, measurement error, residual confounding, or a true lack of association between drinking habits and FTND-measured nicotine dependence.

Accumulated evidence has shown that combustible tobacco use is linked to increased alcohol intake and hazardous drinking behaviors, and daily cigarette consumption is also associated with weekly alcohol consumption[22,23]. In the present study, alcohol consumption habit was associated with FTND score in univariable analysis, but this association was no longer independent after adjustment for demographic and smoking-related covariates. This attenuation suggests that the crude association was largely explained by shared smoking-related characteristics, such as smoking quantity and duration, rather than by an independent association of drinking on FTND-measured nicotine dependence. Alternative explanations include selection bias related to sampling sources and local lifestyle characteristics, limited statistical power, measurement error, residual confounding, or a true lack of independent association. By contrast, tea consumption habit was not significantly associated with FTND score before adjustment but was associated with lower FTND score after adjustment, suggesting a suppression association. Previous studies suggest that neither tea drinking alone nor post-dinner mental activity alone was significantly associated with FTND; a significant association was observed only when tea drinking and post-dinner mental activity co-occurred[24]. Therefore, the association between tea consumption and nicotine dependence may be context-dependent and may be confounded or suppressed by behavioral and sociodemographic factors, rather than directly reflecting a protective association of tea itself. These findings highlight the importance of multivariable adjustment in distinguishing independent from confounded associations and warrant validation in broader populations with different alcohol-drinking, tea-drinking, and smoking patterns.

Previous studies have suggested that large gathering events may serve as settings for smoking initiation or resumption, while culturally embedded social practices such as cigarette gifting and sharing can reinforce smoking behavior and social smoking norms[25,26]. The present study is related to these findings in that folk activity scenarios may also act as non-negligible environmental triggers for smoking behavior. Inducing factors of smoking behaviors in folk activity scenarios are diversified. More than half of the participants reported that ambient atmosphere tended to encourage smoking during such events, and personal preference ranked as the leading driving factor, which indicates that individual smoking habits and subjective inclination play dominant roles in folk-related smoking behaviors. The majority of smokers did not develop exclusive smoking tendency specifically during festivals or folk activities, demonstrating that the impacts of these scenarios on smoking are situational and random rather than fixed and dominant.

In the present study, three-subgroup smoking-dependence subtypes were defined based on FTND nicotine-dependence and environmental-dependence scores. Ordinal logistic regression showed that ln (smoking index) and age were the only two factors associated with dependence subtypes. Higher ln (smoking index) was associated with greater odds of being classified into the severe-dependence subtype, which supported that cumulative smoking exposure is a core determinant of smoking-dependence severity.

An inverse association was observed for age: older participants were more likely to fall into mild or moderate-dependence subtypes relative to severe dependence. This counter-intuitive finding may be attributable to survival bias: given that the mean age of this cohort was around 60 years, individuals with heavy smoking and severe dependence

might have quit smoking or died with ageing, and therefore be under-represented among smokers of this age in this cross-sectional sample. Consistent with this interpretation, previous studies have also observed that smoking cessation rates were significantly higher in older Chinese populations than in younger populations[4,27]. Marital status, education level, retirement status, job status, BMI, and chronic disease status showed no independent association with dependence subtypes. These findings suggested that conventional sociodemographic and chronic disease-related covariates have limited explanatory power for subtypes defined by combined nicotine and environmental dependence in community smokers.

Limitations

Several limitations of this study should be acknowledged. First, the STED is a newly developed scale, and its cutoff values have not yet been validated using receiver operating characteristic (ROC) curve analyses in an independent population. Furthermore, the clinical utility of smoking dependence subtypes for guiding smoking cessation management still requires multi-dimensional assessment incorporating cessation outcomes within high-quality prospective cohort studies. Second, folk-activity-related items may exhibit regional heterogeneity, and single-community sampling limits the generalizability of our findings. Third, self-reported smoking behaviors are susceptible to both social desirability bias and recall bias. As this is a cross-sectional study, we cannot establish causal relationships among the investigated variables, and residual confounding cannot be fully excluded. Fourth, owing to our recruitment approach, whereby data were collected via household surveys and from attendees at community health service centers, our sample had poor representation of younger participants. In addition, the present study included a very low proportion of female participants. Hence, the observed findings related to smoking dependence subtypes should be interpreted with caution. Future studies with larger female samples and more balanced age distributions are needed to explore potential sex-specific and age-related differences in smoking dependence subtype distribution.

CONCLUSIONS

Smoking behaviors among community residents are association with multiple factors with distinct regional features. Most local smokers showed severe dependence, and older age was associated with lower dependence severity, whereas higher smoking index was associated with greater severity. Attention could be paid to younger smokers and individuals with a high smoking index. Smoking during festivals and folk activities differed across dependence subtypes, suggesting that tobacco control publicity in folk activity settings such as weddings, funerals, and Spring Festival gatherings may be considered. Intervention strategies tailored to population-specific dependence characteristics might help improve outcomes of community-based smoking cessation.

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CONFLICTS OF INTEREST
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ETHICAL APPROVAL AND INFORMED CONSENT
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DATA AVAILABILITY
The data supporting this research are available from the authors on reasonable request.

AUTHORS' CONTRIBUTION
HZ: data analysis, data interpretation and drafted the original manuscript. ZZhou: designed the questionnaire contents and research indicators, formulated the classification and diagnostic criteria for smoking dependence and completed the data analysis and interpretation. ZZhang: revision of the manuscript. YD: conception and overall design of the study, and reviewed the final manuscript. All authors read and approved the final version of the manuscript.

AI DECLARATION
AI was used for language polishing only.

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