Tobacco-related knowledge, attitudes and practices among college students in Fujian Province, China: A cross-sectional study

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ABSTRACT

INTRODUCTION Tobacco use is the leading preventable cause of death globally, and college students are a critical population for China's tobacco-control efforts. University-level data from Fujian Province are scarce. This study applied the Knowledge-Attitude-Practice (KAP) framework to assess tobacco-related knowledge, policy attitudes, perceptions, information-channel exposure, and tobacco use among college students in Fujian, China.

METHODS Eligible participants were undergraduate students aged ≥18 years at a university in Fuqing City, Fujian. A cross-sectional online survey was conducted in December 2025 (n=415; valid response rate 84.35%). Variables included tobacco use, disease-specific knowledge, perceived addictiveness and attractiveness, support for venue-specific bans, eight information channels, and demographic and social-environmental covariates. Chi-squared tests, t-tests, ANOVA, and logistic regression were used.

RESULTS Of 415 participants (75.4% female), 11.3% reported ever tobacco use. Lung cancer awareness was high (91.6%), but heart disease (64.1%) and stroke (68.0%) awareness was substantially lower. Only 44.1% correctly identified low-tar cigarettes as equally harmful. Recognition of tobacco addictiveness was lower among ever users than never users (68.1% vs 85.9%, p=0.005). Smoking-ban support ranged from 95.9% (public transport) to 71.8% (entertainment venues); 83.9% supported comprehensive bans at tourist sites. Greater multi-channel exposure was associated with higher knowledge (F=16.94, p<0.001). Alcohol consumption (AOR=5.40; 95% CI: 2.43–11.99), male sex (AOR=3.80; 95% CI: 1.86–7.77), and bar attendance (AOR=2.87; 95% CI: 1.29–6.42) independently predicted ever tobacco use.

CONCLUSIONS Cardiovascular disease awareness lagged behind lung cancer awareness, and general harm awareness did not translate consistently into product-specific risk literacy. Lower addictiveness recognition among ever users than never users is consistent with optimistic bias. Broad support for smoke-free tourism is consistent with acceptability among college-aged respondents and may merit further evaluation as one component of tobacco-control strategies in China. Findings may inform priority topics for multi-channel health communication, including cardiovascular harm and addiction misconceptions.

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INTRODUCTION

Tobacco use remains the leading preventable cause of death globally, killing

more than 8 million people annually[1]. China bears a disproportionate share of this burden: as the world's largest tobacco producer and consumer, China has over 300 million current smokers, with smoking accounting for approximately one-fifth of all adult male deaths[2]. The Healthy China 2030 Action Plan sets an ambitious target of reducing smoking prevalence among adults aged ≥15 years to below 20% by 2030[3], but achieving this target requires coordinated price and non-price interventions[4].

College students represent a critical population for tobacco control. The first nationally representative Chinese college student tobacco survey (2021; n=124119) reported a current smoking rate of 7.8% and an ever e-cigarette use rate of 10.1%[5]. E-cigarettes have rapidly penetrated youth markets through marketing narratives emphasizing novelty and reduced harm[6]. A global systematic review found highly heterogeneous e-cigarette prevalence among students (0.9–75%), with an overall upward trend[7].

In Fujian Province, southeastern China, recent evidence highlights ongoing tobacco-control challenges. A social-ecological analysis of 7652 Fujian adolescents found that accepting an offered cigarette increased smoking risk 67-fold[8]. Among Fujian middle-school students, the current e-cigarette use rate was 1.9%, and students who did not perceive e-cigarettes as addictive had 2.29 times higher use risk[9]. Secondhand smoke exposure among Fujian residents reached 57.1%, with notably low awareness of the cardiovascular consequences of secondhand smoke[10]. However, university-level data from Fujian remain scarce.

The Knowledge-Attitude-Practice (KAP) model provides a structured framework for health-behavior assessment, positing that knowledge acquisition, attitude formation, and behavioral adoption are interrelated[11]. This framework has been widely applied in tobacco research among college populations[12-14] and offers particular value for identifying gaps between knowledge acquisition, attitude formation, and behavioral change – the so-called 'KAP gap'[15]. Understanding where this disconnect occurs within the KAP pathway can inform targeted intervention design: identifying specific knowledge deficits suggests educational targets, while documenting attitude-behavior gaps points to the need for environmental and policy-level strategies.

China's tobacco-control policy landscape provides important context for examining attitudes. Despite ratifying the WHO Framework Convention on Tobacco Control (FCTC) in 2005, China still lacks national comprehensive smoke-free legislation[16]. Fujian Province does not have a provincial-level comprehensive smoke-free law, meaning that individual-level knowledge and attitudes may carry proportionally greater weight in shaping tobacco-related behaviours[17]. Understanding college students' attitudes toward specific policy measures – including venue-specific smoking bans, tobacco taxation, and product regulation – provides actionable evidence for ongoing legislative efforts.

This study aimed to: 1) comprehensively assess tobacco-use behavior, disease-specific health-knowledge patterns, and tobacco-control attitudes among college students in Fuqing City, Fujian, using the KAP framework; 2) identify demographic and social-environmental factors associated with tobacco use; and 3) evaluate the association between tobacco-control information-channel exposure and health-knowledge levels.

METHODS

Study design and participants

This cross-sectional study is reported in accordance with the STROBE Statement for cross-sectional studies (Supplementary file). The survey was conducted among undergraduate students at a university in Fuqing City, Fujian Province, China. Eligible participants were undergraduate students enrolled at the institution and aged ≥18 years. Data were collected in December 2025. Convenience sampling was employed, with the online questionnaire distributed via the 'Wenjuanxing' platform through class groups and the university's social media channels. Snowball sampling supplemented recruitment as participants shared the survey link through their own social networks. Of 492 returned questionnaires, 77 were excluded (41 for completion time <3 minutes, 25 for non-undergraduate status, and 11 for >50% missing data on tobacco items), yielding 415 valid responses (valid response rate: 84.35%).

An *a priori* sample-size estimation for prevalence used the formula:

$n = Z^2 \times p \times (1-p)/d^2$

with Z=1.96, an assumed cigarette ever use prevalence of p=12% based on the 2021 Chinese national college student survey[5], and a margin of error d=4%, yielding a minimum required sample of approximately 254. Allowing for an anticipated 30% rate of invalid responses, our recruitment target was 360, which was exceeded by the 415 valid responses obtained.

The survey instrument was developed with reference to the China CDC 2021 National College Student Tobacco Survey[5], the Global Adult Tobacco Survey (GATS) core questionnaire[18], and the Global Youth Tobacco Survey (GYTS)[19]. The tobacco-related module was reviewed by two public-health faculty members for content validity and pilot-tested with 30 students (not included in the final sample).

Measures

The questionnaire assessed the following domains within the KAP framework.

Knowledge dimension

Disease-specific health knowledge was assessed using four independent factual items asking whether smoking causes stroke, heart disease, lung cancer, and erectile dysfunction (response options for each item: 'yes', 'no', 'don't know'). For each item, the correct response ('yes') was scored as 1 point; incorrect responses ('no') and 'don't know' responses were each scored as 0. Item scores were summed to give a total disease-specific knowledge score ranging from 0 to 4. These items assess distinct disease-specific awareness rather than a unidimensional latent construct; accordingly, internal consistency analysis (e.g. Cronbach's alpha) was not applied, as high inter-item correlation would indicate redundancy rather than reliability for factual knowledge items with different correct-answer probabilities. Secondhand smoke (SHS) knowledge was assessed through four items – whether SHS causes serious illness in non-smokers, adult heart disease, children's lung disease, and adult lung cancer (response options for each: 'yes', 'no', 'don't know'). E-cigarette awareness was assessed with a single item: 'Have you heard of e-cigarettes?' (response options: yes, no). Among e-cigarette users, nicotine content awareness was assessed: 'Does the e-cigarette you regularly use contain nicotine?' (response options: 'yes', 'no', 'don't know'). Perceived addictiveness was assessed with four items rated on a 5-point Likert scale (response options: 1=strongly disagree to 5=strongly agree): 'Using cigarettes is addictive', 'Once you start smoking cigarettes, it is difficult to quit', and parallel items for e-cigarettes. For descriptive analyses, responses were dichotomized as agree (scores 4–5) versus other (scores 1–3). Each item was analyzed individually as the proportion endorsing 'agree' or 'strongly agree', rather than as a composite scale score, because the items assess perceptions of different products (cigarettes vs e-cigarettes) and different addiction dimensions (addictiveness vs difficulty quitting). Perceived attractiveness of tobacco use was assessed with two items: 'Smoking cigarettes makes people look more attractive' and 'Using e-cigarettes makes people look more attractive' (response options: 1=strongly disagree to 5=strongly agree).

Attitude dimension

Support for indoor smoking bans was assessed across 10 public venue types (hospitals, workplaces, restaurants, entertainment venues, universities, primary/secondary schools, taxis, public transport, hotels, scenic spots) (response options for each venue: 'should not allow smoking', 'should allow smoking in some areas', 'should allow smoking'). Additionally, support for a comprehensive smoking ban (both indoor and outdoor areas) at tourist and cultural sites was assessed (response options: 'yes', 'no', 'don't know'), along with a behavioral intention item: 'If tourist and cultural sites implemented a comprehensive indoor and outdoor smoking ban, would you be more willing to visit, less willing to visit, unaffected, or uncertain?' (response options: more willing, less willing, unaffected, uncertain). Support for tobacco-tax increases was assessed (response options: 'yes', 'no'). Perception of low-tar cigarettes relative to regular cigarettes was assessed (response options: 'less harmful', 'equally harmful', 'more harmful', 'don't know'). Home smoking rules were assessed (response options: 'no smoking allowed', 'generally not allowed with occasional exceptions', 'no rules', 'smoking allowed').

Practice dimension

Ever use of cigarettes and e-cigarettes was assessed: 'Have you ever tried the following tobacco products, even one or two puffs?' (response options: 'yes', 'no' for each product). Among ever users, smoking locations, reasons for use, quit attempts in the past 12 months, and e-cigarette flavor preferences were assessed. As a measure of behavioral intention within the KAP framework, future tobacco-use intentions were assessed using six items adapted from the Pierce susceptibility algorithm: three for cigarettes and three for e-cigarettes. Susceptibility was defined as the absence of a 'definitely not' response to any item within each product category, producing a binary summary indicator.

Information channel exposure

Exposure to tobacco-control information in the past 30 days was assessed across eight channels: billboards/posters, professional health websites/apps, medical institution platforms, social media platforms, short-video platforms, traditional media, school health education, and family/friends (response options: 'yes', 'no' for each channel). A total channel-exposure count (range 0–8) was calculated.

Social environment

Parental and peer smoking behavior (cigarettes, e-cigarettes), bar attendance in the past 3 months, and alcohol consumption, were assessed.

Demographics

Sex (male, female), academic grade (year 1, year 2, year 3, year 4), household registration (urban, rural), and monthly expenditure (RMB) (≤1500, 1501–2500, ≥2501) were recorded.

Statistical analysis

Data were analyzed using Python (version 3.11) with the SciPy (1.12) and NumPy (1.26) libraries[20,21]. Categorical variables were described as frequencies and percentages. Continuous variables were described as means and standard deviations. Chi-squared (χ^2) tests were used to assess associations between tobacco use and demographic and social-environmental factors. Independent samples t-tests compared health-knowledge scores between subgroups (sex, tobacco-use status, information-channel exposure). One-way ANOVA with Bonferroni-corrected *post hoc* tests assessed the association between total information-channel exposure (categorized as low: 0–5, medium: 6–7, high: 8 channels) and health-knowledge scores.

Univariate logistic regression was used to estimate crude odds ratios (ORs) for each candidate predictor of ever tobacco use, and a multivariable logistic regression model with five covariates entered simultaneously was used to estimate adjusted odds ratios (AORs); both ORs and AORs are reported with 95% confidence intervals (CIs). The five covariates entered into the multivariable model – sex, alcohol consumption, peer cigarette smoking, bar attendance in the past 3 months, and parental e-cigarette use – are the variables for which AORs are reported in Table 2. They were selected *a priori* based on prior Chinese college-student tobacco research identifying these factors as key correlates of tobacco use, and were entered simultaneously in an exploratory model. With 47 events and 5 predictors, the events-per-variable ratio was 9.4, approaching the recommended minimum of 10; results should therefore be interpreted with appropriate caution. Statistical significance was set at $p<0.05$ (two-tailed).

Ethical considerations

Participation was voluntary and anonymous. Informed consent was obtained electronically before questionnaire completion. The study protocol was reviewed and approved by the Research Ethics Committee of Fujian Polytechnic Normal University (Approval No. 2025-07).

RESULTS

Participant characteristics

Of 415 participants, 313 (75.4%) were female and 102 (24.6%) were male. The mean age was approximately 20 years. Grade distribution was: year 1 (161; 38.8%); year 2 (66; 15.9%); year 3 (146; 35.2%); year 4 (42; 10.1%). Urban residents were 55.9% (n=232) and rural residents 44.1% (n=183). Monthly expenditure (RMB) was ≤1500 for 34.5%, 1501–2500 for 58.3%, and ≥2501 for 7.2% (Table 1).

Tobacco-use prevalence (practice dimension)

Overall, 47 students (11.3%) reported ever tobacco

use: 23 (5.5%) cigarettes only, 23 (5.5%) both cigarettes and e-cigarettes, and 1 (0.2%) e-cigarettes only (Table 1). Among the 47 ever users, 34.0% had not smoked in the past 12 months; the remaining 66.0% represent recent or continuing users. Ever use rather than current use was selected as the primary outcome to maximize statistical power given the low overall prevalence, consistent with approaches used in comparable university samples. The male tobacco-use rate (25.5%; 26/102) was significantly higher than the female rate (6.7%, 21/313; χ^2=27.02, p<0.001). Among 47 ever users, 46.8% reported no intention to quit, 34.0% had not smoked in the past 12 months, and 19.1% had attempted quitting in the past 12 months. Home was the most common smoking location (68.1%), followed by school (42.6%). Among the 24 e-cigarette users, traditional tobacco flavor was most common (33.3%), followed by fruit (29.2%) and menthol/cooling (20.8%). Regarding behavioral intention, 20.2% of all participants were susceptible

Table 1. Demographic characteristics, social environment, and tobacco-use status of undergraduate students at a university in Fuqing City, Fujian Province, China, December 2025 (N=415)

Characteristics	Total n (%)	Ever tobacco users n (%)	Never users n (%)	p*
Sex				<0.001
Female	313 (75.4)	21 (6.7)	292 (93.3)	
Male	102 (24.6)	26 (25.5)	76 (74.5)	
Grade				0.937
Year 1	161 (38.8)	17 (10.6)	144 (89.4)	
Year 2	66 (15.9)	8 (12.1)	58 (87.9)	
Year 3	146 (35.2)	18 (12.3)	128 (87.7)	
Year 4	42 (10.1)	4 (9.5)	38 (90.5)	
Residence				0.403
Urban	232 (55.9)	29 (12.5)	203 (87.5)	
Rural	183 (44.1)	18 (9.8)	165 (90.2)	
Monthly expenditure (RMB)				0.757
≤1500	143 (34.5)	14 (9.8)	129 (90.2)	
1501–2500	242 (58.3)	29 (12.0)	213 (88.0)	
≥2501	30 (7.2)	4 (13.3)	26 (86.7)	
Alcohol consumption				<0.001
No	247 (59.5)	10 (4.0)	237 (96.0)	
Yes	168 (40.5)	37 (22.0)	131 (78.0)	
Bar attendance (past 3 months)				<0.001
No	371 (89.4)	33 (8.9)	338 (91.1)	
Yes	44 (10.6)	14 (31.8)	30 (68.2)	
Peer cigarette smoking				0.029
None	181 (43.6)	13 (7.2)	168 (92.8)	
Some/most/all	234 (56.4)	34 (14.5)	200 (85.5)	
Tobacco-use category				
Never tried either	368 (88.7)			
Cigarettes only	23 (5.5)			
Both cigarettes and e-cigarettes	23 (5.5)			
E-cigarettes only	1 (0.2)			

Column 2 refers to column percentages, and columns 3 and 4 refer to row percentages, for each category. *Chi-squared tests of independence. RMB: 1000 Chinese Renminbi about US$150.

Table 2. Crude and adjusted odds ratios for factors associated with ever tobacco use among undergraduate students at a university in Fuqing City, Fujian Province, China, December 2025 (N=415)

Variables	Univariate model		Multivariable model	
	OR (95% CI)	p	AOR (95% CI)	p
Male sex (ref: female)	4.76 (2.54–8.91)	<0.001	3.80 (1.86–7.77)	<0.001
Alcohol consumption (ref: no)	6.69 (3.22–13.90)	<0.001	5.40 (2.43–11.99)	<0.001
Peer cigarette smoking (ref: none)	2.20 (1.12–4.30)	0.022	0.82 (0.37–1.84)	0.628
Bar attendance (ref: no)	4.78 (2.31–9.90)	<0.001	2.87 (1.29–6.42)	0.010
Parental e-cigarette use (ref: no)	1.81 (0.59–5.59)	0.303	1.50 (0.39–5.77)	0.557

OR: crude odds ratio derived from univariate logistic regression. AOR: adjusted odds ratio derived from multivariable logistic regression with the five covariates listed in the table entered simultaneously. Variables in the multivariable model: sex, alcohol consumption, peer cigarette smoking, bar attendance in the past 3 months, and parental e-cigarette use. McFadden pseudo-R^2=0.190; events=47; events-per-variable ratio=9.4.

to future cigarette use and 17.6% to future e-cigarette use, based on the Pierce algorithm.

Chi-squared tests revealed significant associations between ever tobacco use and sex (male > female, p<0.001), alcohol consumption (drinkers 22.0% vs non-drinkers 4.0%, p<0.001), bar attendance in the past 3 months (p<0.001), peer cigarette smoking (p=0.029), and peer e-cigarette use (p<0.05). Grade, residence, and monthly expenditure showed no significant associations (Table 1).

Table 3. Tobacco-related health knowledge among undergraduate students at a university in Fuqing City, Fujian Province, China, December 2025 (N=415)

Knowledge item	Yes n (%)	No n (%)	Don't know n (%)
Smoking-related diseases			
Lung cancer	380 (91.6)	14 (3.4)	21 (5.1)
Erectile dysfunction	290 (69.9)	33 (8.0)	92 (22.2)
Stroke	282 (68.0)	40 (9.6)	93 (22.4)
Heart disease	266 (64.1)	55 (13.3)	94 (22.7)
Secondhand-smoke-related diseases			
Adult lung cancer	368 (88.7)	19 (4.6)	28 (6.7)
Children's lung disease	360 (86.7)	18 (4.3)	37 (8.9)
Serious illness in non-smokers	356 (85.8)	27 (6.5)	32 (7.7)
Adult heart disease	294 (70.8)	36 (8.7)	85 (20.5)
E-cigarette awareness	394 (94.9)	21 (5.1)	
Health-knowledge score, mean ± SD (range 0–4)	2.93 ± 1.37		
Male	2.65 ± 1.51		0.015
Female	3.03 ± 1.33		

Disease-specific knowledge items were each scored 1 for the correct response ('yes') and 0 for 'no' or 'don't know'; item scores were summed for the total score (range 0–4). Sex difference in mean total score tested by independent-samples t-test (t= -2.44; p=0.015).

In multivariable logistic regression with the five *a priori* covariates entered simultaneously (Table 2), alcohol consumption was the strongest independent predictor of tobacco use (AOR=5.40; 95% CI: 2.43–11.99; p<0.001), followed by male sex (AOR=3.80; 95% CI: 1.86–7.77; p<0.001) and bar attendance (AOR=2.87; 95% CI: 1.29–6.42; p=0.010). Peer cigarette smoking was significant in univariate analysis (OR=2.20; 95% CI: 1.12–4.30; p=0.022) but was attenuated and non-significant in the adjusted model (AOR=0.82; 95% CI: 0.37–1.84; p=0.628), suggesting confounding by alcohol consumption and bar attendance. The model's McFadden pseudo-R^2 was 0.190.

Tobacco health knowledge (knowledge dimension)

Disease-specific awareness revealed a consistent awareness pattern (Table 3). Lung cancer awareness was highest (91.6%), while awareness of smoking-related stroke (68.0%), erectile dysfunction (69.9%), and heart disease (64.1%) was substantially lower, each with >22% of participants responding 'don't know'. The gap between lung cancer awareness and heart disease awareness was 27.5 percentage points. For secondhand smoke, awareness of causing adult lung cancer was 88.7%, children's lung disease 86.7%, and serious illness in non-smokers 85.8%, but only

Table 4. Attitudes toward tobacco-control policies among undergraduate students at a university in Fuqing City, Fujian Province, China, December 2025 (N=415)

Attitude item	n (%)
Support for indoor smoking ban	
Public transport	398 (95.9)
Taxis	398 (95.9)
Hospitals	397 (95.7)
Primary/secondary schools	395 (95.2)
Workplaces	390 (94.0)
Scenic spots	387 (93.3)
Restaurants	386 (93.0)
Hotels	362 (87.2)
Universities	358 (86.3)
Entertainment venues	298 (71.8)
Entertainment-venue ban support	
Male (N=102)	56 (54.9)
Female (N=313)	242 (77.3)
Ever tobacco users (N=47)	24 (51.1)
Never users (N=368)	274 (74.5)
Support increasing cigarette tax	278 (67.0)
Low-tar cigarette perception	
Equally harmful (correct)	183 (44.1)
Less harmful	47 (11.3)
More harmful	94 (22.7)
Don't know	91 (21.9)
Home smoking rules	
No smoking allowed	202 (48.7)
Generally not allowed, exceptions	118 (28.4)
No rules	59 (14.2)
Smoking allowed	36 (8.7)
Comprehensive smoking ban (indoor + outdoor) at tourist and cultural sites	
Overall support (N=415)	348 (83.9)
Female (N=313)	287 (91.7)
Male (N=102)	61 (59.8)
Ever users (N=47)	32 (68.1)
Never users (N=368)	316 (85.9)
Willingness to visit smoke-free tourist/cultural sites	
More willing	350 (84.3)
Unaffected	30 (7.2)
Less willing	22 (5.3)
Uncertain	13 (3.1)

All percentages are within-row proportions of N=415 unless otherwise indicated.

70.8% recognized secondhand smoke as a cause of adult heart disease – a pattern that mirrored the primary smoking-knowledge hierarchy. The mean health-knowledge score (0–4 scale) was 2.93 ± 1.37. Females scored significantly higher than males (3.03 ± 1.33 vs 2.65 ± 1.51; t= -2.44, p=0.015).

E-cigarette awareness was high (94.9%), yet among the 24 e-cigarette users, 45.8% (n=11) did not know whether their product contained nicotine, and 16.7% (n=4) believed it did not (Table 3).

Regarding perceived addictiveness, 83.9% agreed or strongly agreed that cigarette use is addictive, and 82.2% that cigarettes are difficult to quit once started. Parallel figures for e-cigarettes were 81.7% and 80.0%, respectively. Notably, ever tobacco users showed substantially lower addictiveness recognition than never users: 68.1% vs 85.9% for cigarette addictiveness, and 59.6% vs 84.5% for e-cigarette addictiveness – suggesting that personal experience may paradoxically reduce perceived addiction risk.

Perceived attractiveness of tobacco use was a concern: 42.4% agreed or strongly agreed that smoking cigarettes makes people look more attractive, and 40.2% held the same view for e-cigarettes, while only 47.0% and 49.2% disagreed, respectively. Female students showed slightly higher perceived attractiveness of smoking than males for both cigarettes (43.1% vs 40.2%) and e-cigarettes (41.9% vs 35.3%). Ever tobacco users endorsed cigarette attractiveness more frequently (55.3% vs 40.8%).

Tobacco-control attitudes (attitude dimension)

Support for indoor smoking bans showed a clear venue-specific gradient (Table 4). Support was highest for public transport (95.9%), taxis (95.9%), and hospitals (95.7%), and lowest for entertainment venues (71.8%), where 20.2% endorsed allowing smoking in designated areas. For universities, support was 86.3%. Entertainment-venue ban support was notably lower among male students (54.9%) than female students (77.3%), and lower among ever tobacco users (51.1%) than never users (74.5%).

A discrepancy between general harm awareness and specific risk literacy was observed. Although 91.6% of participants recognized the smoking-lung cancer link, only 44.1% correctly identified low-tar cigarettes as similarly harmful to regular cigarettes,

Table 5. Total information-channel exposure and total tobacco health-knowledge score among undergraduate students at a university in Fuqing City, Fujian Province, China, December 2025 (N=415)

Channel exposure	n (%)	Knowledge score Mean ±SD	Bonferroni-corrected post-hoc p
Low (0–5 channels)	110 (26.5)	2.35 ± 1.56	Ref.
Medium (6–7 channels)	46 (11.1)	2.76 ± 1.37	0.358 (medium vs low)
High (8 channels)	259 (62.4)	3.22 ± 1.21	<0.001 (high vs low) 0.067 (high vs medium)

Knowledge score range: 0–4 (sum of correct responses across four disease-specific items). One-way ANOVA: F(2, 412)=16.94, p<0.001. The per-channel breakdown of exposure and corresponding knowledge differences for each of the eight individual channels is provided in Supplementary file Table S1.

while 11.3% believed they were less harmful and 21.9% did not know – a 47.5 percentage-point gap between general harm awareness and specific product risk literacy. Regarding tobacco taxation, 67.0% supported increasing cigarette taxes. For home smoking rules, 48.7% reported that smoking was not allowed indoors, 28.4% reported 'generally not allowed with exceptions', 14.2% reported no rules, and 8.7% reported smoking was allowed (Table 4).

Support for a comprehensive smoking ban (both indoor and outdoor) at tourist and cultural sites was 83.9%, with 84.3% reporting they would be more willing to visit such sites if the ban were implemented, 7.2% unaffected, 5.3% less willing, and 3.1% uncertain. A notable gender gap was observed: 91.7% of female students supported the comprehensive ban compared with 59.8% of males, and 90.4% of females would be more willing to visit compared with 65.7% of males. Ever tobacco users showed lower support (68.1%) and lower willingness to visit (70.2%) than never users (85.9% and 86.1%, respectively) (Table 4).

Tobacco-control information-channel exposure

Social media platforms had the highest contact rate (83.1%), followed by school health education (82.4%), billboards/posters (81.4%), and short-video platforms (80.7%). Medical institution platforms (77.3%), traditional media (77.1%), family/friends (74.2%), and professional health websites (70.6%) also had substantial reach (Supplementary file Table S1).

Association between information-channel exposure and health knowledge

Exposure to each of the eight information channels was significantly associated with higher health-knowledge scores (all p<0.01) (Supplementary file Table S1). Total information-channel exposure showed a dose-response relationship with health knowledge (Table 5). Students exposed to all 8 channels scored significantly higher than those exposed to 0–5 channels (3.22 ± 1.21 vs 2.35 ± 1.56; Bonferroni-corrected p<0.001). The overall ANOVA was significant [F(2.412)=16.94, p<0.001]. The majority of students (62.4%) reported exposure to all 8 channels, while 26.5% reported exposure to 5 or fewer channels.

DISCUSSION

In this cross-sectional KAP study of 415 college students at a university in Fuqing, Fujian, four findings stood out. First, awareness of smoking-related cardiovascular disease lagged far behind awareness of lung cancer. Second, general harm awareness did not transfer reliably to product-specific risk literacy, as illustrated by the low-tar cigarette item. Third, ever tobacco users were less likely than never users to recognize tobacco as addictive, a pattern consistent with optimistic bias. Fourth, support for comprehensive smoke-free policies at tourist and cultural sites was broad among college-aged respondents. Several findings merit further discussion, particularly regarding knowledge gaps, the discrepancy between general harm awareness and product-specific risk literacy, and the role of information channels.

Knowledge gaps across disease domains

The most notable knowledge finding was the gap between cancer and cardiovascular awareness: while lung cancer awareness exceeded 91%, awareness of

smoking-caused heart disease (64.1%) and stroke (68.0%) was substantially lower, producing a 27.5 percentage-point gap. This pattern mirrors findings from the 2018 Global Adult Tobacco Survey in China[22], which reported lung cancer awareness above 80% but cardiovascular awareness approximately 30 percentage points lower, and is consistent with regional studies from Hebei Province[23] and Ningxia[24]. It also echoes the low secondhand smoke-cardiovascular disease awareness observed specifically among Fujian residents (70.8% in our sample)[10]. This pattern is consistent with the possibility that public health communication in China may have placed comparatively more emphasis on the smoking-cancer link than on cardiovascular and other non-pulmonary consequences, although our data assess students' knowledge rather than the content of any specific communication strategy. Future campus health-education programs may benefit from explicitly incorporating cardiovascular disease content, including stroke and heart disease, to address this persistent knowledge gap.

This pattern was mirrored in secondhand smoke knowledge, where awareness of adult lung cancer (88.7%) substantially exceeded awareness of adult heart disease (70.8%). The consistent cardiovascular knowledge deficit across both primary and secondhand smoke domains is consistent with a broad rather than topic-specific knowledge deficit, although the underlying communication mechanisms cannot be inferred directly from this study.

Among e-cigarette users, 45.8% were unaware whether their product contained nicotine, consistent with findings from Hangzhou (57.4% unaware)[13] and Fuzhou (showing similar knowledge gaps)[25]. This 'high-awareness-low-literacy' phenomenon – where most students have heard of e-cigarettes but lack basic product knowledge – may represent a potential target for tailored health education.

An unexpected finding was the addictiveness cognition paradox: while over 80% of all participants recognized both cigarettes and e-cigarettes as addictive, the proportion recognizing addictiveness was markedly lower among ever tobacco users than among never users for both products. This inverse association – where personal experience appears to diminish rather than reinforce perceived addiction risk – may reflect cognitive dissonance reduction or optimistic bias among users, and may inform the design of intervention messaging that relies on addiction warnings.

The finding that 42.4% of students agreed that smoking makes people look more attractive, with female endorsement (43.1%) slightly exceeding that of males (40.2%), warrants attention in the context of rising tobacco-use concerns among Chinese young women. While the 2021 national survey reported female college-student smoking rates well below male rates[5], the attractiveness perception data suggest that social-image framing of tobacco use may resonate with female students. E-cigarette attractiveness showed a similar pattern. These findings may suggest potential directions for counter-marketing strategies that address the social-image appeal of tobacco products among young adults.

Discrepancy between general harm awareness and product-specific risk literacy

The KAP framework can reveal discrepancies across knowledge, attitude, and behavioral domains[11,15]. In this study, a notable gap was observed between general harm awareness and product-specific risk literacy: 91.6% of participants correctly identified smoking as a cause of lung cancer, yet only 44.1% correctly identified low-tar cigarettes as similarly harmful to regular cigarettes – a 47.5 percentage-point gap. This discrepancy suggests that general harm awareness does not automatically transfer to specific product risk literacy. The association between knowledge and attitude domains was not formally tested in this study, and the observed gap is descriptive rather than inferential, suggesting that health-education efforts may benefit from extending beyond general harm messaging to address specific industry marketing claims, particularly regarding low-tar and 'reduced-harm' products.

Venue-specific policy attitudes provide further evidence of attitude complexity. While support for smoking bans in hospitals (95.7%) and public transport (95.9%) approached universal levels, support dropped by over 24 percentage points for entertainment venues (71.8%). This gradient likely reflects the perceived social function of smoking in recreational settings[26]. Notably, male students

and ever tobacco users showed substantially lower entertainment-venue ban support than their counterparts, suggesting that personal behavior and social norms shape policy attitudes in venue-specific ways. These findings are relevant to China's ongoing legislative debates: the absence of comprehensive national smoke-free legislation means that public support levels – particularly among young adults who will drive future norms – inform the feasibility of venue-specific implementation[16].

The high support for comprehensive smoking bans at tourist and cultural sites (83.9%) and the finding that 84.3% of students would be more willing to visit smoke-free sites are consistent with broad acceptability of smoke-free tourism among college-aged respondents. The substantial gender gap and the tobacco-use gap parallel patterns observed for other venue types. These data suggest that smoke-free policies at tourist and cultural sites would be welcomed by college-aged visitors. However, these findings are based on stated preferences in hypothetical scenarios rather than observed behavioral responses to actual policy changes, which limits their predictive validity. In a context where China's national smoke-free legislation remains absent and progress has been slow, framing smoke-free policies around tourism and cultural experiences – rather than solely around health protection – may merit further evaluation as one approach to broadening public and governmental support for tobacco control.

Factors associated with tobacco use

In adjusted analysis, alcohol consumption was the strongest independent predictor of tobacco use, followed by male sex and bar attendance (Table 2). The strong association between alcohol consumption and tobacco use corroborates evidence of behavioral clustering between these risk behaviors[27,28]. That bar attendance remained significant after adjusting for alcohol consumption suggests that the bar environment itself – perhaps through social modeling, peer pressure, or reduced perceived risk – confers additional risk beyond alcohol use per se. This aligns with a recent Chinese study identifying bar attendance as a significant predictor of e-cigarette use susceptibility among college students[29].

The attenuation of peer smoking from significance in univariate analysis to non-significance in adjusted analysis is noteworthy. This suggests that the apparent peer effect may be substantially confounded by shared behavioral risk environments (bars, alcohol use) rather than representing direct peer influence on tobacco initiation. The role of peer influence in tobacco research has been debated, with some evidence suggesting that perceived rather than actual peer behavior drives susceptibility[30].

Information-channel exposure and health knowledge

The association between information-channel exposure and health knowledge represents a novel contribution of this study. All eight assessed channels showed significant positive associations with knowledge scores, and the dose-response relationship between total channel exposure and knowledge suggests cumulative benefit from multi-channel health communication. Social media platforms (83.1%) and school health education (82.4%) had the highest reach, consistent with their identification as priority platforms in prior Chinese tobacco-communication research[31]. The findings align with evidence that redundant messaging across multiple platforms reinforces health-knowledge retention[32].

The finding that information-channel exposure is associated with higher knowledge levels suggests a potential upstream pathway: multi-channel health communication may enhance disease-specific knowledge, which in turn could shape more protective attitudes and reduce tobacco-use susceptibility. This interpretation is consistent with redundant messaging theory, which posits that repeated exposure to health messages through diverse channels reinforces knowledge acquisition and retention[32]. However, the cross-sectional design precludes causal inference; reverse causality – whereby health-conscious individuals actively seek out more information channels – cannot be excluded, and the observed association may reflect self-selection rather than a causal effect of information exposure. Future longitudinal studies should examine whether increasing information-channel exposure prospectively improves tobacco-related health knowledge.

Limitations

Several limitations should be noted. First and most importantly, the study is subject to substantial sampling bias. Recruitment relied on convenience and snowball sampling distributed via class groups and the university's social-media channels, and respondents were therefore likely to be more interested in tobacco-related issues than the broader student population. This self-selection probably inflates apparent support for smoke-free policies and apparent levels of health knowledge, while it may either over- or under-estimate tobacco-use prevalence depending on the direction of motivated response. The single-institution origin of the sample, the strong female overrepresentation (75.4%), and online-only delivery further compound these concerns and limit generalizability to other university types, regions, and the broader Chinese college-student population. Second, the cross-sectional design precludes causal inference; the channel-knowledge association in particular may reflect self-selection rather than a causal effect of information exposure. Third, self-reported data may be subject to social-desirability bias, which is a particular concern for sensitive items such as tobacco use and home smoking rules. Fourth, with 47 ever tobacco users and 5 predictors, the events-per-variable ratio of 9.4 approaches but does not meet the recommended minimum of 10; the logistic regression results should be interpreted cautiously and require replication. Fifth, information-channel exposure was assessed as binary (yes, no) rather than through frequency or intensity measures, limiting the depth of channel-knowledge analysis. Sixth, the health-knowledge score was derived from only four disease-specific items, which may not fully capture the breadth of tobacco health knowledge; future studies should consider expanded item pools. Seventh, formal psychometric validation of the questionnaire was not performed, although the instrument was developed with reference to nationally validated survey tools. Strengths include the comprehensive KAP framework encompassing both cigarettes and e-cigarettes, the novel channel-knowledge analysis, the detailed venue-specific policy-attitude assessment, and the quantification of KAP gaps.

CONCLUSIONS

This study identified persistent gaps in tobacco health knowledge among college students, with cardiovascular disease awareness substantially lower than lung cancer awareness, and general harm awareness failing to translate consistently into product-specific risk literacy. Ever tobacco users' lower recognition of addictiveness compared with never users is consistent with addiction-related optimistic bias and suggests that experimentation may reduce rather than reinforce perceived risk. Broad support for comprehensive smoking bans at tourist and cultural sites, with most students more willing to visit smoke-free sites, is consistent with acceptability of smoke-free tourism among college-aged respondents and may merit further evaluation as one component of tobacco-control strategies in China. Multi-channel information exposure was positively associated with health knowledge, with social media and school-based health education emerging as the highest reach platforms for this population.

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CONFLICTS OF INTEREST
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DATA AVAILABILITY
The data supporting this research are available from the corresponding author on reasonable request.

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