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AWARENESS OF THE ADVERSE EFFECTS OF SMOKING ON THE GASTROINTESTINAL TRACT AMONG AL-SHAM PRIVATE UNIVERSITY STUDENTS: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Tobacco use remains a major public health concern among young adults, while awareness of its gastrointestinal consequences is often less developed than awareness of its respiratory and cardiovascular effects. This study aimed to assess smoking behaviors, gastrointestinal symptoms, and awareness of the adverse effects of smoking on the gastrointestinal tract among university students.

Methods: A descriptive cross-sectional study was conducted among 700 students at Al-Sham Private University, Syria, between July 25 and August 8, 2026. Participants were recruited using convenience sampling and completed a structured self-administered questionnaire assessing sociodemographic characteristics, tobacco-use patterns, secondhand smoke exposure, knowledge of gastrointestinal effects, gastrointestinal symptoms, medication use, sources of health information, and smoking-cessation intentions. Descriptive statistics were used to summarize the data, and associations between academic discipline and smoking-related knowledge and behaviors were assessed using appropriate statistical tests. A P-value <0.05 was considered statistically significant.

Results: Among the 700 participants, 28% were current smokers and 23% reported occasional or social smoking. Conventional cigarettes were the most frequently reported tobacco product (57%), followed by waterpipe (47%) and electronic cigarettes (16%). Secondhand smoke exposure was common, with many participants reporting several hours of exposure per day. Awareness was highest regarding the association between smoking and gastrointestinal malignancies (79%) and lower esophageal sphincter dysfunction and reflux (69%), but was substantially lower for Crohn's disease (43%) and pancreatic dysfunction (48%). Medical students demonstrated significantly greater awareness of several gastrointestinal effects of smoking than students from non-medical disciplines. Gastrointestinal symptoms were reported daily by 7% of participants and several times per week by 23%. Approximately 29% of all participants (representing 57% of smokers) reported that their gastrointestinal symptoms became worse during or after smoking. Social media and the internet were the most commonly reported sources of health information (88%), followed by physicians (79%).

Conclusion: The study identified a substantial burden of tobacco exposure and important gaps in students' knowledge regarding the gastrointestinal consequences of smoking, particularly Crohn's disease and pancreatic dysfunction.

Medical students generally demonstrated better knowledge than students from non-medical disciplines, while smoking was more common among males. University-based interventions combining evidence-based health education, smoke-free policies, accessible cessation counseling, and targeted digital campaigns may improve awareness and support tobacco-cessation behaviors among young adults.

Keywords: Tobacco use; Smoking; Gastrointestinal tract; Gastroesophageal reflux disease; Waterpipe smoking; Health awareness; University students; Smoking cessation; Secondhand smoke; Health education.

1 INTRODUCTION

Tobacco smoking remains one of the leading preventable causes of morbidity and premature mortality worldwide. Despite extensive evidence regarding its harmful effects on cardiovascular and respiratory health, the adverse consequences of smoking on the gastrointestinal tract may receive comparatively less attention among the general population and young adults. Tobacco exposure affects multiple organ systems, and there is no safe level of tobacco use. The World Health Organization estimates that tobacco use causes more than 7 million deaths annually and contributes substantially to the global burden of chronic disease [1].

The gastrointestinal tract is particularly susceptible to the systemic and local effects of tobacco smoke and its numerous toxic constituents. Smoking has been associated with a broad spectrum of gastrointestinal disorders, including peptic ulcer disease, gastroesophageal reflux-related disorders, inflammatory bowel disease, and several gastrointestinal malignancies [2,3]. Proposed mechanisms include impairment of mucosal blood flow, disruption of mucosal defense mechanisms, altered gastrointestinal motility, increased oxidative stress, impaired immune responses, and interference with tissue repair [2,4]. Nicotine and other components of cigarette smoke may increase gastric acid and pepsin secretion while reducing mucus production, prostaglandin synthesis, and gastric mucosal blood flow, thereby compromising the protective mechanisms of the upper gastrointestinal tract [4].

The association between smoking and peptic ulcer disease has been well documented. Smoking not only increases the risk of ulcer development but may also delay ulcer healing and increase the likelihood of recurrence [2,5]. In addition, smoking has been associated with an increased risk of gastroesophageal reflux disease and other upper gastrointestinal conditions [6]. Recent evidence from a systematic review and meta-analysis demonstrated significant associations between inhalational exposures, including cigarette smoking, and several upper gastrointestinal diseases, including gastroesophageal reflux disease, peptic ulcer disease, esophagitis, esophageal cancer, and gastric cancer [6].

Smoking also has complex effects on inflammatory bowel disease. Current smoking is associated with an increased risk of Crohn's disease and may worsen its clinical course, whereas an inverse association has traditionally been observed between smoking and ulcerative colitis [3,7]. Importantly, the apparent protective association between smoking and ulcerative colitis should not be interpreted as evidence of a health benefit, given the substantial overall morbidity and mortality associated with tobacco exposure [1,3]. Smoking has additionally been recognized as an important risk factor for several gastrointestinal cancers, with mechanisms involving chronic inflammation, oxidative stress, DNA damage, altered cellular signaling, and impaired immune surveillance [2,3].

University students represent an important population for studying awareness of smoking-related health consequences. Young adulthood is a critical period during which health behaviors and lifestyle practices may become established and persist into later life. Although students may have considerable access to health information, awareness of the specific effects of smoking on the gastrointestinal system may not be proportional to awareness of its respiratory and cardiovascular consequences. Identifying gaps in knowledge among university students may therefore help inform targeted health education, smoking-prevention strategies, and cessation interventions.

Al-Sham Private University provides an important setting for assessing health-related knowledge among young adults from different academic backgrounds. However, data regarding students' awareness of the adverse effects of smoking specifically on the gastrointestinal tract remain limited. Assessing this awareness may provide useful information for developing educational interventions that emphasize the broader systemic consequences of tobacco use beyond its well-recognized effects on the lungs and cardiovascular system.

Therefore, this study aimed to assess the level of awareness regarding the adverse effects of smoking on the gastrointestinal tract among students at Al-Sham Private University and to identify factors associated with their level of awareness. The findings may help identify knowledge gaps and support the development of targeted educational and preventive strategies addressing tobacco-related gastrointestinal morbidity among university students.

2 METHODS AND MATERIALS

2.1 Study Design and Setting

A descriptive cross-sectional study was conducted to assess smoking behaviors, patterns of tobacco use, exposure to secondhand smoke, gastrointestinal symptoms, and awareness of the adverse effects of smoking on the gastrointestinal tract among university students. The study was conducted at Al-Sham Private University, Syria, between July 25 and August 8, 2026.

The study population included students from several academic faculties, representing both health-related and non-health-related disciplines. Medical faculties included Medicine, Dentistry, and Pharmacy, whereas non-medical faculties included Law, International Relations, Administrative Sciences, and Information Technology Engineering.

2.2 Study Population and Sampling

A total of 700 university students participated in the study. Participants were recruited using a convenience sampling technique based on their accessibility within university facilities, including lecture halls, faculty buildings, cafeterias, and common areas.

Eligible participants were currently enrolled students at Al-Sham Private University who were aged ≥ 18 years and agreed to participate in the study. Students who declined participation or submitted incomplete questionnaires were excluded from the analysis.

Before completing the questionnaire, participants were informed about the purpose of the study and the voluntary nature of participation. No financial or other incentives were provided.

2.3 Data Collection Instrument

Data were collected using a structured, self-administered questionnaire developed specifically for this study. The questionnaire was informed by previously used epidemiological instruments addressing tobacco use and smoking-related health knowledge and was adapted to include items specifically related to gastrointestinal health.

The questionnaire consisted of the following domains:

2.3.1 Sociodemographic characteristics

Age, sex, academic faculty, academic year, and living arrangement.

2.3.2 Smoking and tobacco-use behaviors

Current smoking status, type of tobacco product used (cigarettes, waterpipe/shisha, electronic cigarettes, and heated tobacco products), smoking frequency and duration, time to first cigarette after waking, and occasional or social smoking patterns.

2.3.3 Exposure to secondhand smoke

Frequency and duration of exposure to tobacco smoke and the main setting of exposure, including the home, university, and social environments.

2.3.4 Awareness of gastrointestinal effects of smoking

Participants were asked to indicate whether they agreed, disagreed, or were uncertain about statements concerning the potential effects of smoking on the gastrointestinal tract. The knowledge items addressed the effect of smoking on the lower esophageal sphincter, intestinal microbiota, Crohn's disease severity, pancreatitis, and gastrointestinal malignancies.

2.3.5 Gastrointestinal symptoms

Participants reported the frequency of gastrointestinal symptoms, including heartburn, epigastric pain, bloating, dyspepsia, nausea, and retrosternal burning.

2.3.6 Gastrointestinal medication use

Information was collected regarding the use of antacids, proton pump inhibitors (PPIs), histamine-2 receptor antagonists (H2 blockers), and other gastrointestinal medications.

2.3.7 Sources of health information

Participants were asked about their main sources of information regarding smoking and its health consequences, including social media, physicians, university curricula, family members, and friends.

2.3.8 Intention to quit smoking

Among smokers, participants were asked about their likelihood of quitting smoking if they were diagnosed with a gastrointestinal condition known to be aggravated by smoking.

2.4 Assessment of Awareness

Awareness of the gastrointestinal adverse effects of smoking was assessed using the dedicated knowledge items included in the questionnaire. Each statement was categorized according to the participant's response as correct, incorrect, or uncertain based on the established evidence regarding the relationship between smoking and gastrointestinal disease.

For the analysis, responses were used to derive an overall awareness score by assigning one point for each correct response and zero points for incorrect or uncertain responses. Higher scores indicated greater awareness of the adverse gastrointestinal effects of smoking. The resulting score was analyzed as a continuous variable and, where appropriate, categorized into awareness levels according to predefined score ranges.

2.5 Study Variables

The primary outcome was students' awareness of the adverse effects of smoking on the gastrointestinal tract. The main explanatory variable was academic discipline, categorized into medical and non-medical faculties. Other variables assessed included age, sex, academic year, smoking status, tobacco product type, smoking duration and frequency, secondhand smoke exposure, gastrointestinal symptoms, gastrointestinal medication use, sources of health information, and intention to quit smoking.

2.6 Statistical Analysis

Data were coded and analyzed using statistical software. Categorical variables were summarized as frequencies and percentages, whereas continuous variables were summarized using means and standard deviations or medians and interquartile ranges, as appropriate based on the distribution of the data.

The distribution of continuous variables was assessed before statistical analysis. Differences between students from medical and non-medical faculties were evaluated using the chi-square test or Fisher's exact test for categorical variables, as appropriate. For continuous variables, the independent-samples t-test or Mann-Whitney U test was used according to data distribution.

Associations between academic discipline and smoking behaviors, gastrointestinal symptoms, and individual awareness items were assessed using appropriate inferential statistical tests. The overall awareness score was compared between medical and non-medical students using the appropriate parametric or non-parametric test.

Where applicable, regression analysis was performed to identify factors independently associated with awareness of the gastrointestinal adverse effects of smoking. Effect estimates were reported with 95% confidence intervals. A two-sided P value <0.05 was considered statistically significant.

2.7 Ethical Considerations

Ethical approval was obtained from the Institutional Review Board of Al-Sham Private University before commencement of the study. Participation was voluntary, and informed consent was obtained from all participants before questionnaire completion.

No personally identifying information was collected. All data were treated confidentially and analyzed anonymously. Participants were informed that they could decline participation or withdraw from the study at any time without any consequences.

3 RESULTS

A total of 700 university students participated in the study, with an equal distribution by sex (350 males and 350 females). Most participants were aged 21–24 years (65%), and students from medical and non-medical disciplines were represented across several academic faculties.

Table 1: Sociodemographic characteristics of the study participants (N=700)

Characteristic	N	%
Sex		
Male	350	50
Female	350	50
Age group (years)		
18-20	173	25
21-24	458	65
24+	69	10
Academic faculty		
Medicine	215	31
Pharmacy	82	12
Dentistry	61	9
Law	87	12
International Relations	50	7
Administrative Sciences	80	11
Information Technology Engineering	125	18
Academic discipline		
Medical faculties*	358	51
Non-medical faculties*	342	49
Residence		
With family	538	77
Independent accommodation	115	16
Student residence	47	7

*Medical faculties included Medicine, Pharmacy, and Dentistry; non-medical faculties included Law, International Relations, Administrative Sciences, and Information Technology Engineering.

Never smokers represented the largest smoking-status category (46%), whereas 28% were current smokers and 23% were occasional/social smokers. Conventional cigarettes and waterpipe were the most commonly reported tobacco products.

Table 2: Smoking status and tobacco-use characteristics

Variable	n	%
Smoking status		
Never smoker	319	46
Current smoker	197	28
Former smoker	25	4
Occasional/social smoker	159	23
Smoking frequency/intensity		
Non-smoker	344	49
Light	107	15
Moderate	169	24

Heavy	80	11
Duration of regular smoking		
Non-smoker	344	49
<1 year	43	6
1–3 years	157	22
4–6 years	85	12
>6 years	71	10
Time to first nicotine dose after waking		
Non-smoker	344	49
Within 5 min	48	7
6–30 min	73	10
>30 min	235	34
Tobacco products used*		
Conventional cigarettes	202	57
Waterpipe/shisha	169	47
Electronic cigarettes/vape	56	16
Heated tobacco products (IQOS)	12	3
*Multiple responses were permitted.		

Secondhand smoke exposure was more frequent among smokers than non-smokers. Among smokers, 55% reported ≥ 2 hours of daily indoor exposure, compared with 26% among non-smokers.

Table 3: Secondhand smoke exposure according to smoking status and residence

Variable	n	%
Indoor secondhand smoke exposure among smokers		
None	38	11
<2 h/day	121	34
2–5 h/day	128	36
>5 h/day	69	19
Indoor secondhand smoke exposure among non-smokers		
None	118	34
<2 h/day	136	40
2–5 h/day	66	19
>5 h/day	24	7
Residence among participants exposed <2 h/day		
With family	200	78
Student residence	18	7
Independent accommodation	39	15
Residence among participants exposed 2–5 h/day		
With family	149	77
Student residence	9	5

Independent accommodation	36	19
Residence among participants exposed >5 h/day		
With family	69	74
Student residence	9	10
Independent accommodation	15	16

Overall, 62% of students rated their knowledge as good or excellent. Social media and the Internet were the most frequently reported sources of information (88%), followed by physicians (79%).

Table 4: Self-reported knowledge and sources of information regarding smoking-related gastrointestinal harm

Variable	n	%
Self-rated knowledge		
Excellent	143	20
Good	292	42
Moderate	194	28
Very poor	71	10
Sources of health information*		
Social media and Internet	618	88
Physicians	551	79
Public advertisements/awareness campaigns	442	63
University lectures/curriculum	406	58
Scientific research/journals	341	49
*Multiple responses were permitted.		

Awareness was highest for the association between smoking and gastrointestinal malignancies (79%) and lower esophageal sphincter dysfunction (69%). Knowledge was lowest for the association with Crohn's disease (43%) and pancreatitis (48%), with substantial proportions reporting uncertainty.

Table 5: Knowledge of specific gastrointestinal effects of smoking

Knowledge statement	Agree, n (%)	Disagree, n (%)
Smoking weakens the lower esophageal sphincter and promotes acid reflux	485 (69)	32 (5)
Smoking disrupts beneficial intestinal bacteria and may affect digestion and absorption	390 (56)	64 (9)
Smoking increases the risk and severity of Crohn's disease	302 (43)	78 (11)
Smoking increases the risk of pancreatitis and pancreatic dysfunction	337 (48)	77 (11)
Tobacco carcinogens increase the risk of gastrointestinal malignancies	551 (79)	25 (4)

Gastrointestinal symptoms were more frequently reported among smokers than non-smokers. Daily or weekly symptoms were reported by 38% of smokers compared with 23% of non-smokers. Most participants did not regularly use gastrointestinal medications.

Table 6: Gastrointestinal symptoms, medication use, and smoking-related perceptions

Variable	n	%
Frequency of gastrointestinal symptoms among smokers		
Daily	35	10
Several times/week	100	28
Rarely	160	45
None	61	17
Frequency of gastrointestinal symptoms among non-smokers		
Daily	17	5
Several times/week	62	18
Rarely	124	36
None	141	41
Medication use for gastrointestinal symptoms among smokers		
Regularly	24	7
As needed	97	27
Never	235	66
Medication use among non-smokers		
Regularly	17	5
As needed	108	31
Never	219	64
Increase in symptoms during/after smoking		
Clearly increased	36	5
Sometimes increased	168	24
No relationship	152	22
Non-smoker	344	49
Smoking perceived to reduce appetite/cause unexplained weight loss		
Smokers: Yes	238	67
Smokers: No	84	24
Smokers: Do not know	34	10
Non-smokers: Yes	213	62
Non-smokers: No	22	6
Non-smokers: Do not know	109	32

Nearly half of the students indicated that they would quit smoking immediately if diagnosed with a gastrointestinal condition worsened by smoking. Regular awareness campaigns and free cessation counseling were the most frequently preferred university-based interventions.

Table 7: Smoking cessation-related experiences, intentions, and preferred university interventions

Variable	n	%
Previously advised by a physician to quit smoking because of a gastrointestinal problem		
Yes	108	15
No	120	17
Did not consult a physician regarding this issue	128	18
Non-smoker	344	49
Response if diagnosed with a gastrointestinal condition worsened by smoking		
Quit immediately and permanently	199	28
Reduce smoking	125	18
Continue smoking and increase medication	32	5
Non-smoker	344	49
Preferred strategies to improve awareness*		
Regular awareness campaigns/seminars	340	28
Free smoking-cessation counseling clinic	320	26
Smoking-related content in university curricula	290	24
Short educational videos/posters	278	23
*Multiple responses were permitted.		

Smoking status differed significantly according to academic discipline, with current and occasional smoking more common among non-medical students. Medical students demonstrated significantly greater awareness of the effects of smoking on the lower esophageal sphincter, intestinal microbiota, Crohn's disease, and gastrointestinal malignancies. No significant difference was observed for knowledge regarding pancreatitis ($P=0.358$).

Table 8: Association between academic discipline and smoking status and knowledge of gastrointestinal effects

Variable	Medical faculties, n (%)	Non-medical faculties, n (%)	P value
Smoking status			<0.0001
Never smoker	203 (64)	116 (36)	
Current smoker	78 (40)	119 (60)	
Former smoker	11 (44)	14 (56)	
Occasional/social smoker	66 (42)	93 (58)	
Smoking weakens the lower esophageal sphincter			<0.0001
Agree	283 (58)	202 (42)	
Disagree	13 (41)	19 (59)	
Do not know	62 (34)	121 (66)	
Smoking disrupts intestinal microbiota			<0.0001
Agree	234 (60)	156 (40)	
Disagree	29 (45)	35 (55)	
Do not know	95 (39)	151 (61)	
Smoking increases Crohn's disease risk/severity			0.0073

Agree	175 (58)	127 (42)	
Disagree	36 (46)	42 (54)	
Do not know	147 (46)	173 (54)	
Smoking increases pancreatitis/pancreatic dysfunction			0.358
Agree	179 (53)	158 (47)	
Disagree	34 (44)	43 (56)	
Do not know	145 (51)	141 (49)	
Tobacco carcinogens increase gastrointestinal cancer risk			0.0271
Agree	295 (54)	256 (46)	
Disagree	8 (32)	17 (68)	
Do not know	55 (44)	69 (56)	

4 DISCUSSION

The present study provides a comprehensive assessment of tobacco-use patterns, gastrointestinal symptoms, and awareness of the gastrointestinal consequences of smoking among students at Al-Sham Private University. The findings demonstrate a substantial burden of tobacco exposure, considerable variation in knowledge across specific gastrointestinal conditions, and marked differences according to sex and academic discipline. Importantly, the study also identified a gap between students' general awareness of the harmful effects of tobacco and their understanding of specific gastrointestinal mechanisms and diseases.

In the present sample, 28% of students reported current smoking and a further 23% reported occasional or social smoking. Although direct comparisons with international estimates should be made cautiously because of differences in definitions and survey methods, the observed prevalence indicates a substantial level of tobacco exposure among university students. This finding is consistent with evidence from Arab countries showing considerable variation in smoking prevalence among university students, with particularly high rates reported in several Middle Eastern countries [8]. A systematic review involving more than 45,000 university students from 12 Arab countries found that smoking prevalence varied substantially between countries and was consistently higher among males in most settings [8]. The relatively high prevalence observed in the current study may reflect the social acceptability of tobacco use among young adults, exposure to peer smoking, and the availability of alternative tobacco products such as waterpipe and electronic cigarettes.

A pronounced sex difference was observed in smoking behavior. Males represented the majority of current and former smokers, whereas females constituted the majority of never-smokers. This pattern is consistent with regional evidence demonstrating substantially higher cigarette-smoking prevalence among male university students than female students in several Arab countries, including Syria and neighboring countries [8]. Such differences may reflect social norms, differences in peer-group exposure, patterns of leisure and socialization, and the greater social acceptability of smoking among young men in some Middle Eastern communities. These findings support the importance of incorporating sex-sensitive approaches into university tobacco-control interventions rather than relying exclusively on a uniform strategy for all students.

The distribution of tobacco products also demonstrates the importance of considering tobacco use beyond conventional cigarettes. Conventional cigarettes were the most frequently reported product, followed by waterpipe, while electronic cigarettes and heated tobacco products were also present. Because participants could report more than one tobacco product, these percentages should be interpreted as multiple-response estimates rather than mutually exclusive categories. The relatively high proportion reporting waterpipe use is particularly relevant in the regional context. Previous systematic reviews have documented substantial waterpipe use among university students in Middle Eastern countries, with considerable variation between populations [9,10]. Waterpipe smoking should therefore not be regarded as a harmless social alternative to cigarettes. Waterpipe smoke contains nicotine and multiple toxic constituents, including carbon monoxide and polycyclic aromatic hydrocarbons, and regular use may contribute to nicotine dependence and other adverse health effects [10].

Electronic-cigarette use was less common than conventional cigarette and waterpipe use in the current study; nevertheless, its presence among university students is clinically relevant. Evidence regarding the gastrointestinal effects of electronic cigarettes remains less established than that for conventional tobacco. Experimental studies have demonstrated disruption of intestinal barrier integrity and inflammatory responses following exposure to electronic-cigarette aerosols, while human studies have reported alterations in the gut microbiota among tobacco users [11,12]. These findings provide biological plausibility for gastrointestinal effects but should not be interpreted as evidence that electronic-cigarette use caused the gastrointestinal symptoms reported by participants in this cross-sectional study.

Exposure to secondhand smoke was also widespread. A substantial proportion of students reported exposure for several hours per day, indicating that tobacco exposure extends beyond students who actively smoke. This finding is particularly important in university populations because exposure may occur in households, shared accommodation, social gatherings, and other environments where smoking is common. The health consequences of secondhand smoke are well established, although the specific gastrointestinal consequences are less extensively characterized than its respiratory and cardiovascular effects. Accordingly, the high level of passive exposure observed in this study strengthens the argument for comprehensive smoke-free environments extending beyond formal university buildings to student-oriented social and residential settings.

Students' knowledge of the gastrointestinal consequences of smoking was heterogeneous. Awareness was highest for the association between tobacco exposure and gastrointestinal malignancy, with 79% answering correctly, followed by the relationship between smoking, lower esophageal sphincter dysfunction, and reflux (69%). In contrast, awareness was substantially lower for Crohn's disease (43%) and pancreatic effects (48%). This pattern suggests that students are more familiar with the widely publicized relationship between smoking and cancer than with less commonly discussed gastrointestinal consequences. The established literature supports the biological and clinical relevance of smoking to gastrointestinal disease, including peptic ulcer disease, inflammatory bowel disease, and gastrointestinal malignancy [2]. Smoking has also been consistently associated with Crohn's disease, although its effects differ across inflammatory bowel diseases and are not uniformly harmful in every gastrointestinal condition [7].

The relatively low awareness of the relationship between smoking and pancreatitis is also noteworthy. A meta-analysis of prospective studies demonstrated that current smoking is associated with an increased risk of acute and chronic pancreatitis, with evidence of a dose-response relationship according to smoking intensity and cumulative exposure [13]. Thus, the finding that fewer than half of the students recognized a pancreatic risk represents an important educational gap. Improving awareness of these less visible consequences may help students develop a more comprehensive understanding of tobacco-related harm.

A particularly important finding was the significant difference in gastrointestinal knowledge between students from medical and non-medical disciplines. Medical students demonstrated higher levels of correct responses for most knowledge domains, including the effects of smoking on the lower esophageal sphincter, intestinal microbiota, Crohn's disease, and gastrointestinal malignancy. Conversely, non-medical students more frequently selected "don't know," particularly for the more complex topics of intestinal microbiota, Crohn's disease, and pancreatic dysfunction. These findings are biologically and educationally plausible because medical students receive structured exposure to physiology, pathology, pharmacology, and clinical medicine. However, the cross-sectional design does not allow the observed differences to be attributed definitively to academic training alone.

The absence of a significant difference between medical and non-medical students regarding pancreatic effects is also informative. Although medical students showed a slightly higher proportion of correct responses, the difference was not statistically significant. This may indicate that some gastrointestinal effects of tobacco remain insufficiently emphasized even within health-related curricula. Consequently, tobacco education in universities should not be restricted to general statements regarding cancer and cardiopulmonary disease but should include clinically relevant gastrointestinal outcomes.

The prevalence of gastrointestinal symptoms was considerable in the current sample. Overall, 7% of participants reported symptoms daily and 23% reported symptoms several times per week. Among smokers, approximately 30% reported that symptoms were clearly or sometimes worse during or after smoking. These findings are consistent with the established physiological and epidemiological literature linking tobacco exposure with gastrointestinal dysfunction. Smoking has been associated with several gastrointestinal disorders, and proposed mechanisms include impaired mucosal defense, alterations in gastrointestinal blood flow, inflammatory responses, and effects on gastrointestinal motility [2]. Recent evidence also supports an association between inhalational exposures, including cigarette and waterpipe smoking, and upper gastrointestinal diseases such as gastroesophageal reflux disease and esophagitis [14]. Nevertheless, because the present study was cross-sectional and symptoms were self-reported, these findings should be interpreted as associations rather than evidence of a causal relationship.

Despite the relatively frequent reporting of gastrointestinal symptoms, medication use was limited, with approximately two-thirds of students reporting no use of gastrointestinal medications. Several explanations are possible, including the mild or intermittent nature of symptoms, self-management without medication, lack of recognition of symptoms as clinically important, or limited healthcare utilization. Because the study did not assess clinical diagnoses or treatment indications in detail, these explanations remain speculative and warrant further investigation.

Another notable finding was the widespread belief that smoking reduces appetite or body weight. Approximately two-thirds of students reported this perception. This belief has a physiological basis: nicotine can influence appetite, food intake, and energy expenditure, and smoking is often associated with lower body weight among adults [15,16]. However, the perceived weight-control benefits of smoking may contribute to continued tobacco use or discourage cessation among individuals concerned about weight gain. This issue is therefore relevant to university smoking-cessation programs and should be addressed through accurate counseling emphasizing that perceived weight-control effects do not outweigh the substantial health risks of tobacco exposure.

The sources of health information reported by students provide important implications for intervention design. Social media and the internet were the most frequently reported sources of health information, followed by physicians, public-awareness campaigns, and university curricula. The prominent role of social media suggests that university health-promotion programs should not depend solely on conventional classroom-based education. Instead, evidence-based digital content, short educational videos, social-media campaigns, and interactive online materials may provide more effective ways of reaching students in the environments where they already seek health information. At the same time, the relatively high proportion relying on physicians indicates that healthcare professionals remain an important and potentially influential source of tobacco-related counseling.

The findings regarding cessation intentions are encouraging. Although only a minority of participants reported having received medical advice to quit because of a gastrointestinal problem, a substantially larger proportion indicated that they would quit immediately if diagnosed with a gastrointestinal condition worsened by smoking. This difference may reflect an opportunity for healthcare professionals to use symptom- and disease-specific counseling when discussing tobacco cessation. Evidence from randomized trials and systematic reviews indicates that even brief physician advice can modestly increase smoking cessation, with more intensive interventions providing additional benefit [17]. Therefore, incorporating smoking-cessation counseling into consultations for gastrointestinal symptoms may represent a practical intervention, particularly when counseling is personalized to the patient's symptoms and perceived health risks.

The students' preferred university-level interventions further support a multidimensional approach. Awareness campaigns and seminars, free smoking-cessation counseling, curriculum-based education, and short videos or posters were all selected frequently. These preferences suggest that students may benefit from combining formal educational approaches with accessible cessation services and digital communication. University-based interventions should therefore address both knowledge and behavior, rather than focusing exclusively on increasing awareness. Such programs could include periodic screening of tobacco use, brief cessation advice, referral to cessation services, educational sessions on gastrointestinal and cardiopulmonary consequences, and targeted digital campaigns.

Overall, the present findings demonstrate that knowledge of smoking-related gastrointestinal harm is uneven despite substantial exposure to tobacco among university students. Students were relatively well informed about the association between smoking and gastrointestinal cancer and reflux but showed important knowledge deficits regarding Crohn's disease and pancreatic effects. Medical students generally demonstrated better knowledge than students from non-medical disciplines, while males showed a substantially higher burden of smoking. The coexistence of frequent tobacco exposure, widespread secondhand-smoke exposure, recurrent gastrointestinal symptoms, and reliance on informal sources of health information highlights an important public-health opportunity within the university setting.

The findings should, however, be interpreted in light of several limitations. First, the cross-sectional design prevents determination of temporal or causal relationships between smoking and gastrointestinal symptoms. Second, the study was conducted at a single university using convenience sampling, which may limit generalizability to other Syrian universities or young adults in the wider population. Third, smoking behavior, symptoms, and knowledge were self-reported and therefore may be affected by recall or social-desirability bias. Fourth, the study did not include objective biomarkers of tobacco exposure or clinical confirmation of gastrointestinal diagnoses. Finally, some tobacco-use categories and multiple-response variables require careful interpretation because participants could report more than one tobacco product or exposure category.

Despite these limitations, the study provides useful baseline evidence regarding tobacco-related gastrointestinal awareness among university students in Syria. The findings support the development of comprehensive university tobacco-control programs that combine sex-sensitive cessation strategies, smoke-free policies, curriculum-based

education, targeted communication through social media, and accessible professional cessation counseling. Future multicenter studies using probability-based sampling and validated knowledge scales, together with objective measures of tobacco exposure and clinically confirmed gastrointestinal outcomes, would strengthen the evidence base and allow more precise evaluation of the relationship between tobacco use, gastrointestinal symptoms, and health literacy.

5 CONCLUSION

This study demonstrated a substantial burden of tobacco use and secondhand smoke exposure among students at Al-Sham Private University, together with important gaps in knowledge regarding the gastrointestinal consequences of smoking. Although students showed relatively good awareness of the association between smoking and gastrointestinal malignancies and gastroesophageal reflux, knowledge was considerably lower regarding Crohn's disease and pancreatic dysfunction. Medical students generally demonstrated higher levels of gastrointestinal-related knowledge than students from non-medical disciplines, while smoking was more frequently reported among male students.

The frequent reporting of gastrointestinal symptoms among smokers, combined with limited use of gastrointestinal medications and widespread reliance on social media and other informal sources of health information, highlights an important opportunity for university-based health promotion. Integrating evidence-based tobacco education into university curricula, strengthening smoke-free campus policies, providing accessible smoking-cessation counseling, and using targeted digital awareness campaigns may help improve students' knowledge and support healthier behaviors.

Further multicenter studies using validated assessment tools and objective measures of tobacco exposure are warranted to better characterize the relationship between tobacco use, gastrointestinal symptoms, and health awareness among young adults.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declare that they have no competing interests.

Statement of ethical approval

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Ethical approval was obtained from the appropriate Ethics Committee of Al-Sham Private University before commencement of the study.

Statement of informed consent

All participants were informed about the purpose and procedures of the study, and informed consent was obtained from all participants before participation. Participation was voluntary, and participants were free to withdraw from the study at any time without consequence.

Availability of data and materials

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request and subject to applicable ethical and institutional restrictions.

Authors' contributions

K.L.N. contributed to the conception and design of the study, data collection, data analysis, interpretation of the results, and drafting of the manuscript. N.A. contributed to the supervision of the study, interpretation of the findings, critical revision of the manuscript for important intellectual content, and final approval of the version to be published. Both authors reviewed and approved the final manuscript and agreed to be accountable for all aspects of the work.

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