

Incidence of Gastroesophageal Reflux Disease and Its Potential Oncogenic Implications Among Saudi Populations

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Abstract: Background: Gastroesophageal reflux disease (GERD) is a common problem encountered in daily clinical practice with variable prevalence among different populations. Chronic reflux can progress to Barrett's esophagus, a premalignant condition that may lead to esophageal adenocarcinoma (EAC).

Purpose: This study aimed to assess the prevalence of GERD in the Saudi population and to correlate associated risk factors and lifestyle behaviors linked to esophageal carcinogenesis. The study emphasizes the importance of early recognition and public health interventions to reduce the potential progression from GERD to Barrett's esophagus and EAC.

Patients and methods: This was a cross-sectional study. A designed questionnaire was carefully formulated from previously approved questionnaires (GerdQ) to screen the local population's awareness of GERD. SPSS software was used to perform the chi-square test. In total, 1,745 responses were received.

Results: GERD-confirmed symptoms were prevalent in 669 adults. Thus, the prevalence of GERD and confirmed answers meeting the GERD criteria was 38.3%, including men (37.8%) and women (62.2%). However, most of the patients were Saudis, resided in the western region, and a considerable number of men were smokers. Many women had a family history of GERD compared with their counterparts. Women (8.4%) smoked shisha at least once daily, whereas men (27.7%) smoked cigarettes.

Conclusion: The prevalence of GERD among Saudi populations is 38.3%, which is higher than that previously reported in Western countries. Considering GERD's association with Barrett's esophagus and esophageal adenocarcinoma, these findings highlight the need for increased awareness and early preventive measures to reduce related oncologic risks.

Keywords: GERD, Barrett's esophagus, Esophageal adenocarcinoma, Cancer risk, Saudi population.

1. INTRODUCTION

Gastroesophageal reflux disease (GERD) is defined as the involuntary movement of gastric contents into the lower part of the esophagus. GERD is widely recognized as a condition presenting with chest discomfort, commonly referred to as "heartburn." When gastric reflux becomes chronic, it is classified as a disease capable of causing severe symptoms and mucosal injury [1]. The most frequent complications of chronic gastric reflux include esophagitis, Barrett's esophagus, and dysfunction of the lower esophageal sphincter. The typical symptoms of GERD include heartburn, dysphagia, sore throat, coughing, and hypersalivation [2].

Barrett's esophagus (BE) represents a well-established premalignant consequence of chronic GERD, resulting from prolonged exposure of the distal esophagus to gastric refluxate. This condition induces replacement of the normal squamous epithelium with specialized columnar epithelium containing goblet cells — a hallmark of intestinal metaplasia. Such histological transformation, referred to as metaplastic epithelium, significantly elevates the risk of dysplasia and progression to esophageal adenocarcinoma (EAC). The incidence of EAC has been increasing globally over the past few decades, accompanied by high mortality and morbidity rates [3].

GERD is among the most frequently encountered conditions by both general physicians and gastroenterologists. Reports indicate that the prevalence of GERD has increased from 10% to 20% in Western countries, compared with less than 5% in Asian populations [4]. Despite its rising burden,

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GERD remains underrecognized in many regions. Data from Saudi Arabia, located in the western part of Asia, have shown a significant increase in GERD prevalence in recent years—up to 40%—which is considerably higher than earlier estimates [5].

The British Society of Gastroenterology identifies histologically confirmed intestinal metaplasia with goblet cells as the only pathognomonic feature of Barrett's esophagus [6]. Early endoscopic detection of mucosal irritation or erythema can serve as a clinical indicator for biopsy and disease confirmation. Although Barrett's metaplasia often remains asymptomatic, it is primarily found in patients with chronic GERD and typical reflux symptoms. Revised guidelines for BE management continue to evolve, emphasizing risk stratification, surveillance, and the potential for future diagnostic innovations [7–8].

Several demographic and clinical factors are associated with increased GERD incidence, including age, male sex, obesity (which raises the risk approximately 2.5-fold), and diabetes mellitus [6]. A high disease prevalence may also reflect limited public awareness of GERD and its potential oncologic consequences [9]. Enhancing lifestyle awareness and preventive health measures may help mitigate disease progression from GERD to Barrett's esophagus and, ultimately, EAC [10].

In recent years, Saudi Arabia has implemented national health strategies to promote better nutrition, reduce obesity, and improve overall population wellness. Such interventions may indirectly reduce GERD prevalence by encouraging healthier dietary habits and increased physical activity. Numerous studies have demonstrated that certain foods—including high-fat, spicy, or acidic meals—exacerbate reflux symptoms [11]. Additionally, caffeine-containing beverages such as coffee and tea, as well as smoking, may contribute to reflux by relaxing the lower esophageal sphincter through compounds such as theobromine and theophylline [12–13].

Despite the high burden of GERD, studies assessing its prevalence and oncologic implications remain limited in Saudi Arabia [14]. The present study, conducted as part of the GERMS Project funded by Taibah University, aimed to determine the prevalence of GERD in a large Saudi cohort and to explore its association with demographic, nutritional, and lifestyle factors. This investigation provides essential baseline data for understanding the potential transition from GERD to Barrett's esophagus and esophageal adenocarcinoma. These findings may guide future preventive oncology programs not only within Saudi Arabia but also across Gulf and global populations with similar dietary and lifestyle patterns.

2. PATIENTS AND METHODS

This study followed a cross-sectional design to address its main objectives. A structured online questionnaire was developed using Google Forms, and the link was distributed throughout Saudi Arabia via various social media platforms such as X (Twitter), Facebook, and WhatsApp. Participants self-reported the survey. A convenient non-randomized sampling technique was used to target adult populations residing in the Kingdom of Saudi Arabia.

Inclusion criteria included adult male and female participants aged ≥ 18 years who were permanent residents of Saudi Arabia. Exclusion criteria included individuals who were not permanent residents, those below 18 years of age, or those diagnosed with chronic systemic diseases such as cancer or chronic kidney disease, to ensure accurate assessment of reflux symptoms without potential oncologic or systemic confounders. The invitation page provided a full explanation of the study objectives. Informed consent was obtained from all participants and/or their legal guardians prior to completing the questionnaire. Data were collected between December 2022 and the end of March 2023.

The sample size was calculated based on a previous study conducted in Riyadh, Saudi Arabia, where 1,265 participants completed a questionnaire and the prevalence of GERD was estimated at 45.4% [15]. The following equation was used to calculate the minimum sample size:

$$n = (Z_{1-\alpha/2})^2 \times P(1 - P) \div d^2$$

where:

n = sample size

$Z_{1-\alpha/2} = 1.465$ for 98% confidence level

d = desired margin of error (0.05)

P = prevalence of the disease (45.4%)

Thus, the minimum required sample size was 539 participants.

1.1. The Gastroesophageal Reflux Disease Questionnaire (GerdQ)

This study used the Gastroesophageal Reflux Disease Questionnaire (GerdQ), a tool developed for the diagnosis and management of gastroesophageal reflux disease in primary care settings [17]. An Arabic version of the GerdQ, previously validated and used in published studies on Saudi populations [15, 16], was also adapted to ensure convenience and clarity for local participants. The questionnaire was specifically developed and validated for the purpose of this study to enhance reliability and cultural relevance.

The GerdQ consisted of several sections addressing local factors known to exacerbate GERD symptoms and potentially contribute to the development of Barrett's esophagus and esophageal adenocarcinoma. In Section A, demographic information was collected, including participants' sex, age, nationality, region of residence (West, East, North, or Southern region of Saudi Arabia), smoking habits and type (vape, shisha, cigarettes), history of chronic diseases, family history of GERD, pregnancy status for women, and whether they had physician-confirmed GERD. Age was categorized as 18–25, 26–35, 36–45, and >46 years.

In Section B, participants were asked whether GERD symptoms negatively affected their daily activities and whether stress or psychological factors aggravated their symptoms, as chronic reflux-related stress has been linked to epithelial injury and increased oncogenic risk. In Section C, participants provided their weight and height data, guided by uploaded images in the survey to ensure accurate self-measurement. Body mass index (BMI) was calculated by dividing body weight (kg) by the squared height (m²). The

World Health Organization (WHO) classification was used to define BMI categories as underweight (<18.5 kg/m²), normal (18.5–24.9 kg/m²), overweight (25.0–29.9 kg/m²), and obese (≥30 kg/m²) [14].

Section D focused on dietary habits during the previous two weeks. Participants reported their intake of coffee, tea, soft drinks (number of cans), and preference for spicy or sour foods. They also specified their daily water consumption (0–2, 3–5, >6 cups), sleep timing after the last meal (immediately, after 2 hours, or >3 hours), number of meals per day, and which meal(s) worsened GERD symptoms. These factors were analyzed considering their potential contribution to chronic mucosal irritation, a known risk for Barrett’s esophagus and subsequent malignant transformation.

According to the GerdQ scoring system, a total score of 8 or above was considered positive for GERD, as recommended by Jones et al. [17]. Participants scoring 0–7 were considered negative, indicating less than a 50% likelihood of GERD, whereas those scoring above 8 had more than a 50% likelihood of GERD and were categorized as positive.

The questionnaire was pretested on ten participants (n = 10) to ensure clarity and understanding; these individuals were not included in the final analysis. Unclear questions were revised accordingly. A hotline number was provided for participants needing assistance. All procedures were performed in accordance with relevant ethical guidelines and research regulations.

Ethical approval for this study was obtained from the College of Applied Medical Sciences Research Ethics Committee, Taibah University, Al-Madinah Al-Munawarah, Saudi Arabia (Certificate #SREC/AMS 2020/51/CLD). Participation was voluntary, and confidentiality was maintained throughout the research process.

3. STATISTICAL ANALYSIS

Data were coded, and statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 26.0 (IBM Corp., Chicago, IL, USA). The Kolmogorov–Smirnov test was applied to assess the normality of continuous variables (age, waist circumference, and BMI). Vari-

ables with normal distribution were expressed as mean ± standard deviation (SD).

Chi-square analysis was conducted to compare the distribution of categorical variables. The independent t-test was applied to determine differences between male and female participants. The Spearman correlation coefficient test was used to assess associations between variables, particularly focusing on risk factors potentially linked to chronic GERD progression, Barrett’s esophagus, and esophageal adenocarcinoma.

A multiple linear regression model was employed to identify the most significant predictors influencing GERD prevalence and its potential oncologic implications. Results were presented in tables stratified by sex. The significance level was set at $P \leq 0.05$.

4. RESULTS

A total of 1,746 responses were received. Among these, 669 participants were diagnosed with GERD, while 1,077 had no GERD, yielding a prevalence rate of 38.3%. Of those with GERD, 253 (37.8%) were men and 416 (62.2%) were women. GERD was particularly prevalent among young men (<26 years) and middle-aged women (36–45 years) (Table 1). Most patients were Saudi nationals residing in the Western region, and a notable proportion were smokers — a factor known to contribute not only to GERD but also to esophageal mucosal damage, which may increase susceptibility to Barrett’s esophagus and esophageal adenocarcinoma. A higher proportion of women reported a family history of GERD compared to men. Smoking patterns varied, with 35 women (8.4%) smoking shisha daily and 70 men (27.7%) smoking cigarettes (data not shown in Table 1).

No significant differences were found between men and women regarding medical history ($P = 0.217$) and food preferences ($P = 0.494$). Women (n = 79, 19%) and men (n = 51, 20.2%) reported comorbidities, mainly hypertension and/or diabetes (women, n = 68, 86%; men, n = 47, 92.2%). Dietary preferences were similar across genders, with 53% of women and 58.5% of men reporting frequent consumption of spicy, sour, or chili foods — all potential triggers for chronic esophageal inflammation (Table 2).

Table 1. Demographic characteristics of GERD patients as categorized by sex

Variables	Men n = 253 (37.8%)	Women n = 416 (62.2%)	Total n = 669 (100%)	P-value
Age groups (years)				
18-25	76 (30.0)	93 (22.4)	169 (25.3)	0.036
26-35	40 (15.8)	71 (17.1)	111 (16.6)	
36-45	44 (17.4)	106 (25.5)	150 (22.4)	
>46	93 (36.8)	146 (35.1)	239 (35.7)	
Nationality				
Saudi	223 (88.1)	384 (92.3)	607 (90.7)	0.072
Non-Saudi	30 (11.9)	32 (7.7)	62 (9.3)	

Region of residence				
Western	201 (79.4)	328 (78.8)	529 (79.1)	0.386
Middle	26 (10.3)	57 (13.7)	83 (12.4)	
Others ^a	26 (10.3)	31 (7.5)	57 (8.5)	
Smoking status				
Smokers	107 (42.3)	55 (13)	162 (24.2)	<0.0001
Non-smokers	146 (57.7)	361 (87)	507 (75.8)	
Family history of GERD				
Yes	172 (68.0)	347 (83.4)	519 (77.6)	<0.0001
No	81 (32.0)	69 (16.6)	150 (12.4)	

Notes: Values are numbers and percentages.

Abbreviations: ^aOthers = include the Eastern, Southern, and Northern regions of Saudi Arabia.

Table 2. Nutritional and selected risk factors associated with GERD symptoms.

Variables	Men n = 253 (37.8%)	Women n = 416 (62.2%)	Total n = 669 (100%)	P-value
BMI (Kgm ⁻²)				
Mean (SD) ^a	29.0 (6.3)	27.6 (6.7)	28.1 (6.6)	0.007**
Underweight (<18.5)	7 (2.8)	23 (5.5)	30 (4.5)	0.017*
Normal (18.5-24.9)	56 (22.1)	137 (33.0)	193 (28.8)	
Overweight (25-29.9)	94 (37.2)	120 (28.8)	214 (32.0)	
Obesity grade I (30-34.9)	57 (22.5)	80 (19.2)	137 (20.5)	
Obesity grade II (35-39.9)	28 (11.1)	39 (9.4)	67 (10.0)	
Obesity grade III (≥40)	11 (4.3)	17 (4.1)	28 (4.2)	
Number of meals and snacks				
1	130 (55.0)	241 (58.0)	371 (55.5)	0.465*
2	101 (40.0)	161 (38.7)	262 (39.2)	
≥3	13 (5.1)	14 (3.4)	27 (4.0)	
Last meal of the day before bedtime (hours)				
1	69 (27.3)	96 (23.1)	165 (24.7)	0.045*
2	102 (40.3)	151 (36.3)	253 (37.8)	
≥3	82 (32.4)	169 (40.6)	251 (37.5)	
Meals that aggravate GERD symptoms				
Dinner	126 (49.8)	216 (52.0)	342 (51.1)	0.251*
Lunch	72 (28.5)	136 (32.7)	208 (31.0)	
Others ^b	55 (21.7)	64 (15.4)	119 (17.8)	
The Practice of chewing well before swallowing				
Yes	164 (64.8)	231 (55.5)	395 (59.0)	0.011*
No	89 (35.2)	185 (44.5)	274 (41.0)	

Daily consumption of water (250 ml cup)				
0-2	46 (18.2)	131 (31.5)	177 (26.5)	0.001*
3-5	151 (59.7)	204 (49.0)	355 (53.0)	
≥6	56 (22.1)	81 (19.5)	137 (20.4)	
Coffee consumption per day (150 ml cup)				
1-2 times	174 (68.8)	303 (73.0)	477 (71.3)	0.944*
≥3	25 (10.0)	44 (10.6)	69 (10.3)	
Tea consumption per day (150 ml cup)				
1-2 times	168 (66.4)	261 (62.7)	429 (64.4)	<0.0001*
≥3	35 (13.8)	22 (5.3)	57 (8.5)	
Soft drink consumption (a 250 ml can)				
1	101 (40.0)	137 (33.0)	238 (35.6)	<0.0001*
≥2	54 (21.3)	32 (7.7)	86 (12.8)	
Association of GERD symptoms with psychological and stress status				
Sometimes	125 (49.4)	212 (51.0)	337 (50.3)	0.563*
Always	85 (33.6)	146 (35.1)	231 (34.5)	
Not at all	43 (17.0)	58 (14.0)	101 (15.1)	
Wearing tight clothes worsen GERD symptoms				
Yes	12 (4.7)	60 (14.4)	72 (10.8)	<0.0001*
No	241 (95.3)	356 (85.6)	597 (89.2)	

Notes: **P-value obtained from the Independent Student's t-test; *P-value obtained from the Chi-square test.

Abbreviations: ^aMean (SD)= Geometric Mean and standard deviation; ^bOthers included breakfast alone, a combination of meals, or all meals.

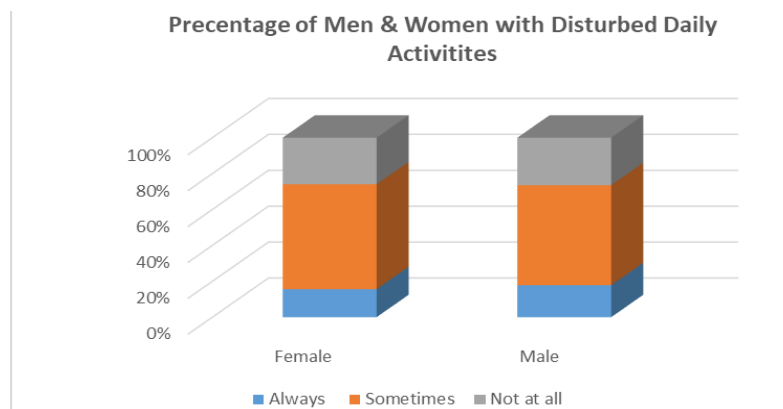


Fig. (1). Effect of GERD on daily life activities of men and women in Saudi Arabia. There were no significant differences between them. Among most patients, GERD sometimes disrupted their daily activities.

Men exhibited higher mean BMI values, with obesity more prevalent among them (Table 2). Overall, most participants consumed only one meal per day. Men tended to sleep two hours after their final meal, while many women waited over three hours. Dinner was the most commonly reported meal associated with GERD symptom exacerbation. Additionally, men were more likely to chew food thoroughly before swallowing. While both sexes consumed 1–2 cups of coffee daily, women generally drank less water, tea, and soft drinks than men (Table 2).

Nearly half of all respondents reported that psychological stress aggravated their GERD symptoms — a factor that could amplify chronic inflammatory responses within the esophagus, potentially facilitating pre-neoplastic changes. Moreover, more women than men indicated that wearing tight clothing worsened their symptoms (Table 2). Many participants also reported that GERD interfered with their daily life activities (Fig. 1). Over 90% of participants were Saudi nationals (90.7%), nearly one-quarter were smokers (24.2%), and over three-quarters reported a family history of GERD (77.6%) (Table 1).

Pearson’s correlation analysis revealed that GERD symptoms among adults were associated positively or negatively with certain demographic, nutritional, and behavioral risk factors (Table 3). Positive associations were observed with BMI, existing medical conditions, inadequate chewing, and consumption of water, tea, soft drinks, and tobacco. Conversely, late-night meals, tight clothing, and family history showed negative associations (Table 3).

Table 3. Association between demographic characteristics, nutritional and selected risk factors, and GERD symptoms.

Factors:	r	P-value
BMI	0.102	<0.008
History of medical diseases	0.249	<0.004
The last meal of the day before bedtime	-0.077	<0.046
Chewing practices	0.092	<0.018
Water consumption	0.113	<0.003
Tea consumption	0.204	<0.0001
Soft drink consumption	0.237	<0.0001
Smoking practices	0.40	<0.0001
Wearing tight clothes	-0.151	<0.0001
Family history of GERD	-0.179	<0.0001

The multiple linear regression model identified coffee intake, smoking habits, stress levels, and psychological status as key contributors to GERD severity (Table 4). These findings underscore how modifiable risk factors associated with GERD may also serve as early indicators for chronic esophageal injury — potentially linking persistent reflux to precancerous conditions such as Barrett’s esophagus and subsequent malignancy.

DISCUSSION

The present study found a GERD prevalence of 38.3%, with women representing the majority of affected individuals (n = 416, 62.2%) compared to men (n = 253, 37.8%). The higher incidence observed among young men (<26 years) and middle-aged women (36–45 years) aligns with regional

and global patterns of increasing reflux-related morbidity. Although 38.3% reflects a high prevalence, similar trends have been reported previously in Saudi populations, ranging from 20.6% to 45.4% (14–16, 20). Almadi et al. (2014) documented the highest rate at 45.4% in Riyadh [15], while another study from the Eastern region showed a lower rate of 20.6% [16]. Comparable data from the Middle East also support this trend, with GERD prevalence reported as 24% in Tunisia [19], 14.8% in Syria, and 21.2% in Iran [20–21]. A North Indian study among medical staff found 16.2%, but Asia overall has experienced a rapid rise in GERD cases, likely driven by urbanization, Westernized diets, and sedentary behaviors [22].

Globally, the prevalence of GERD varies considerably — North America (18–27%), Europe (8–25%), East Asia (2–7%), and the Middle East (8–33%) [23]. A recent global meta-analysis estimated a 13.98% overall prevalence, yet regional differences persist, with particularly high rates in Latin America (12.88%), the Caribbean (19.55%), North America (4.16%), and Turkey (22.40%) [24].

Our findings also demonstrate a significant association between BMI and GERD. Obesity emerged as a major contributing factor, consistent with evidence linking increased BMI to heightened intra-abdominal pressure and esophageal acid exposure. These changes can lead to chronic inflammation, esophageal mucosal metaplasia, and a heightened risk of Barrett’s esophagus (BE) — a well-established precancerous lesion that can progress to esophageal adenocarcinoma (EAC) [25–27]. Although some studies have reported inconsistent associations between BMI and GERD [30–31], the collective evidence supports obesity as a key modifiable determinant of both reflux disease and downstream oncogenic risk.

Cigarette smoking also emerged as a significant predictor of GERD in this study. Similar findings have been reported previously, where nicotine exposure exacerbates reflux symptoms and impairs lower esophageal sphincter function [21, 32]. Notably, recent studies have indicated that smoking not only intensifies GERD symptoms but also enhances bile acid-induced mucosal injury, promoting Barrett’s esophagus and EAC progression [32]. Our prior research has demonstrated that deoxycholic acid (DCA)—a secondary bile acid—acts as a molecular driver of carcinogenesis in Barrett’s esophagus [34], underscoring the biological continuum linking reflux, bile exposure, and oncogenic transformation.

Table 4. Multiple Linear Regression for factors associated with GERD symptoms. Gender was the dependent variable.

Factors	Unstandardized Coefficients		Standardized Coefficients	t	Sig	95%CI	
	B	Std. Error					
BMI	0.039	0.022	0.102	1.820	0.070	-0.003	0.082
Coffee consumption	-0.089	0.039	-0.129	-2.290	0.023	-0.166	-0.012
Smoking consumption	0.223	0.025	0.505	8.889	0.000	0.174	0.272
Stress and psychological status	-0.087	0.042	-0.116	-2.064	0.040	-0.170	-0.004

Notes: Gender was the dependent factor (Regression = 15.596, Residue = 46.072, F = 20.481, Significance = 0.000)

Dietary and lifestyle factors also played an important role. The current study found significant associations between GERD symptoms and consumption of tea, soft drinks, and fast food, as well as the use of nonsteroidal anti-inflammatory drugs (NSAIDs). These findings are consistent with prior research suggesting that acidic beverages and processed foods can lower esophageal pH, impair mucosal defense, and promote chronic esophagitis, a recognized precursor to neoplastic change [35-39]. Although some studies report no significant correlation between coffee or tea and reflux [36], variability in beverage type, caffeine content, and dietary patterns may explain these differences.

From an oncology perspective, these findings highlight a critical preventive intersection: lifestyle factors that exacerbate GERD also contribute to the pathophysiological environment conducive to malignant transformation. Persistent reflux, obesity, and smoking collectively promote oxidative stress, chronic epithelial injury, and cellular dysplasia, all of which increase the risk of gastroesophageal junction and esophageal cancers.

STUDY LIMITATIONS

The study utilized online data collection tools (Google Forms), which may have led to overrepresentation from certain regions, particularly the Western region. Older or illiterate individuals were less likely to participate. Additionally, diagnostic codes were not used to confirm GERD cases, and only English-language literature was reviewed, possibly omitting relevant studies. Variability in methodology, regional diet, and cultural habits across studies may also explain differences in GERD prevalence and risk factor associations.

CONCLUSION

This study identified a GERD prevalence of 38.3% among the Saudi population, exceeding rates reported in many Western and global studies. The widespread occurrence of GERD underscores its growing public health burden in Saudi Arabia and its potential implications for upper gastrointestinal malignancies. The variability in prevalence across regions highlights the need for standardized national screening programs and early risk assessment strategies, particularly targeting individuals with chronic reflux symptoms and high-risk behaviors.

Sociodemographic and lifestyle factors — including age, obesity, smoking, fast food and coffee consumption, and analgesic use — were strongly associated with GERD. These same factors are also implicated in the progression from chronic reflux to Barrett's esophagus and esophageal adenocarcinoma, emphasizing the importance of integrating oncologic vigilance into GERD management protocols.

Public health interventions should prioritize education, dietary modification, weight management, and smoking cessation to mitigate reflux severity and reduce the long-term cancer risk associated with GERD-related mucosal injury. Early awareness and preventive action could significantly curb the rising incidence of reflux-associated esophageal malignancies in the region.

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DATA AVAILABILITY

All data generated or analyzed during this study are included in this published article [and its supplementary information files].

DISCLOSURE

The author(s) report no conflicts of interest in this work.

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