ORIGINAL ARTICLE

Prevalence of gastrointestinal symptoms among medical students at King Faisal University: a cross-sectional study

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ABSTRACT

Background: Gastrointestinal (GI) symptoms are a major concern among medical students due to academic pressures affecting gut–brain interactions. This study aimed to determine the prevalence of GI symptoms among medical students at King Faisal University (KFU) and compare rates between pre-clinical and clinical years.

Subjects and Methods: A cross-sectional descriptive study was conducted at the College of Medicine, KFU, Saudi Arabia, from February 23 to March 29, 2026. A total of 422 medical students were recruited via convenience sampling to complete an online questionnaire. Assessments included sociodemographic characteristics, lifestyle factors, Rome IV criteria, the Bristol Stool Scale, and the Generalized Anxiety Disorder 7-item scale. Statistical analysis was performed with SPSS ($P < 0.05$).

Results: Among the 422 participants (53.3% female; 63.0% pre-clinical), 87.9% reported at least one GI symptom in the previous three months. The most frequent symptoms were abdominal pain (58.3%), bloating (55.3%), regurgitation (46.4%) and heartburn (45.5%).

GI symptoms were significantly associated with positive family history of GI conditions ($P = 0.013$), and a non-significant trend was observed for sleep duration less than 5 hours ($P = 0.052$). There were no significant associations with academic year ($P = 0.070$), gender ($P = 0.339$), or anxiety ($P = 0.654$).

Conclusion: Medical students at KFU have a high burden of GI symptoms significantly associated with a positive family history, while short sleep duration showed a non-significant trend. Academic phase did not significantly influence symptom prevalence, suggesting a need for targeted wellness support.

Keywords: Gastrointestinal symptoms, Medical students, King Faisal University, prevalence, Cross-sectional study.

Introduction

Functional gastrointestinal disorders (FGIDs), recently redefined as disorders of gut–brain interaction, are a significant global public health issue characterized by chronic or recurrent gastrointestinal (GI) symptoms – such as abdominal pain, bloating, heartburn, and altered bowel habits – without structural or biochemical abnormalities [1]. FGIDs affect 10% to 25% of the general population globally [2], with irritable bowel syndrome (IBS) and gastroesophageal reflux disease (GERD) the most studied [3]. Global IBS prevalence ranges from 9.3% to 35.5%, while GERD affects 8.7% to 33.1% of adults in the Middle East and North Africa (MENA) [4]. These chronic, recurrent disorders impose substantial healthcare costs, academic or workplace absenteeism, and reduced quality of life [2].

The burden is especially high in Saudi Arabia, where systematic reviews report an overall IBS prevalence

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AMEM

of 26.3%, with some regions higher [5], and GERD symptom prevalence of 23.5% to 45.4% [6], attributed to genetic, dietary, and lifestyle factors common in the region [4].

University students, particularly medical students, are a uniquely vulnerable subgroup due to a high burden of mental health problems, irregular schedules, and suboptimal dietary habits, especially given the growing recognition of the gut–brain axis [2]. Locally, a King Abdulaziz University (KAU) study found a 31.8% IBS prevalence among medical students [7], and a multicentric MENA study found that 40.1% of medical students met diagnostic criteria for IBS, strongly correlating with underlying depression and anxiety [8].

Saudi medical students face a seven-fold higher risk of IBS compared with peers in other disciplines [1]. Prior King Faisal University (KFU) research has examined specific disorders such as GERD [9], but a comprehensive assessment of the full range of upper and lower GI symptoms along the gut–brain axis is lacking in this population, and no study has yet examined how this burden changes from pre-clinical to clinical years alongside lifestyle and psychological factors using validated tools.

Addressing this knowledge gap is essential for developing interventions to support the well-being of future medical professionals. This study therefore aims to determine the prevalence of GI symptoms among medical students at KFU and to compare rates between pre-clinical and clinical year students to assess whether progression through medical education influences GI symptom risk.

Subjects and Methods

This observational cross-sectional study was conducted from February 23 to March 29, 2026, among male and female medical students at the College of Medicine, KFU, Al Ahsa, Saudi Arabia. Ethical approval was obtained from the KFU Research Ethics Committee (Ref. No. KFU-REC-2026-JAN-ETHICS3922), dated 20/01/2026, in accordance with the Declaration of Helsinki. Eligible participants were medical students who provided electronic informed consent and completed the questionnaire; those who did not consent were excluded from the analysis. According to the KFU curriculum, participants were classified as pre-clinical (Years 1–3; lecture- and laboratory-based foundational sciences) or clinical (Years 4–5; hospital rotations and direct patient contact). Medical interns were excluded, as internship is a distinct post-graduate transition year with different work hours and schedules. As this was an observational, non-interventional study without randomization, allocation concealment, or blinding, CONSORT reporting requirements for randomized trials do not apply.

Sample size was estimated using the single-proportion formula for cross-sectional studies ($n = \frac{Z^2 P(1-P)}{d^2}$). As no local prevalence estimate existed, P was set at 50% (maximizing the required sample size), with a 95% confidence level and 5% margin of error, yielding a minimum requirement of 385 participants. Participants were recruited via convenience sampling, with the questionnaire link distributed through student WhatsApp groups across all academic years. The final analyzed sample comprised 422 medical students, exceeding the minimum requirement; an exact response rate could not be calculated due to electronic distribution via messaging groups.

Data were collected using a researcher-developed, self-administered online questionnaire (Google Forms) written in English, with symptom items informed by established frameworks: the Montreal Definition for GERD, Rome IV concepts for functional GI disorders, and the Bristol Stool Scale for stool consistency [10]. The questionnaire comprised five sections: (1) sociodemographic and health characteristics (age, sex, academic year, marital status, body mass index (BMI), chronic conditions, medication use, family GI history); (2) lifestyle and dietary factors; (3) upper GI symptoms; (4) lower GI symptoms; and (5) the Generalized Anxiety Disorder 7-item scale (GAD-7), categorized as minimal (0–4), mild (5–9), moderate (10–14), or severe (15–21) [11]. All items were mandatory, with negative response options (e.g., “None”), to prevent missing data. The primary outcome was the presence of at least one GI symptom in the preceding three months, compared by academic phase (pre-clinical vs. clinical). Additional variables included daily water intake, caffeine and energy drink use, eating quickly, smoking status, sleep duration, and physical activity frequency. Content validity was established by five consultants (three in internal medicine, two in gastroenterology) who reviewed item relevance, clarity, and comprehensiveness. The questionnaire was then pilot-tested on a sample of 20 medical students (excluded from the final analysis) to confirm face validity, question clarity, and completion time. Internal consistency was satisfactory (Cronbach’s alpha = 0.827), exceeding the 0.70 acceptability threshold.

Electronic informed consent ensured voluntary participation with the right to withdraw prior to submission. No direct identifiers were collected to maintain anonymity, while sign-ins prevented duplicate entries. Data were transmitted securely via SSL/TLS and stored on password-protected accounts accessible only to the research team, with retention for five years before permanent deletion.

Data were analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Categorical variables were reported as frequencies and percentages, and continuous variables (e.g., age) as mean ± SD. GI symptom prevalence was calculated as the proportion of participants reporting at least one symptom in the past three months, with a 95% confidence interval. Associations between GI symptoms and demographic, clinical, lifestyle, and anxiety-related variables were examined using chi-square tests (Fisher’s exact test for small expected cell counts), with pre-clinical versus clinical status as the main comparison. All tests were two-sided with significance set at $P < 0.05$; as all items were mandatory, no incomplete responses required exclusion. As these chi-square analyses were exploratory, no adjustment for multiple comparisons was made, and findings were interpreted cautiously given the potential for increased Type I error.

Results

The study included 422 medical students (mean age 21.16 ± 1.80 years; 53.3% female; 63.0% pre-clinical). Most participants were single (92.9%) with normal BMI (49.5%). Regarding medical history, 13.5% reported chronic conditions, 12.1% used regular medications, and 21.1% reported a family history of GI conditions (Table 1).

At least one GI symptom in the preceding three months was reported by 87.9% of participants. The most frequent symptoms were abdominal pain (58.3%), bloating (55.3%), regurgitation (46.4%), and heartburn (45.5%). Urgency was noted by 41.3%, and alternating bowel habits by 37.2%. Based on the Bristol Stool Scale, 85.3% had normal stool consistency, 11.6% constipation, and 3.1% diarrhea. Mucus and blood in stool were reported by 14.2% and 5.5%, respectively (Table 2).

The association between GI symptoms and demographic/clinical characteristics is shown in (Table 3). No significant associations were found with gender (P = 0.339), academic year (P = 0.070), marital status (P = 0.345), BMI (P = 0.682), or medication use (P = 0.594); chronic conditions showed a non-significant trend (P = 0.089). A significant association was found only with family history of GI conditions (P = 0.013), more common among symptomatic (22.9%) than asymptomatic participants (7.8%).

No significant associations were found between GI symptoms and water intake (P = 0.527), caffeine (P = 0.219), energy drinks (P = 0.922), eating quickly (P = 0.910), smoking (P = 0.961), or physical activity (P = 0.108). Sleep duration showed a borderline association (P = 0.052): 15.1% of symptomatic participants slept

***Table 1**. Demographic and health characteristics of the study population (n = 422).*

Characteristic		*n*	%
Age: mean (SD)		21.16 (1.80)	
Gender	Male	197	46.7
	Female	225	53.3
Academic year	Pre-clinical	266	63.0
	Clinical	156	37.0
Marital status	Single	392	92.9
	Married	30	7.1
BMI	Underweight	66	15.6
	Normal	209	49.5
	Overweight	96	22.7
	Obese	51	12.1
Are you diagnosed with chronic medical conditions?	Yes	57	13.5
	No	365	86.5
Are you currently taking any regular medications?	Yes	51	12.1
	No	371	87.9
Do you have a first-degree relative diagnosed with GI condition (e.g., IBS, IBD, colon cancer)?	Yes	89	21.1
	No	333	78.9

BMI = body mass index; GI = gastrointestinal; IBS = irritable bowel syndrome; IBD = inflammatory bowel disease; SD = standard deviation.

***Table 2.** Prevalence and frequency of gastrointestinal symptoms among participants.*

GI symptoms		*n*	%
During the last 3 months, how often have you experienced Heartburn (burning behind chest/ sternum):	Never	230	54.5
	Daily	16	3.8
	Weekly	54	12.8
	Monthly	122	28.9
During the last 3 months, how often have you experienced Regurgitation (acidic/sour fluid into throat):	Never	226	53.6
	Daily	15	3.6
	Weekly	48	11.4
	Monthly	133	31.5
Usual bowel habit:	A. Less than 3 bowel movements per week	89	21.1
	B. More than 3 bowel movements per day	66	15.6
	Alternating between A and B	157	37.2
	None of the above	110	26.1
Stool consistency (Bristol Stool Scale)	Constipation	49	11.6
	Normal	360	85.3
	Diarrhea	13	3.1
Bloating/abdominal distension:	Never	189	44.8
	Sometimes	180	42.7
	Always	53	12.6
Urgency (sudden need to defecate):	Never	248	58.8
	Sometimes	159	37.7
	Always	15	3.6
Mucus in stool	Yes	60	14.2
	No	362	85.8
Blood in stool	Yes	23	5.5
	No	399	94.5
In the last 3 months, how often have you had abdominal pain?	Never	176	41.7
	1 day/month	77	18.2
	2-3 days/ month	77	18.2
	At least 1 day/week	77	18.2
	Daily	15	3.6
Having GI Symptoms?	No	51	12.1
	Yes	371	87.9

GI = Gastrointestinal.

Table 3. *Factors associated with the presence of gastrointestinal symptoms among participants.*

Characteristic		Having GI symptoms?				*P* value
		No		Yes		
		n	%	*n*	%	
Gender	Male	27	52.9	170	45.8	0.339
	Female	24	47.1	201	54.2	
Academic year	Pre-clinical	38	74.5	228	61.5	0.070
	Clinical	13	25.5	143	38.5	
Marital status	Single	49	96.1	343	92.5	0.345
	Married	2	3.9	28	7.5	
BMI	Underweight	7	13.7	59	15.9	0.682
	Normal	23	45.1	186	50.1	
	Overweight	15	29.4	81	21.8	
	Obese	6	11.8	45	12.1	
Are you diagnosed with chronic medical conditions?	Yes	3	5.9	54	14.6	0.089
	No	48	94.1	317	85.4	
Are you currently taking any regular medications?	Yes	5	9.8	46	12.4	0.594
	No	46	90.2	325	87.6	
Do you have a first-degree relative diagnosed with GI condition (e.g., IBS, IBD, colon cancer)?	Yes	4	7.8	85	22.9	0.013
	No	47	92.2	286	77.1	

BMI = body mass index; GI = gastrointestinal; IBS = irritable bowel syndrome; IBD = inflammatory bowel disease.

less than 5 hours nightly versus 5.9% of asymptomatic participants (Table 4).

The association between GI symptoms and GAD-7 anxiety levels is shown in (Table 5). Participants with GI symptoms showed higher rates of moderate (19.4%) and severe anxiety (15.9%) than asymptomatic participants (17.6% and 7.8%), though this association did not reach statistical significance ($P = 0.654$).

Discussion

This study found that most medical students (87.9%) reported at least one GI symptom during the past three months—markedly higher than a similar-sized Indian study using Rome IV criteria (34.4%) and a Tunisian pilot study of first- and second-year students using Rome III criteria (54.2%) [12,13].

Heartburn and regurgitation, cornerstone symptoms of GERD, were reported by nearly half of participants, though weekly (~12%) and daily (~4%) frequencies were uncommon. Numerous studies report higher GERD symptom prevalence: a KAU study found weekly heartburn and regurgitation in 20.3% and 30.5% of students, rising to 11.1% and 10.7% for more-than-weekly-to-daily symptoms [14], and a 2024 Egyptian study reported heartburn and regurgitation rates of 55.0% and 54.2% [4]. A 2023 KFU study, however, yielded results consistent with ours [9].

Only about a quarter of participants had normal bowel habits, while over a third showed alternating patterns; fewer had constipation, and diarrhea was even less common. This aligns with a King Khalid University (KKU) study finding IBS-M (mixed diarrhea/constipation) as the predominant subtype (43.6%) [19], though two Egyptian studies instead found IBS-C (constipation-predominant) most common [16,17].

Bloating affected 55.3% of the study population, with frequency ranging from occasional to daily per Rome IV criteria for Functional Abdominal Bloating/Distension. This is higher than a recent KFU study (34.1%) [9], but lower than studies at Riyadh (67.1%) and Pakistani universities (85%) [18,19].

Abdominal pain was experienced by more than half of participants at varying frequencies, with about a fifth meeting Rome IV criteria for IBS—most experiencing pain at least weekly, and few daily. This is lower than Egyptian and Pakistani studies reporting nearly 60% of medical students with weekly abdominal pain [16,19], but higher than a 2018 Saudi study reporting 10.7% meeting Rome IV IBS criteria [15].

Table 4. *Lifestyle determinants of gastrointestinal symptoms among participants.*

Lifestyle factor		Having GI symptoms?				*P* value
		No		Yes		
		n	%	*n*	%	
On average, how much water do you drink per day?	<1 liter/day	13	25.5	123	33.2	0.527
	1–2 liters/day	29	56.9	194	52.3	
	>2 liters/day	9	17.6	54	14.6	
Caffeine intake (e.g., tea, coffee):	None	13	25.5	82	22.1	0.219
	1 cup/day	13	25.5	146	39.4	
	2–3 cups/day	22	43.1	117	31.5	
	>3 cups/day	3	5.9	26	7.0	
How often do you consume energy drinks (e.g., Red Bull, Code Red)?	Never	35	68.6	250	67.4	0.922
	1–2 times/week	11	21.6	86	23.2	
	3–4 times/week	4	7.8	23	6.2	
	Daily	1	2.0	12	3.2	
Do you typically eat your meals quickly (less than 15 minutes)?	Yes	26	51.0	186	50.1	0.910
	No	25	49.0	185	49.9	
Smoking:	Never	46	90.2	339	91.4	0.961
	Quit smoking	2	3.9	13	3.5	
	Current smoker	3	5.9	19	5.1	
Average sleep duration per night:	<5 hours	3	5.9	56	15.1	0.052
	5–6 hours	31	60.8	155	41.8	
	7–8 hours	15	29.4	132	35.6	
	>8 hours	2	3.9	28	7.5	
Physical activity frequency (e.g., walking, running, swimming):	Never	9	17.6	107	28.8	0.108
	1–2 times/week	26	51.0%	154	41.5	
	3–4 times/week	9	17.6	84	22.6	
	≥5 times/week	7	13.7	26	7.0	

Table 5. *Relationship between anxiety severity and the presence of gastrointestinal symptoms.*

Variable		Having GI Symptoms?				P value
		No		Yes		
		n	%	*n*	%	
GAD-7	Minimal anxiety	23	45.1	111	29.9	0.654
	Mild anxiety	15	29.4	129	34.8	
	Moderate anxiety	9	17.6	72	19.4	
	Severe anxiety	4	7.8	59	15.9	

GAD-7 = Generalized Anxiety Disorder 7-Item Scale.

Blood in stool, an alarming symptom, was uncommon among participants, while urgency—a hallmark of IBD and a supporting Rome IV feature of IBS—was frequently reported. Prior literature has not explored these symptoms in medical students, as they were typically part of exclusion criteria [1,20,21].

No significant association was found between academic year and GI symptoms, though a higher proportion of clinical-year students were symptomatic. This is consistent with an Egyptian study showing only a borderline association between academic year and GERD symptoms (highest in fourth-year students) [4], possibly reflecting similar online survey methodology.

In contrast, a Jordanian study found a highly significant association between academic year and IBS, with higher prevalence among junior students [22]. This discrepancy may reflect methodological differences in data collection, participant selection, and outcome definitions—including that study's use of Rome III IBS criteria versus our broader assessment of general GI symptoms.

Gender was not significantly associated with GI symptoms in our study, though a higher proportion of females were symptomatic—consistent with a nation-based Egyptian study [23], while a KKU study found similar non-significance but with more symptomatic males [15]. Some other studies did report significant gender associations [4,8,12,22].

Chronic medical conditions were nearly three times more common among symptomatic than asymptomatic participants, approaching but not reaching statistical significance—consistent with a few prior studies reporting non-significant associations [8,17]. The relatively small number of young participants with chronic conditions may have limited statistical power to detect an association.

A statistically significant association was found between family history of GI conditions (e.g., IBS, IBD, colon cancer) and having GI symptoms: nearly a quarter of symptomatic participants had an affected first-degree relative, three times the proportion among asymptomatic participants. This aligns with studies linking family history to GERD and IBS [14,22,23], reflecting genetic predisposition and shared environmental exposures such as household dietary habits, early-life microbial exposure, and learned health behaviours. Other studies, however, found no such association [15,16,24].

No significant associations were found between GI symptoms and caffeine, energy drink, or daily water intake, consistent with several prior studies [4,25,26], though an Egyptian study found a significant caffeine association [23], an Ethiopian study found soft drink consumption significantly associated with GERD [27], and another study reported a significant water-intake association [13].

Eating meals quickly showed no meaningful association with GI symptoms, with nearly equal distributions between

groups—consistent with prior studies [17,23], though an Indian study reported a significant association [28].

Smoking status was not significantly associated with GI symptoms, as most participants in both groups were non-smokers—consistent with Egyptian and Jordanian studies on GERD [4,26], though KKU and Zagazig University studies found significant smoking–IBS associations [15,16]. Limited variance in smoking status, given the low prevalence of smokers, may explain this lack of association.

Sleep duration showed a borderline association with GI symptoms: symptomatic participants more often slept fewer than 5 hours nightly than asymptomatic participants, suggesting a possible trend despite not reaching significance. This holds clinical relevance, as short sleep is a known physiological stressor that can disrupt the gut–brain axis via altered gut motility, increased mucosal permeability, and visceral hypersensitivity. Most prior studies found no significant sleep–GI association [4,8,17], though a few did [16,19].

Physical activity frequency was not significantly associated with GI symptoms, though asymptomatic participants reported slightly higher activity levels—consistent with most Saudi and Egyptian studies [4,14,15], though a few reported opposite findings [8,19].

BMI categories were not significantly associated with GI symptoms in our study, consistent with other findings [4,15], though MENA and KAU studies found significant associations [9,14], possibly because those studies focused on single diseases (GERD/IBS) where obesity is a known risk factor, unlike our broader symptom assessment.

GI symptoms were not significantly associated with GAD-7 anxiety levels, though symptomatic participants showed higher rates of mild anxiety and nearly double the rate of severe anxiety compared with asymptomatic participants. Most prior GAD-7-based studies reported significant associations [2,8,25], a discrepancy that may reflect their focus on specific diagnoses—such as Rome IV-defined IBS, where psychological comorbidity is pronounced—versus our broader assessment of general GI symptoms. Comparisons with studies using other scales, such as the Hospital Anxiety and Depression Scale (HADS) [29], should be interpreted cautiously, as HADS emphasizes somatic anxiety symptoms differently than GAD-7. This relationship warrants further investigation using more robust analytical approaches.

Several limitations should be acknowledged. First, the cross-sectional design precludes establishing causal relationships. Second, the sample was drawn exclusively from medical students at KFU, limiting generalizability to broader populations.

Data collection relied on a self-reported Google Forms questionnaire, introducing potential selection and recall bias. Convenience sampling via WhatsApp groups, without individual tracking, meant a precise response rate could not be calculated, precluding assessment of non-response bias. Students experiencing GI symptoms, or with greater baseline interest in health and lifestyle factors, may have been more motivated to respond, potentially overestimating prevalence.

Stigma surrounding sensitive items, such as the GAD-7 scale and smoking status, may have led to social desirability bias and underreporting, and the influence of other unmeasured confounders cannot be ruled out. Additionally, evaluating a broad spectrum of general GI symptoms rather than a single disease entity may have reduced statistical power to detect associations with factors such as BMI, smoking, and chronic conditions.

Finally, multiple statistical comparisons without adjustment for multiplicity increase the risk of Type I error; these exploratory findings should be interpreted with caution and considered hypothesis-generating rather than confirmatory.

Conclusion

Our study reveals that GI symptoms are prevalent among the vast majority of medical students, with a positive family history being significantly associated with symptom presence, while short sleep duration showed a non-significant trend as a potential contributing factor – though other risk factors such as smoking and BMI cannot be ruled out given the study's limitations. Academic year did not significantly affect GI symptom prevalence. These findings highlight an under-recognized burden of disease that may impact the academic performance and quality of life of medical students. Screening programs are recommended for early detection and management of GI symptoms, and the role of academic advisors could be strengthened to provide additional support.

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Conflict of interest

The authors declare that they have no conflicts of interest that could have influenced the conduct, interpretation, or reporting of this study. No external organization or third party was involved in the study or has any financial or other interest in its findings.

Informed consent

Electronic informed consent was obtained from all participants prior to participation. Participation was voluntary, and participants could withdraw before submitting their responses.

Author contributions

Dr. Alnasib and Dr. Abid contributed to the conception and overall design of the study. Dr. Alsaqer, Dr. Almousa, and Dr. Alduwayrij contributed to the interpretation of the findings and the initial drafting of the manuscript. Dr. Almaghnam conducted the statistical analysis and provided guidance on the interpretation of the analytical results. Dr. AlQarni and Dr. Baalghunaym were involved in data collection through questionnaire administration and critically reviewed the

manuscript. All authors contributed to manuscript revision, critically reviewed the final content, approved the final version of the manuscript, and agreed to be accountable for all aspects of the work and its overall integrity.

Data availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Abbreviations

BMI	Body mass index;
FGIDs	Functional gastrointestinal disorders;
GAD-7	Generalized Anxiety Disorder 7-item scale;
GERD	Gastroesophageal reflux disease;
GI	Gastrointestinal;
HADS	Hospital Anxiety and Depression Scale;
IBD	Inflammatory bowel disease;
IBS	Irritable bowel syndrome;
IBS-C	Irritable bowel syndrome constipation-predominant;
IBS-M	Irritable bowel syndrome mixed diarrhea/constipation;
KAU	King Abdulaziz University;
KFU	King Faisal University;
KKU	King Khalid University;
MENA	Middle East and North Africa;
SD	Standard deviation;
SPSS	Statistical Package for the Social Sciences;
SSL	Secure sockets layer;
TLS	Transport layer security.

Consent for participation

Electronic informed consent was obtained from all participants prior to participation. Participation was voluntary, and participants could withdraw before submitting their responses.

Consent for publication

Not applicable.

Ethical approval

Ethical approval was obtained from the KFU Research Ethics Committee (Ref. No. KFU-REC-2026-JAN-ETHICS3922), dated 20/01/2026, in accordance with the Declaration of Helsinki.

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Supplementary content (If any) is available online.

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