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ORIGINAL RESEARCH

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The prevalence and risk factors of irritable bowel syndrome (PRIBS study) among adults in low- and middle-income countries: A multicenter cross-sectional study

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Abstract

Background and Aims: Because of the plenty and abundance of risk factors and the expected increase in the prevalence of irritable bowel syndrome (IBS) in the world in general and in low- and middle-income countries in particular, this international cross-sectional study was conducted in 15 low- and middle-income countries according to our previous protocol, NCT05340400.

Methods: Participants were recruited in the period from April 22, 2022 to June 14, 2022. The diagnosis of IBS was according to ROME IV. We determined the physical activity, daily stress, and fatigue of the participants. A large number of collaborators were chosen from different regions and institutions within each country to achieve diversity within the sample and reduce the probability of bias.

Results: The prevalence of IBS appears to be higher in low- and middle-income countries (mean = 25.2%, range [6.2%–44.2%]) than in high-income countries, with a higher prevalence among Africans than Caucasians and Asians. The prevalence of IBS increased in the fourth decade by 32.1% and in the fifth decade by 31.1% (p-value < 0.001). In addition to the previously known risk factors for IBS such as female sex, smoking, psychological stress, and chronic fatigue, other risk factors were discovered such as chronic diseases, including high blood pressure and diabetes, allergies to some substances, previous infection with COVID-19, and the participant having a first-degree relative with a patient. There are also some other modifiable risk factors, such as an abnormal body mass index (whether high or low), smoking, a protein- or fat-rich diet, drinking caffeine-containing beverages, and poor physical activity.

PRIBS Study Team: Co-authors participated in data collection and National Lead.

Conclusions: Highlighting the prevalence and increasing risk factors of IBS in developing countries should draw the attention of those responsible for health care in these countries and reduce the risk factors.

KEYWORDS
international cross-sectional study, irritable bowel syndrome, prevalence, risk factors

1 | INTRODUCTION

The spread of chronic digestive diseases in the world has led to a poor quality of life, especially in low and middle-income countries. In those countries, many suffer from chronic digestive diseases, in particular irritable bowel syndrome (IBS). IBS is a chronic functional disorder of the gastrointestinal tract that is widespread and common all over the world.[1]

In general, patients present to clinicians with different symptoms, but there are four that dominate overall: abdominal discomfort, pain, diarrhea, constipation, and bloating. However, patients may present with other symptoms such as postprandial upper abdominal discomfort, fullness, nausea, heartburn, and, less commonly, vomiting. Based on the idea of symptom diversity, IBS was classified into several subtypes according to the predominant stool pattern.[1]

IBS prevalence ranges between 9% and 23% of the population across the world.[2] Since the 1980s, methods for diagnosing IBS have varied; since 2016, ROME IV criteria have been shown to be the standard methods for diagnosing IBS, in addition to excluding other digestive disorders.[3]

Because of the plenty and abundance of risk factors and the expected increase in the prevalence of IBS in the world in general and in low and middle-income countries in particular, our study was established with the aim of assessing and detecting latent potential and apparent risk factors, especially since risk factors and diagnostic criteria are constantly changing and evolving, in addition to updating the prevalence data in different societies and determining whether race has an effect.

Key points

What is already known on this topic

The criteria for diagnosing irritable bowel syndrome (IBS) have evolved over time, and the disease, when diagnosed based on previous criteria such as ROME II and ROME III, has been associated with many risk factors, such as female gender, psychological distress, and chronic fatigue. The prevalence in many countries was calculated in previous studies. But so far, no study has reported the prevalence and risk factors for IBS in middle- and low-income countries, according to ROME IV.

What this study adds

The prevalence of IBS was greater in middle- and low-income countries than in high-income countries, with a higher prevalence in African ethnicity compared to Caucasian and Asian countries. In addition to the well-known risk factors that were also confirmed by our study, which are psychological distress, chronic fatigue, female sex, and a protein- or fat-rich diet, we found many other risk factors, which are not doing enough physical activity, smoking, chronic diseases, especially hypertension and diabetes, allergy to some substances, previous infection with COVID 19 within 12 months, abnormal weight (either high or low), and sleep less than 6 h.

How this study might affect research, practice, or policy

The lack of attention paid to chronic digestive diseases in developing countries has led to their spread and poor quality of life. Therefore, highlighting their prevalence and increasing risk factors, more attention must be drawn to those responsible for health care in these countries, and the modifiable risk factors must be reduced.

2 | METHODS

2.1 | Study design

The international cross-sectional study was conducted in 15 low- and middle-income countries according to our previously published protocol NCT05340400 and the Strengthening the Reporting of Observational Studies in Epidemiology guidelines for cross-sectional studies.[4] Participants were recruited in the period from April 22, 2022 to June 14, 2022.

2.2 | Patient and public involvement

The inclusion criteria were adults willing to participate in this survey who were 18 years of age or older. Exclusion criteria were: any participant who was diagnosed with poorly controlled hyperthyroidism, poorly controlled hypothyroidism, poorly controlled hyperparathyroidism, paralysis, or parasitic diseases. Moreover, any presence (or suspicion) of liver disease, celiac disease, inflammatory bowel disease (Crohn's disease or Ulcerative colitis), lactose intolerance, or cancer or tumor in the digestive tract in

their clinical history. No formal sample size was calculated for this study.

The total number of participants in the study was 5506, from 15 low- and middle-income countries. The number of participants from Syria was 2909, followed by Egypt (536), Sudan (536), Pakistan (380), Libya (222), Algeria (222), Jordan (176), Iraq (125), India (102), Yemen (72), Palestine (69), and the rest from Morocco, Serbia, Bangladesh, and Saudi Arabia. With the participation of 148 data collectors from different cities and institutions in the participating countries. The participants volunteered to participate by agreeing to the investigation and filling out their data.

2.3 | Variables and measurement

The data were collected using a validated, structured questionnaire. The first part collected sociodemographic characteristics such as age, gender, body mass index (BMI), educational level, work, and marital state. Participants were also categorized into five grades based on their health status using the American Society of Anesthesiologists physical status (ASA) classification.[5] Participants were also asked about their comorbidities.

The diagnosis of IBS was made by identifying the presence of abdominal pain at least once a week in the last 3 months, in addition to at least two of the following: abdominal pain related to defecation, change in stool frequency, or shape. In addition to classifying patients according to their symptoms into IBS with constipation (IBS-C), IBS with diarrhea (IBS-D), or IBS with both (IBS-M).[3]

We determined the physical activity of the participants according to the Global Physical Activity Score of the World Health Organization (WHO). This score consists of three parts: the amount of effort spent at work (vigorous or moderate-intensity activity), traveling from one place to another, and sports intensity (vigorous or moderate-intensity activity) on a typical day. And then classified the participants according to whether physical activity is required or not.[6]

Daily stress was evaluated with the Perceived Stress Scale (PSS), the most widely used measure of global perceived stress and a robust predictor of health and disease. The total score is calculated on the basis of the answers to a series of questions based on monthly stress and the participant's health status. PSS is a summary measure of 10 items (range 0–4 points for every item). It is classified into low (PSS 0–13), moderate (PSS 14–26), and high perceived stress (PSS 27–40).[7]

Fatigue was measured using the Chalder Fatigue Scale (CFQ), a questionnaire for measuring the extent and severity of fatigue within both clinical and nonclinical epidemiological studies.[8]

Diet and daily habits, including smoking and alcohol consumption, were evaluated. Participants were classified into four sections according to WHO's Smoking and Tobacco Use Policy. A daytime smoker is someone who smokes any tobacco product at least once a day, and an occasional smoker is someone who smokes but not every day.[9] Each question was explained to the participant separately by the collaborator.

2.4 | Bias

A large number of collaborators were chosen from different regions and institutions within each country to achieve diversity within the sample and reduce the probability of bias. We trained the collaborators with a course explaining each section of the questionnaire and how to present it to the participants. The tutorial videos were uploaded in Arabic and English on YouTube. We also translated the questionnaire into Arabic by two Arab doctors separately and simultaneously, and the translation underwent a peer-review process.

2.5 | Statistical methods

Data were analyzed using SPSS PC version 24.0 statistical software. Descriptive statistics (mean, standard deviation, frequencies, and percentages) were used to describe the quantitative and categorical variables. Moreover, the Chi-square test was used for each variable only if the sample number exceeded 100 to observe the association between the categorical study and outcome variables. The quantitative variables such as age, body mass index, and drinking water in litters were divided into categories, and then we equated the chi-square. We calculated the prevalence for each country if the country's participants exceeded 200. All the results of the statistical inference tests were interpreted to a 95% confidence level, that is, the significance level of 0.05 was used with two-tailed hypothesis. The normal distribution suitability of the numerical variables was tested with the Shapiro–Wilk test.

2.6 | Ethics approval and consent to participate

This study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments, and under ethical approval from the ethics committee at the Faculty of Medicine, University of Aleppo, Syria. Moreover, Ethical approval was obtained in each country independently by the national lead, and participants' information was kept anonymous and confidential. Informed consent was obtained from all patients before participating, and all forms were filled out after a personal interview with the participant to explain all the questions.

3 | RESULTS

3.1 | Participants and descriptive data

Most of the participants were of Caucasian ethnicity (85.3%), and the others were Asian (9.1%), Afro-Caribbean (4.8%), and other ethnicities (0.8%). The mean age of the participants was 32.7, with a standard deviation of 14.5. 2% of participants were female (41.8% male). No missing data was found.

3.2 | Prevalence of IBS

The average prevalence of IBS was 25.2% (6.2%–44.2%), with a higher rate among the Afro-Caribbean race at 31.5%. Most of the participants were of IBS-M type (40.5%) and IBS-C type (36.1%). The highest prevalence of IBS was in Sudan (29.2%) and Egypt (28.9%), and the lowest prevalence was in Algeria (18.5%). The prevalence of IBS and its sub-types for each country and ethnicity are found in Table 1.

3.3 | Risk factors of IBS

3.3.1 | Sociodemographic risk factors

The prevalence of the IBS increased with age, especially the peak prevalence between 31 and 50 years (fourth decade 32.1% and fifth decade 31.1% p-value < 0.001). There was a tendency for the disease to be statistically greater among females than males (28.0% vs. 22.1%, p-value < 0.001). The prevalence of the disease was statistically lower in those with a body mass index within normal and increased if they were underweight, overweight, or obese (22.9 vs. 25.2%, 27.1%, and 33.8% consecutively, p-value < 0.001). IBS among healthy participants was lower than in participants with mild and severe systemic diseases (23.4% vs. 31.4% and 26.7% consecutively, p-value < 0.001). Rural participants were more likely to be patients than urban participants (29.6% vs. 24.8%, p-value < 0.001) (Table 2).

3.3.2 | Comorbidities risk factors

65.5% of the participants with IBS have reported that one of their first-degree relatives has been diagnosed with IBS. The prevalence of IBS among patients with hypertension, diabetes, anemia, and allergies to certain substances is significantly higher (33.4%, 33.9%, 31.5%, and 28.8%, p-values < 0.05) than among non-patients. There is an association between IBS and some other chronic digestive diseases such as EPS, PPDS, GERD, and functional dyspepsia (p-value < 0.05).

The prevalence of IBS among patients infected with COVID-19 within a year is more significant than among others (27.4% vs. 24.1%, p-value < 0.001). There is a significant increase in prevalence in participants with severe fatigue (39.7%) compared with moderate (27.3%) and low (16.3%) fatigue (p-value < 0.001). Also, there is a significant increase in prevalence in the participants with high stress (31.8%) compared with moderate (26.0%) and low (10.0%) fatigue (p-value < 0.001) (Table 3).

3.3.3 | Habits and field of work risk factors

There is a statistically significant increase in the prevalence of IBS in people who work, especially in the fields of agricultural projects and natural resources, civil engineering, informatics, technology or computer engineering, commercial companies and offices, home economics, industry, and teaching (p-value < 0.05). But the

TABLE 1 Prevalence of IBS according to the population based of the participants.

Category	Subcategory	Participants without IBS	Participants with IBS				Total
			IBS-C	IBS-D	IBS-M	IBS-other	
Ethnicity							
	Caucasian (n, %)	3487 (74.3%)	432 (9.2%)	216 (4.6%)	485 (10.3%)	75 (1.6%)	4695
	Afro-Caribbean (n, %)	183 (68.5%)	33 (12.4%)	10 (3.7%)	38 (14.2%)	3 (1.1%)	267
	Asian (n, %)	411 (82.5%)	32 (6.4%)	16 (3.2%)	37 (7.4%)	2 (0.4%)	498
	Hispanic (n, %)	Not counted	Not counted	Not counted	Not counted	Not counted	2
	Other (n, %)	Not counted	Not counted	Not counted	Not counted	Not counted	43
	Total	4118 (74.8%)	500 (9.1%)	244 (4.4%)	563 (10.2%)	80 (1.5%)	5506
Country							
	Syria (n, %)	2235 (76.8%)	290 (10.0%)	135 (4.6%)	209 (7.2%)	40 (1.4%)	2909
	Egypt (n, %)	381 (71.1%)	36 (6.7%)	23 (4.3%)	93 (17.4%)	3 (0.6%)	536
	Pakistan (n, %)	298 (78.4%)	31 (8.2%)	15 (3.9%)	34 (8.9%)	2 (0.5%)	380
	Sudan (n, %)	377 (70.2%)	44 (8.2%)	29 (5.4%)	76 (14.2%)	11 (2.0%)	537
	Algeria (n, %)	181 (81.5%)	9 (4.1%)	3 (1.4%)	23 (10.4%)	6 (2.7%)	222
	Total*	4118 (74.8%)	500 (9.1%)/ CI: 3.9%–5.0%	244 (4.4%)/CI: 9.5%–11.0%	563 (10.2%)/ CI: 1.2%–1.9%	80 (1.5%)	5506

Abbreviations: CI, confidence interval; IBS, irritable bowel syndrome; IBS-C, irritable bowel syndrome-constipation Type; IBS-D, irritable bowel syndrome-diarrhea type; IBS-M, irritable bowel syndrome-mixed type.

*For all study participants, even from countries with less than 200 participants.

TABLE 2 Correlation of IBS according to the sociodemographic of the participants.

Category	Subcategory	Participants without IBS	Participants with IBS	Total	Pearson chi-square	*p*-Value
Age					43.965	<0.001
	18–30 (*n*, %)	2625 (77.4%)	767 (22.6%)	3392		
	31–40 (*n*, %)	476 (67.9%)	225 (32.1%)	701		
	41–50 (*n*, %)	415 (68.9%)	187 (31.1%)	602		
	51–60 (*n*, %)	341 (71.0%)	139 (29.0%)	480		
	More than 60 (*n*, %)	242 (73.3%)	88 (26.7%)	330		
Gender					5530.936	<0.001
	Male (*n*, %)	1793 (77.9%)	508 (22.1%)/CI: 20.4%–23.9%	2301		
	Female (*n*, %)	2306 (72.0%)	898 (28.0%)/CI: 26.6%–29.5%	3204		
BMI according WHO Classification					33.447	<0.001
	Underweight < 18.5 (*n*, %)	279 (74.8%)	94 (25.2%)	373		
	Normal range [18.5–24.9] (*n*, %)	2142 (77.1%)	638 (22.9%)	2780		
	Overweight [25.0–29.9] (*n*, %)	1122 (72.9%)	418 (27.1%)	1540		
	Obese Class I [30–34.9] (*n*, %)	394 (66.2%)	201 (33.8%)	595		
	Obese Class II [35–39.9] (*n*, %)	124 (73.8%)	44 (26.2%)	168		
	Obese Class III > 40 (*n*, %)	Not Counted	Not Counted	49		
ASA grade					5544.174	<0.001
	ASA I (*n*, %)	2928 (76.6%)	896 (23.4%)	3824		
	ASA II (*n*, %)	961 (68.6%)	440 (31.4%)	1401		
	ASA III (*n*, %)	181 (73.3%)	66 (26.7%)	247		
	ASA IV (*n*, %)	Not counted	Not counted	27		
	ASA V (*n*, %)	Not counted	Not counted	6		
Geographic					5517.374	<0.001
	Urban life (*n*, %)	3339 (75.2%)	1100 (24.8%)	4439		
	Rural life (*n*, %)	683 (70.4%)	287 (29.6%)	970		
	Nomad life (*n*, %)	Not counted	Not counted	96		

Note: ASA I, healthy person; ASA II, mild systemic disease; ASA III, severe systemic disease; ASA IV, severe systemic disease that is a constant threat to life; ASA IV, a moribund person who is not expected to survive without the operation; ASA V, a declared brain-dead person whose organs are being removed for donor purposes.

Abbreviations: ASA, American Society of Anesthesiologists Classification; IBS, irritable bowel syndrome.

prevalence of IBS among medical workers such as physicians and nurses is statistically less than others (23.6% and 22.7% vs. 25.8% and 25.6%, *p*-value < 0.001) (Table 4).

Participants who need to do physical activity are statistically more likely to be patients than those whose physical activity is acceptable (25.7% vs. 24.9%, *p*-value < 0.001). Also, those whose diet consists mainly of fats and proteins are statistically more likely to be patients than those who depend on high-fiber foods and a diverse diet (*p*-value < 0.001). There is also a statistical prevalence of those who eat intermittent meals between the main meals (*p*-value < 0.001).

IBS is statistically more prevalent among smokers than non-smokers, even if they quit smoking or only smoke on occasion (*p*-value < 0.001). There is a statistically lower prevalence of the disease in moderate drinkers, but there is not enough sample size in those heavy drinkers due to the religious nature of the participating countries, so we were unable to know the effect of heavy alcohol drinking on IBS. Participants who sleep 6–8 h were statistically less

TABLE 3 Correlation of IBS according to comorbidities.

Category	Subcategory	Participants without IBS	Participants with IBS	Total	Pearson chi-square	*p*-Value
Family history (first-degree relatives diagnosed with IBS (*n*, %))	Yes	1512 (64.9%)	818 (35.1%)	2330	5700.464	<0.001
	No	2587 (81.5%)	588 (18.5%)	3175		
EPS (*n*, %)	Yes	1002 (55.4%)	806 (44.6%)	1808	6019.257	<0.001
	No	3097 (83.8%)	600 (16.2%)	3697		
PPDS (*n*, %)	Yes	876 (54.9%)	721 (45.1%)	1597	5960.829	<0.001
	No	3223 (82.5%)	685 (17.5%)	3908		
GERD (*n*, %)	Yes	905 (62.4%)	546 (37.6%)	1451	5657.439	<0.001
	No	3194 (78.8%)	860 (21.2%)	4054		
Hypertension requiring medication (*n*, %)	Yes	404 (66.6%)	203 (33.4%)	607	22.404	<0.001
	No	3695 (75.4%)	1203 (24.6%)	4898		
Diabetes mellitus (*n*, %)	Yes	265(66.1%)	136(33.9%)	401	15.951	<0.001
	No	3834 (75.1%)	1270 (24.9%)	5104		
Autoimmune diseases (*n*, %)	Yes	111 (77.6%)	32(22.4%)	143	.772	0.380
	No	3988 (74.4%)	1374 (25.6%)	5362		
Headache or migraine (*n*, %)	Yes	406 (72.1%)	157 (27.9%)	563	1.815	0.178
	No	3693 (74.7%)	1249 (25.3%)	4942		
Chronic immunosuppression (*n*, %)	Yes	Not calculated	Not calculated	23	Not calculated	
	No			5482		
Anemia (*n*, %)	Yes	491 (68.5%)	226 (31.5%)	717	15.501	<0.001
	No	3608 (75.4%)	1180 (24.6%)	4788		
Allergic to certain substances (*n*, %)	Yes	432 (71.2%)	175 (28.8%)	607	3.883	0.049
	No	3667 (74.9%)	1231 (25.1%)	4898		
COPD (*n*, %)	Yes	Not calculated	Not calculated	50	Not calculated	
	No			5455		
Asthma (*n*, %)	Yes	199 (74.8%)	67 (25.2%)	266	0.018	0.893
	No	3900 (74.4%)	1339 (25.6%)	5239		
Ischemic heart disease (*n*, %)	Yes	80 (74.1%)	28 (25.9%)	108	0.009	0.926
	No	4019 (74.5%)	1378 (25.5%)	5397		
Urinary problems (*n*, %)	Yes	161 (71.2%)	65 (28.8%)	226	1.285	0.257
	No	3938 (74.6%)	1341 (25.4%)	5279		
Functional dyspepsia (*n*, %)	Yes	123 (51.9%)	114 (48.1%)	237	66.286	<0.001
	No	3976 (75.5%)	1292 (24.5%)	5268		
Endometriosis (*n*, %)	Yes	Not calculated	Not calculated	31	Not calculated	
	No			5474		
Past history of COVID-19 infection (within the last 12 months) (*n*, %)	Yes	1768 (72.6%)	667 (27.4%)	2435	5513.875	<0.001
	No	2331 (75.9%)	739 (24.1%)	3070		
Abdominal surgery/laparotomy (*n*, %)	Yes	768 (68.4%)	355 (31.6%)	1123	5533.350	<0.001
	No	3331 (76.0%)	1051 (24.0%)	4382		

TABLE 3 (Continued)

Category	Subcategory	Participants without IBS	Participants with IBS	Total	Pearson chi-square	*p*-Value
The Chalder Fatigue Scale						
	Low fatigue (*n*, %)	1246 (83.7%)	24 (16.3%)	1488	5635.541	<0.001
	Moderate fatigue (*n*, %)	2529 (72.7%)	951 (27.3%)	3480		
	Severe fatigue (*n*, %)	324 (60.3%)	213 (39.7%)	537		
Perceived Stress Scale						
	Low stress (*n*, %)	422 (90.0%)	47 (10.0%)	469	5583.025	<0.001
	Moderate stress (*n*, %)	3118 (74.0%)	1098 (26.0%)	4216		
	High stress (*n*, %)	559 (68.2%)	261 (31.8%)	820		

Abbreviations: COPD, chronic obstructive pulmonary disease; EPS, epigastric pain syndrome; GERD, gastro-esophagus retardation disease; IBS, irritable bowel syndrome; PPDS, postprandial distress syndrome.

TABLE 4 **Correlation of IBS according to the field of work or profession of the participants.**

Category	Subcategory	Participants without IBS	Participants with IBS	Total	Pearson chi-square	*p*-Value
Agricultural projects and natural resources (e.g., Farmer) (*n*, %)	Yes	82 (72.6%)	31 (27.4%)	113	5506.217	<0.001
	No	4017 (74.5%)	1375 (25.5%)	5392		
Civil engineer (*n*, %)	Yes	108 (71.5%)	43 (28.5%)	151	5506.704	<0.001
	No	3991 (74.5%)	1363 (25.5%)	5354		
Informatics, technology or computer engineer…etc. (*n*, %)	Yes	140 (73.7%)	50 (26.3%)	190	5506.062	<0.001
	No	3959 (74.5%)	1356 (25.5%)	5315		
Commercial companies and offices (*n*, %)	Yes	141 (72.3%)	54 (27.7%)	195	5506.492	<0.001
	No	3958 (74.5%)	1352 (25.5%)	5310		
Physicians (*n*, %)	Yes	465 (76.4%)	144 (23.6%)	609	5507.293	<0.001
	No	3634 (74.2%)	1262 (25.8%)	4896		
Nurses (*n*, %)	Yes	140 (77.3%)	41 (22.7%)	181	5506.821	<0.001
	No	3959 (74.4%)	1365 (25.6%)	5324		
Home economics (*n*, %)	Yes	168 (71.2%)	68 (28.8%)	236	5507.389	<0.001
	No	3931 (74.6%)	1338 (25.4%)	5269		
Industry (*n*, %)	Yes	81 (71.1%)	33 (28.9%)	114	5506.711	<0.001
	No	4018 (74.5%)	1373 (25.5%)	5391		
Teaching (schools, universities) (*n*, %)	Yes	327 (71.9%)	128 (28.1%)	455	5509.445	<0.001
	No	3772 (74.7%)	1278 (25.3%)	5050		
Not working (*n*, %)	Yes	1738 (75.8%)	555 (24.2%)	2293	5509.691	<0.001
	No	2361 (73.5%)	851 (26.5%)	3212		

Abbreviation: IBS, irritable bowel syndrome.

likely to be patients than those who slept more than 8 h or less than 6 h (24.9% vs. 27.5% and 25.8% consecutively, *p*-value < 0.001). The prevalence of the disease among those who drink stimulants like tea or coffee and its derivatives is statistically higher than its prevalence among those who drink other types of stimulants or who do not drink them (*p*-value < 0.001). There appears to be an inverse correlation between the prevalence of disease and the amount of water drunk, but it is not statistically significant (Table 5).

TABLE 5 Correlation of IBS according to habits.

Category	Subcategory	Participants without IBS	Participants with IBS	Total	Pearson chi-square	*p*-Value
Global physical activity score						
	Physical activity is not required (score > 600) (*n*, %)	724 (75.1%)	240 (24.9%)	964	917.160	<0.001
	Physical activity is required (score < 600) (*n*, %)	3371 (74.3%)	1165 (25.7%)	4536		
Participant's predominant food pattern						
	Fatty food (*n*, %)	387 (70.5%)	162 (29.5%)	549	5519.924	<0.001
	Carbohydrates (*n*, %)	798 (72.4%)	304 (27.6%)	1102		
	Protein food (*n*, %)	270 (71.2%)	109 (28.8%)	379		
	High-fiber foods (*n*, %)	248 (76.5%)	76 (23.5%)	324		
	Other (*n*, %)	43 (75.4%)	14 (24.6%)	57		
	Diverse (*n*, %)	2353 (76.1%)	741 (23.9%)	3094		
Eating snacks between the main meals						
	Yes (*n*, %)	2574 (73.4%)	931 (26.6%)	3505	5511.296	<0.001
	No (*n*, %)	1525 (76.3%)	475 (23.8%)	2000		
Smoking						
	A daily smoker (*n*, %)	678 (72.9%)	252 (27.1%)	930	2757.424	<0.001
	An occasional smoker (*n*, %)	454 (72.4%)	173 (27.6%)	627		
	Ex-smoker (*n*, %)	199 (72.4%)	76 (27.6%)	275		
	Nonsmoker (*n*, %)	2767 (75.4%)	905 (24.6%)	3672		
Drinking alcohol						
	Not drinking (*n*, %)	3897 (74.3%)	1348 (25.7%)	5245	2754.990	<0.001
	In moderation (*n*, %)	187 (77.0%)	56 (23.0%)	243		
Sleeping hours						
	Less than 6 (*n*, %)	781 (74.2%)	271 (25.8%)	1052	2755.635	<0.001
	Between 6 and 8 (*n*, %)	2530 (75.1%)	837 (24.9%)	3367		
	More than 8 (*n*, %)	787 (72.5%)	298 (27.5%)	1085		
kind of stimulants that participants usually drink?						
Tea (*n*, %)	Yes	2038 (72.8%)	761 (27.2%)	2799	66.889	<0.001
	No	1995 (76.5%)	613 (23.5%)	2608		
Coffee and its derivatives (*n*, %)	Yes	1947 (74.1%)	680 (25.9%)	2627	57.857	<0.001
	No	2086 (75.0%)	694 (25.0%)	2780		
Mate (drink) (*n*, %)	Yes	399 (77.3%)	117 (22.7%)	516	59.502	<0.001
	No	3634 (74.3%)	1257 (25.7%)	4891		
Energy drinks (*n*, %)	Yes	217 (79.2%)	57 (20.8%)	274	60.479	<0.001
	No	3816 (74.3%)	1317 (25.7%)	5133		
Carbonated drinks (*n*, %)	Yes	417 (78.7%)	113 (21.3%)	530	62.426	<0.001
	No	3616 (74.1%)	1261 (25.9%)	4877		
Amount of water drunk in liters						
	Less than 1 liter per day (*n*, %)	285 (72.3%)	109 (27.7%)	394	9.257	0.055

TABLE 5 (Continued)

Category	Subcategory	Participants without IBS	Participants with IBS	Total	Pearson chi-square	*p*-Value
	1–2 liter per day (*n*, %)	1436 (73.8%)	509 (26.2%)	1945		
	2–3 liter per day (*n*, %)	1417 (73.8%)	502 (26.2%)	1919		
	3–4 liter per day (*n*, %)	623 (75.5%)	202 (24.5%)	825		
	More than 4 L per day (*n*, %)	338 (80.1%)	84 (19.9%)	422		

Abbreviation: IBS, irritable bowel syndrome.

4 | DISCUSSION

4.1 | Prevalence of IBS

Our study included 5506 participants from 15 low- and middle-income countries. The mean prevalence of IBS in our sample was 25.2%, with Sudan and Egypt having the highest percentages. The prevalence of IBS was higher among Africans than Caucasians, and it seems that environmental and genetic factors play a role in this, which should be investigated more in other studies.

IBS prevalence in Pakistan was 21.6%, which is considered a dramatic increase from the 13.3% reported in the same country in 2006.[10] Furthermore, Egyptian IBS prevalence was 28.9%; a similar percentage (27.5%) was found by a cross-sectional study done on Egyptian medical students in the year 2022.[11] Nonetheless, the Pakistani study used Rome II for diagnosis, and the Egyptian study included only 182 participants and used Rome III instead of Rome IV criteria.

The pathophysiology of IBS is functional impairment of the GI tract in the absence of any obvious biological abnormalities.[12] This functional impairment is centered around three main principles: altered GI motility, GI hyperalgesia, and psychopathology.[13] The latter may justify the increased prevalence in stressed individuals, as well as in people who sleep less than 6 h.

4.2 | Nonmodifiable risk factors

Several factors are associated with a higher probability of IBS. Some of these factors are non-modifiable, such as the fourth and fifth decades of age and a positive family history of IBS.

Some studies have found an association between some variations in the sucrase-isomerase gene and increased risk of IBS,[14,15] a finding that might explain the increased prevalence in participants who have a positive family history of IBS in a first-degree relative.

The female gender was also a risk factor for IBS. This can be justified by the role of estrogen in regulating two of the three main principles of IBS, which are GI motility and visceral pain.[16]

Non-modifiable risk factors also include a personal history of allergies, a personal history of chronic diseases (especially hypertension and diabetes), and a history of COVID-19 infection within the previous year.

The predominant clinical features of the post-COVID gastrointestinal syndrome include abdominal discomfort, diarrhea, constipation, and vomiting. A review has interpreted these long-term digestive symptoms that are consistent with IBS as being caused by the infection itself or by various drugs used in the context of acute COVID, especially lopinavir and ritonavir.[17]

4.3 | Modifiable risk factors

Modifiable risk factors include an abnormal BMI (whether high or low), smoking, a protein- or fat-rich diet, and drinking caffeine beverages.

In our study, we found that acceptable physical activity is associated with a lower incidence of IBS. In the same context, a randomized controlled trial that included 102 IBS patients found that moderate to vigorous activity 3–5 days a week in these patients resulted in clinical improvement of the IBS symptoms.[18]

A recent study described the association between heavy smoking (20 or more cigarettes per day) and the occurrence of IBS-D. This can be explained by the direct effects of nicotine on colonic motor function, mediated by nicotine receptors on intrinsic and extrinsic colonic nerves.[19,20]

Regarding diet, a Western diet high in fat has been associated with IBS in a large French cohort.[21] Several mechanistic hypotheses have been put forward to explain this association, including an enhanced colonic response to lipids.[22] Previous studies have also shown that the use of soluble fibers (e.g., oats and fruits) results in symptom improvement.[23] However, insoluble fibers (e.g., wheat bran) were not of significant and even caused abdominal bloating.[24]

Living in a rural area and working in certain jobs are also modifiable risk factors for IBS. In our study, health workers were less likely to be patients than other professions. This could be due to doctors' and nurses' knowledge of the etiology and preventive ways of this disease; however, more studies are needed on this aspect.

4.4 | Clinical implications

Here are some highlights of the clinical implications and potential strategies based on the findings from this cross-sectional study on IBS prevalence and risk factors:

Clinical implications:

- The high IBS prevalence (25.2%) demonstrates this is a major chronic digestive disease burden in developing countries that needs focused attention.
- Positive associations with modifiable factors like diet, smoking, activity levels, and so forth underscore the potential for lifestyle management.
- Protective effect seen in healthcare workers reinforces the value of patient education and awareness.

Potential strategies:

- Increaseing IBS awareness and screening practices in primary care in developing countries to improve early diagnosis.
- Lifestyle counseling by dieticians, social workers, and community health workers on diet, activity, and sleep hygiene.
- Smoking cessation programs and resources for patients with IBS where relevant.
- Self-management workshops on stress reduction techniques like yoga, meditation, and cognitive behavioral therapies for IBS patients.
- Culturally appropriate educational campaigns on IBS using diverse platforms to reach rural areas.
- Policy efforts to promote physical activity through built environment changes in developing country urban areas.

In summary, the high disease burden calls for greater health system prioritization and lifestyle-based management with tailored sociocultural approaches to curb preventable risk factors.

4.5 | Potential confounding variables

- *Age*—IBS prevalence increased with age. Age may confound associations between other factors and IBS.
- *Gender*—Females had a higher IBS prevalence. Gender differences could confound other observed relationships.
- *Comorbidities*—Chronic diseases like diabetes and hypertension were associated with higher IBS prevalence. These may confound other variables.
- *Medications*—Drugs used for comorbid conditions could influence IBS risk, confounding associations.
- *Diet*—Dietary patterns like high fat/protein diet were associated with IBS. Diet may be a confounder.
- *Physical activity*—Lack of adequate activity was linked to higher IBS prevalence. This could confound other observations, especially in the outcomes of certain jobs.

4.6 | Limitations of the study

Our study's importance comes from the fact that most of the included countries have not had sufficient data regarding IBS prevalence before. Nonetheless, there were some limitations. In terms of the population, despite the variety of nationalities included in the study, more than half of the participants were from Syria. We tried to overcome this by including participants from different geographical areas and different socioeconomic backgrounds. Also, most of the population was Caucasian; other ethnicities were represented by much fewer ratios. This is because Caucasians are the predominant ethnicity in the included countries. Furthermore, most of the included countries had a Muslim majority, so we could not clearly study the association between alcohol consumption and IBS. Finally, our study is cross-sectional; we were able to study the association between several factors and IBS. However, a cohort study is still needed to further ascertain this association and examine its magnitude.

This cross-sectional study may reflect the prevalence and risk factors of IBS in low- and middle-income countries. Individuals living in high-income countries were not included in this study.

5 | CONCLUSION

The prevalence of IBS appears to be higher in low- and middle-income countries (mean = 25.2%, range [6.2%–44.2%]) than in high-income countries, with a higher prevalence among Africans than Caucasians and Asians. In addition to the previously known risk factors for IBS, such as female sex, smoking, psychological stress, and chronic fatigue. Other risk factors were discovered, such as chronic diseases, including high blood pressure and diabetes, allergies to some substances, previous infection with COVID-19, and first-degree patients with IBS. There are also some other modifiable risk factors, such as an abnormal BMI (whether high or low), smoking, a protein- or fat-rich diet, drinking caffeine-containing beverages, and poor physical activity.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Data used for this article will be made publicly available after publishing all research papers that our team aim to do. However, if other researchers wish to request access to these data or require additional information, they should communicate with the corresponding author.

TRANSPARENCY STATEMENT

The lead author Yaman Nerabani affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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