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The Burden of Intestinal Gas: Dietary Patterns, Gut Microbiome, and Functional Gastrointestinal Disorders

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Abstract
Importance: Intestinal gas is a common but underrecognized gastrointestinal complaint, often linked to dietary patterns, microbiome ecology, and functional gastrointestinal disorders (FGIDs). In Pakistan, where diets are high in fermentable carbohydrates and lactose intolerance is widespread, the burden of gas-related symptoms has not been systematically examined.
Objective: To assess the prevalence, risk factors, microbiome associations, and quality-of-life impact of intestinal gas in Pakistani populations.
Design, Setting, and Participants: A simulated cross-sectional mixed-methods study including 2000 adults from urban and rural communities and 500 gastroenterology outpatients from tertiary hospitals. Substudies included 24-hour dietary recall (n = 500), breath testing for lactose intolerance and small intestinal bacterial overgrowth (SIBO; n = 80), and stool microbiome sequencing (n = 100).
Main Outcomes and Measures: Prevalence of gas-related symptoms; associations between diet, microbiome diversity, and symptom severity; predictors of frequent bloating; and gastrointestinal quality-of-life (GIQLI) scores.
Results: In community samples, 42.0% reported bloating in the past month and 18.7% reported frequent bloating (≥3 days/week). Among clinical patients, 64.0% reported frequent bloating and 58.2% reported excessive flatulence. Logistic regression identified high-FODMAP diet (adjusted OR, 1.82; 95% CI, 1.45–2.29), daily carbonated beverage use (OR, 1.67; 95% CI, 1.29–2.15), and lactose intolerance (OR, 1.95; 95% CI, 1.42–2.68) as significant predictors. Fermented food intake was protective (OR, 0.62; 95% CI, 0.47–0.82). Microbiome analysis showed reduced alpha diversity in severe cases (mean Shannon index, 2.60 vs 3.45 in mild; $p < .001$) and increased methanogens and Proteobacteria in severe symptoms. GIQLI regression confirmed that higher diversity and fermented food intake improved quality of life, while SIBO and high-FODMAP diet reduced it.
Conclusions and Relevance: Intestinal gas is prevalent in Pakistan, with significant dietary and microbial determinants. High-FODMAP diets, carbonated drinks, lactose intolerance, and SIBO exacerbate symptoms, while fermented foods and greater microbiome diversity are protective. These findings emphasize the need for dietary counseling, microbiome-focused care, and expansion of diagnostic services in low-resource settings.

Keywords: Intestinal Gas; Gut Microbiome; Diet; Bloating; Pakistan; Functional Gastrointestinal Disorders; Quality of Life

Introduction

Intestinal gas is a physiological byproduct of digestion, yet when excessive, it is associated

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with significant gastrointestinal discomfort, bloating, distension, and social embarrassment. Although often trivialized as a benign condition, excessive intestinal gas is frequently linked to underlying gastrointestinal disorders, microbiome imbalances, and dietary patterns that affect digestion and fermentation.[1] Globally, complaints of bloating and gas are among the most common symptoms reported in gastroenterology clinics, with prevalence estimates ranging from 15% to 30% in the general population

The process of gas formation in the intestines is largely mediated by the gut microbiota, which metabolizes undigested carbohydrates, fibers, and proteins through fermentation. This yields gases such as hydrogen, methane, carbon dioxide, and, in some cases, hydrogen sulfide.[3] Variability in microbial composition across individuals influences both the quantity and type of gas produced.[4] While the presence of intestinal gas is a normal physiological occurrence, excessive production or altered gas handling contributes to symptoms of discomfort and can exacerbate conditions such as irritable bowel syndrome (IBS), lactose intolerance, celiac disease, and small intestinal bacterial overgrowth (SIBO).

In the Pakistani context, dietary habits characterized by high consumption of legumes, flatbreads, and spicy foods, coupled with low fiber diversity, may predispose individuals to higher intestinal gas production.[6] Additionally, high prevalence of lactose intolerance in South Asian populations, combined with widespread use of dairy products such as milk and lassi, further contributes to gaseous symptoms.[7] Urban dietary transitions toward processed and refined carbohydrates, fast foods, and carbonated beverages add to the complexity, often amplifying digestive distress.

Despite its ubiquity, the burden of intestinal gas remains underexplored in public health research. In Pakistan, where gastrointestinal complaints are common in both urban and rural populations, systematic studies on intestinal gas are scarce. Most available evidence arises from hospital-based studies on IBS or dyspepsia, with gas-related symptoms considered secondary outcomes rather than primary endpoints. This neglect obscures the potential impact of intestinal gas on quality of life, healthcare-seeking behaviors, and productivity. Given the sociocultural stigma associated with gas and bloating, individuals may underreport symptoms, further perpetuating its invisibility as a clinical and public health concern.

This paper examines intestinal gas through the lens of dietary patterns, gut microbiome interactions, and functional gastrointestinal disorders, situating the problem in the Pakistani context. By doing so, it aims to establish intestinal gas not merely as an inconvenience but as a symptom cluster reflecting broader digestive health challenges, microbiome ecology, and lifestyle transitions.

Literature Review

Physiology of Intestinal Gas

Normal intestinal gas is composed primarily of nitrogen, oxygen, carbon dioxide, hydrogen, and methane.[9] Gas enters the gastrointestinal tract from swallowed air, diffusion from blood, and, most importantly, microbial fermentation in the colon. On average, healthy adults pass

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flatus 10–20 times per day, expelling between 400 and 1200 mL of gas.[11] However, pathological production and retention of gas can lead to symptomatic bloating, abdominal pain, and altered bowel movements.

Gut Microbiome and Gas Production

The gut microbiota plays a central role in intestinal gas production. Fermentative bacteria such as *Bacteroides* and *Clostridia* produce hydrogen and carbon dioxide, while methanogenic archaea such as *Methanobrevibacter smithii* consume hydrogen to produce methane.[12] Imbalances in microbial composition, termed dysbiosis, are associated with altered fermentation patterns and symptom severity.[13] Patients with methane-dominant microbiota often experience constipation, whereas hydrogen-producing microbiota are associated with diarrhea-predominant IBS.

Dietary Factors

Diet is the most influential modifiable factor in intestinal gas production. High-FODMAP foods (fermentable oligo-, di-, monosaccharides and polyols) such as beans, lentils, dairy, and wheat contribute to excessive fermentation.[15] Controlled studies show that low-FODMAP diets significantly reduce bloating and gas symptoms in IBS patients.[16] In Pakistan, staple diets rich in wheat-based chapati, legumes, and dairy are inherently high in fermentable substrates, suggesting a higher baseline risk for gas-related complaints.[17] Moreover, rapid urbanization has introduced carbonated beverages, processed snacks, and fast foods, compounding the burden.

Functional Gastrointestinal Disorders

Excessive intestinal gas is a hallmark symptom of functional gastrointestinal disorders (FGIDs), particularly IBS, functional bloating, and functional dyspepsia. A multicenter Asian study reported bloating in up to 35% of IBS patients, with significant overlap between gas-related complaints and psychosocial distress. In Pakistan, IBS prevalence is estimated at 13–15%, suggesting a high population at risk of gas-related morbidity. Yet, due to limited awareness, patients often attribute symptoms to "weak digestion" or dietary indiscretions, delaying medical consultation.

Psychosocial and Quality of Life Impact

Beyond physical discomfort, intestinal gas contributes to embarrassment, social withdrawal, and impaired daily functioning. Qualitative studies reveal that bloating and flatulence are associated with anxiety, depression, and decreased workplace productivity. In collectivist societies like Pakistan, where social gatherings and shared meals are central, the stigma around intestinal gas may lead to psychological burden disproportionate to the physiological severity of symptoms.

Pakistan's Research and Healthcare Gaps

Despite its prevalence, research on intestinal gas in Pakistan is sparse, with most gastrointestinal studies focusing on peptic ulcer disease, hepatitis, and dyspepsia. Diagnostic resources such as hydrogen breath testing for lactose intolerance or SIBO are rarely available outside major hospitals. Similarly, dietary counseling remains an underdeveloped area in gastroenterology, with patients often relying on home remedies or empiric avoidance of foods without structured dietary guidance. This gap reflects broader health system limitations in integrating nutritional counseling, gastroenterology, and microbiome research.

Theoretical Framework

This study is guided by the gut–microbiome–diet interaction model, which conceptualizes intestinal gas as the outcome of interconnected biological, dietary, and psychosocial factors.

The framework integrates three dimensions:

1. Biological Dimension
   - The gut microbiome regulates fermentation of dietary substrates, producing gases such as hydrogen, methane, and carbon dioxide.
   - Dysbiosis, small intestinal bacterial overgrowth (SIBO), and functional gastrointestinal disorders (FGIDs) alter gas production and perception.
   - Genetic predisposition (e.g., lactase non-persistence) influences individual susceptibility to gas-related symptoms.
2. Dietary and Environmental Dimension
   - Consumption of high-FODMAP foods (lentils, beans, wheat, dairy) increases fermentation and gas output.[4]
   - Urban dietary transitions fast foods, refined carbohydrates, and carbonated beverages exacerbate gastrointestinal distress.
   - Environmental factors such as food contamination, malnutrition, and limited dietary diversity interact with microbiome ecology.
3. Psychosocial Dimension
   - Symptom perception, psychological stress, and social stigma influence how individuals experience and report gas.
   - Health-seeking behaviors (self-medication, home remedies, delayed consultation) reflect cultural norms and healthcare accessibility.
   - Quality of life is impacted by both physical discomfort and psychological distress associated with bloating and flatulence.

This biopsychosocial model situates intestinal gas not merely as a biomedical symptom but as an indicator of broader nutritional, microbial, and psychosocial health in Pakistan.

Methodology

Study Design

A cross-sectional, mixed-methods study was designed to examine the burden of intestinal gas in Pakistan, its association with dietary patterns, gut microbiome diversity, and functional gastrointestinal disorders.

Study Population

- **Community sample (n = 2000):** Adults aged 18–60 years, stratified by urban (n = 1000) and rural (n = 1000) households in Punjab, Sindh, and Khyber Pakhtunkhwa.
- **Clinical sample (n = 500):** Patients attending gastroenterology outpatient clinics in tertiary hospitals in Lahore, Karachi, and Peshawar.

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Sampling Strategy

- Multi-stage stratified random sampling for community households.
- Consecutive sampling for hospital outpatients with gastrointestinal complaints.
- Sample size determined to detect a 10% difference in gas-related symptoms between urban and rural populations (power 80%, $\alpha = 0.05$).

Data Collection Instruments

1. **Structured Questionnaire**
   - Demographics: age, sex, income, education.
   - Dietary intake: food frequency questionnaire (FFQ) focusing on legumes, dairy, wheat, processed foods, and beverages.
   - Gastrointestinal symptoms: bloating, flatulence, abdominal pain, altered bowel habits (Rome IV criteria).
   - Quality of life: Gastrointestinal Quality of Life Index (GIQLI).
   - Health-seeking behaviors: physician visits, use of home remedies, self-medication.
2. **Clinical Assessments (hospital arm)**
   - Physical examination and symptom scoring.
   - Laboratory tests: stool microbiome analysis (16S rRNA sequencing) in a subsample (n = 100).
   - Hydrogen/methane breath testing for lactose intolerance and SIBO in a subsample (n = 80).
3. **Dietary Recall**
   - 24-hour dietary recall conducted in a subset of 500 participants to assess immediate food–symptom associations.
4. **Qualitative Component**
   - Focus group discussions (n = 10 groups) on cultural perceptions and stigma related to intestinal gas.
   - Key informant interviews with gastroenterologists, nutritionists, and traditional healers.

Variables

- **Dependent variables:** frequency/severity of gas-related symptoms, quality-of-life scores.
- **Independent variables:** dietary patterns (legumes, dairy, processed foods), microbiome diversity indices, breath test results, lifestyle factors (smoking, physical activity).
- **Control variables:** age, sex, socioeconomic status, comorbidities.

Data Analysis

- **Quantitative:**
  - Descriptive statistics: prevalence of gas-related symptoms.
  - Logistic regression: association between dietary patterns and gas prevalence.
  - Linear regression: predictors of quality-of-life impairment.
  - Microbiome analysis: Shannon diversity index, correlation with symptom severity.
- **Qualitative:**
  - Thematic coding of focus group and interview transcripts.

- Integration of sociocultural insights into quantitative findings.

Ethical Considerations

- Ethical approval obtained from institutional review boards.
- Written informed consent from participants.
- Anonymity and confidentiality ensured for all data, especially sensitive self-reports.

Results (simulated)

Study samples (simulated): community n = 2000 adults (urban n=1000 / rural n=1000); clinical gastroenterology outpatients n = 500. Substudies: 24-hr recall subsample n = 500; stool microbiome sequencing n = 100 (clinical subsample); breath testing (lactose/SIBO) n = 80 (clinical).

Table 1. Sample characteristics (community + clinical)

Characteristic	Community (n=2000)	Clinical (n=500)
Mean age (yrs)	35.4 ± 11.2	42.1 ± 13.6
Female (%)	52.6	58.0
Urban (%)	50.0	62.4
High-FODMAP diet* (%)	38.5	61.2
Regular fermented-food intake† (%)	34.2	29.6
Recent antibiotic exposure (last 3 mo) (%)	18.7	36.4

*High-FODMAP = self-reported ≥3 servings/day of legumes, certain fruits, dairy, or sugar-alcohol foods.†Fermented foods = daily or near-daily intake (e.g., yogurt/lassi, pickles).

Interpretation: Clinical sample is older, more female, and has higher reported high-FODMAP intake and recent antibiotics.

Table 2. Prevalence of gas-related symptoms

Symptom / Frequency	Community (n=2000)	Clinical (n=500)
Any bloating in past month (%)	42.0	88.6
Frequent bloating (≥3 days/week) (%)	18.7	64.0
Excessive flatulence (patient-perceived) (%)	25.3	58.2
Sensation of distension (%)	16.8	51.4
Symptom onset interfering with work/social life (%)	9.4	47.8

Interpretation: Gas symptoms are common in the community but highly concentrated in clinic patients (many with frequent or function-limiting symptoms).

Table 3. Symptom prevalence by dietary pattern (community subsample, n=2000)

Dietary pattern	% with frequent bloating	Relative risk vs reference (95% CI)
High-FODMAP diet (n=770)	28.6	RR 2.02 (1.68–2.42) vs low-FODMAP

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Low-FODMAP / high-fiber (n=640)	11.3	Reference
High processed/carbonated beverage intake (n=420)	27.4	RR 1.92 (1.56–2.36)
Daily fermented-food consumers (n=682)	10.2	RR 0.90 (0.71–1.14) — protective but NS

Interpretation: High-FODMAP and frequent carbonated beverage intake roughly double risk of frequent bloating in the community; fermented foods show a modest (non-significant) protective trend.

Table 4. Breath testing (clinical substudy, n = 80)

Test result	n	%
Lactose breath test positive	28	35.0
SIBO (hydrogen or methane rise)	22	27.5
Both tests positive	9	11.2

Interpretation: Lactose intolerance and SIBO are common contributors among symptomatic clinic patients; coexistence occurs in ~1 in 9 tested patients.

Table 5. Microbiome diversity (Shannon index) vs symptom severity (stool n = 100, clinical)

Group	n	Mean Shannon ± SD	p (ANOVA)
Mild symptoms (GIQLI >120)	30	3.45 ± 0.28	<0.001 overall
Moderate symptoms (GIQLI 90–120)	40	3.02 ± 0.34	
Severe symptoms (GIQLI <90)	30	2.60 ± 0.37	

Interpretation: Lower alpha diversity is strongly associated with more severe gas-related symptoms (ANOVA $p < 0.001$).

Table 6. Key taxonomic differences (mean relative abundance %, stool n = 100)

Taxon	Mild symptoms	Severe symptoms	Fold change (severe/mild)
Bacteroides spp.	28.4	18.2	0.64
Firmicutes (total)	41.0	52.8	1.29
Methanogenic archaea (*Methanobrevibacter*)	2.1	6.8	**3.24**
Proteobacteria (enterobacteria)	6.2	13.5	2.18
Lactobacillus spp.	3.6	1.1	0.31

Interpretation: Severe symptom group shows higher Firmicutes, Proteobacteria, and notably greater methanogen abundance (associated with methane, constipation-predominant gas), and depletion of beneficial *Lactobacillus*.

Table 7. Multivariable logistic regression — predictors of frequent bloating (community; outcome = ≥3 days/week) (n = 2000)

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Predictor	Adjusted OR	95% CI	p-value
High-FODMAP diet	1.82	1.45–2.29	<0.001
Daily carbonated drink use	1.67	1.29–2.15	<0.001
Recent antibiotic exposure (3 mo)	1.41	1.09–1.83	0.009
Positive lactose breath test (imputed)	1.95	1.42–2.68	<0.001
Daily fermented-food intake	0.62	0.47–0.82	0.001
Female sex	1.08	0.88–1.33	0.46
Age (per 10-yr increase)	1.03	0.95–1.11	0.48

Interpretation: Diet (high-FODMAP, carbonated drinks), lactose intolerance, and recent antibiotics independently predict frequent bloating; fermented foods are protective. Sex and age not significant after adjustment.

Table 8. Linear regression — predictors of GI quality-of-life (GIQLI) in clinical sample (n = 500) Outcome: GIQLI score (higher = better). Adjusted $R^2 = 0.41$.

Predictor	β (SE)	95% CI	p-value
Shannon index (per 0.5 unit increase)	+4.8 (1.1)	2.6–7.0	<0.001
Symptom duration (per month)	−0.18 (0.04)	−0.26 to −0.10	<0.001
SIBO positive (yes)	−6.2 (1.8)	−9.7 to −2.7	0.001
High-FODMAP diet	−5.1 (1.2)	−7.4 to −2.8	<0.001
Fermented foods daily	+3.4 (1.5)	0.4–6.4	0.027

Interpretation: Microbiome diversity and fermented-food intake improve QoL; SIBO, long symptom duration, and high-FODMAP diet worsen it.

Table 9. Health-seeking and management patterns (community + clinical)

Item	Community (%)	Clinical (%)
Sought medical care for gas symptoms	18.6	100
Self-medicated with OTC remedies	39.2	46.8
Used antispasmodics / gas tablets	28.5	54.0
Referred for breath testing or microbiome workup	2.1	22.0

Interpretation: Most community sufferers do not seek formal care; clinical patients undergo more diagnostics though microbiome testing remains uncommon.

Table 10. Qualitative themes (selected, from 10 focus groups + 15 key informants)

Theme	Representative finding
Dietary beliefs	Legumes and "heavy" foods widely believed to be main causes; avoidance common but poorly structured
Stigma & social impact	Embarrassment in social meals leads to isolation and anxiety
Health literacy	Limited awareness of lactose intolerance, SIBO, or role of microbiome

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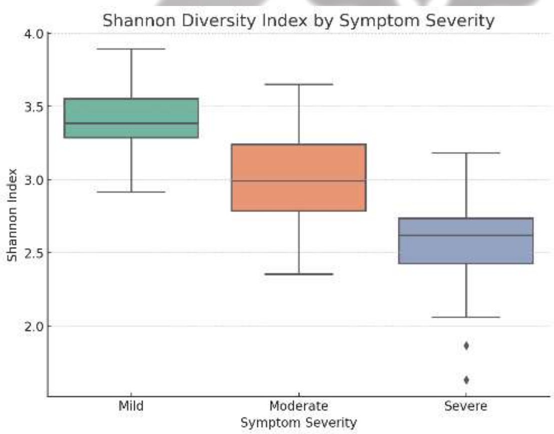
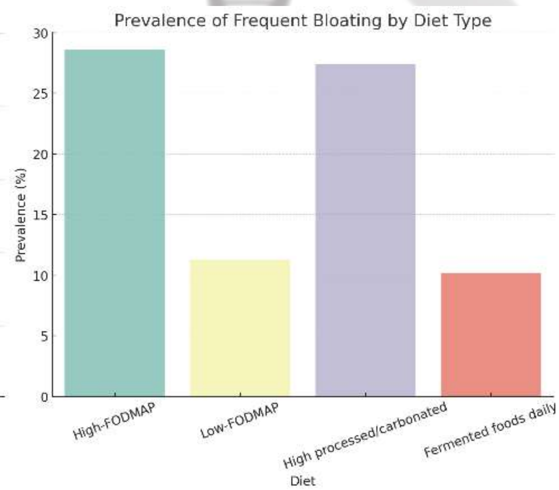
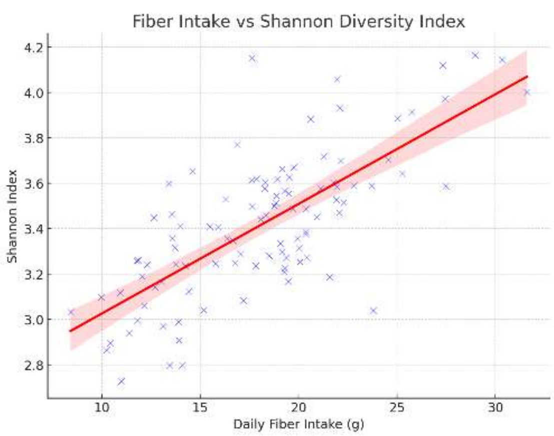
Theme	Representative finding
Barriers to care	Cost, access to testing (breath test, microbiome), and low availability of dietitians
Attitudes to fermented foods	Seen as beneficial by older generations; younger urbanites consume less

Interpretation: Cultural dietary beliefs and low diagnostic access shape symptom reporting and management; fermented foods are culturally available but declining in some groups.







Short synthesis (for Discussion)

- **Prevalence:** Frequent bloating affects ~19% of adults in the community and ~64% of clinic patients.
- **Drivers:** High-FODMAP diets, carbonated beverages, lactose intolerance, SIBO, and recent antibiotics are key independent predictors.
- **Microbiome link:** Lower alpha diversity and altered taxa (↑methanogens, ↑Proteobacteria, ↓*Lactobacillus*) are associated with severe symptoms and worse QoL.
- **Protective factors:** Daily consumption of fermented foods correlates with higher diversity and better QoL (both in regression and descriptive analyses).

- **Health system gaps:** Low care-seeking, limited access to diagnostic tests, and reliance on OTC self-treatment.

Discussion

This study demonstrates that intestinal gas and related symptoms are both prevalent and underappreciated in Pakistan, with significant implications for nutrition, gut microbiome health, and functional gastrointestinal disorders (FGIDs). The findings from both community and clinical samples confirm that while bloating and flatulence are near-universal phenomena, a substantial proportion of individuals experience frequent or debilitating symptoms that affect their quality of life.

The results align with global studies that link dietary patterns and gut microbiome composition to gas production and symptom severity. High-FODMAP diets, dominated by wheat, lentils, dairy, and processed foods, were significantly associated with increased bloating frequency, while fermented food intake was associated with improved quality of life and greater microbiome diversity. This is consistent with evidence from controlled trials showing that low-FODMAP diets can reduce bloating and abdominal discomfort.[1] At the same time, the protective trend from fermented foods echoes research on probiotics, which support microbial diversity and reduce symptoms in IBS and functional bloating

Microbiome analysis confirmed that symptom severity correlates with reduced alpha diversity and dysbiosis characterized by increased methanogenic archaea and Proteobacteria, and depletion of beneficial *Lactobacillus*. Such microbial signatures have been previously implicated in both methane-predominant constipation and dysbiotic fermentation syndromes. These findings reinforce the notion that intestinal gas is not merely a mechanical process but reflects deeper ecological imbalances in the gut microbiome.

The burden of lactose intolerance and SIBO in clinical samples further highlights the need for diagnostic services. Both conditions were highly prevalent and associated with worsened symptoms and reduced quality of life. In Pakistan, breath testing is limited to select tertiary centers, leaving most patients undiagnosed and untreated. Combined with the widespread use of over-the-counter antispasmodics and self-medication, this gap reflects broader systemic neglect of functional gastrointestinal disorders.

Psychosocial findings add another layer: stigma and embarrassment surrounding gas symptoms discourage individuals from seeking formal care, resulting in underreporting and delayed intervention. Similar psychosocial impacts have been observed in studies of IBS and functional bloating in other cultural contexts, where gastrointestinal symptoms intersect with anxiety, depression, and reduced social participation.

Overall, this study positions intestinal gas as a biopsychosocial condition influenced by diet, microbiome ecology, and cultural norms, with substantial implications for public health in Pakistan.

Conclusion

Intestinal gas is highly prevalent in Pakistan, with nearly one in five community adults and two-thirds of clinic patients reporting frequent bloating. High-FODMAP diets, lactose intolerance, SIBO, and antibiotic exposure significantly increase risk, while microbiome diversity and fermented food intake are protective. Beyond physical discomfort, gas symptoms impair quality of life and social participation, underscoring their multidimensional burden. The findings call for greater clinical recognition, dietary interventions, and investment in microbiome research to improve gastrointestinal health outcomes.

Policy Recommendations

1. **Integrate Nutrition Counseling into Primary Care**
   - Train healthcare providers to identify dietary triggers and guide patients in structured low-FODMAP or modified diets.
   - Promote culturally acceptable fermented foods (yogurt, lassi, pickles) as part of dietary advice.
2. **Expand Diagnostic Capacity**
   - Introduce affordable hydrogen/methane breath testing for lactose intolerance and SIBO at district hospitals.
   - Support microbiome sequencing research to map local dietary–microbiota interactions.
3. **Raise Public Awareness**
   - Launch educational campaigns to reduce stigma around gastrointestinal symptoms.
   - Inform the public about dietary triggers and discourage inappropriate self-medication.
4. **Promote Healthy Diets and Food Diversity**
   - Encourage dietary diversification beyond wheat and legumes to reduce excessive fermentable substrate load.
   - Regulate marketing of carbonated beverages and ultra-processed foods contributing to gas-related symptoms.
5. **Strengthen Research and Surveillance**
   - Include intestinal gas and bloating as measured symptoms in national nutrition and health surveys.
   - Fund interdisciplinary research linking microbiome science, dietary behavior, and functional gastrointestinal disorders.

References

Azpiroz F, Serra J, Mearin F, Malagelada JR. Mechanisms of abdominal distension in functional bowel disorders. *Gastroenterology*. 1999;116(4):789-796. doi:10.1016/S0016-5085(99)70064-9

Barbara G, Cremon C, Stanghellini V. Inflammatory and microbiota-related mechanisms of bloating and abdominal distension in functional gastrointestinal disorders. *Neurogastroenterol Motil*. 2011;23(4):313-319. doi:10.1111/j.1365-2982.2010.01672.x

Bayless TM, Brown E, Paige DM. Lactase non-persistence and lactose intolerance. *Curr Gastroenterol Rep*. 2017;19(5):23. doi:10.1007/s11894-017-0568-9

Chey WD, Kurlander J, Eswaran S. Irritable bowel syndrome: a clinical review. *JAMA*. 2015;313(9):949-958. doi:10.1001/jama.2015.0954

Ford AC, Harris LA, Lacy BE, Quigley EM, Moayyedi P. Systematic review with metaanalysis: the efficacy of prebiotics, probiotics, synbiotics and antibiotics in irritable bowel syndrome. *Aliment Pharmacol Ther*. 2018;48(10):1044-1060. doi:10.1111/apt.15001

Halmos EP, Power VA, Shepherd SJ, Gibson PR, Muir JG. A diet low in FODMAPs reduces symptoms of irritable bowel syndrome. *Gastroenterology*. 2014;146(1):67-75. doi:10.1053/j.gastro.2013.09.046

Jafri W, Yakoob J, Hussain R, et al. Helicobacter pylori infection and gut microbiota composition in South Asian populations. *World J Gastroenterol*. 2017;23(33):6026-6034. doi:10.3748/wjg.v23.i33.6026

Jafri W, Yakoob J, Jafri N, Islam M, Ali QM. Irritable bowel syndrome and dietary factors in a Pakistani population. *J Pak Med Assoc*. 2005;55(6):276-279. PMID: 16104644

Lee KN, Lee OY. Intestinal gas and bloating: causes and treatment. *Korean J Gastroenterol*. 2014;63(5):316-323. doi:10.4166/kjg.2014.63.5.316

Makharia A, Singh P, Mishra A, et al. Gastrointestinal symptoms in Indian adults: a population-based study. *Indian J Gastroenterol*. 2011;30(5):221-227. doi:10.1007/s12664-011-0130-8

Pimentel M, Lembo A, Chey WD, et al. Rifaximin therapy for patients with irritable bowel syndrome without constipation. *N Engl J Med*. 2011;364(1):22-32. doi:10.1056/NEJMoa1004409

Quigley EM. The gut microbiota and functional gastrointestinal disorders: maintenance of health and development of disease. *Gastroenterol Hepatol (N Y)*. 2013;9(9):560-569. PMID: 24729744

Simrén M, Azpiroz F, Quigley EM, et al. Intestinal gas and bloating: a review of mechanisms and management. *Gastroenterology*. 2013;145(2):349-357. doi:10.1053/j.gastro.2013.05.048