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Review

# Exploring the Link Between Irritable Bowel Syndrome and Chronic Diseases: A Narrative Overview

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The gut microbiome plays a pivotal role in regulating immune function, metabolism, mental health, and cardiovascular health. Emerging research links gut dysbiosis, an imbalance in gut microbiota to the development of chronic diseases such as diabetes, cardiovascular disease, and neurodegenerative disorders. Despite growing awareness of these connections, Irritable Bowel Syndrome (IBS) remains an underdiagnosed condition that may serve as an early indicator of systemic inflammation and chronic disease risk. This review examines the association between IBS, gut dysbiosis, and chronic diseases, highlighting the potential for IBS to function as a screening tool for long-term health risks. By focusing on college students, a population with high stress levels and poor dietary habits, we explore how early diagnosis and targeted interventions could mitigate future chronic disease burdens. Addressing these research gaps may inform new preventative strategies and public health initiatives aimed at reducing healthcare costs and improving long-term outcomes.

## INTRODUCTION

The gut microbiome plays a crucial role in regulating immune function, metabolism, mental health, cardiovascular health, and digestion. Research increasingly links gut dysbiosis, an imbalance in the gut microbiome to the development of chronic diseases, with potential implications for longevity. This review focuses on the connection between gut health and chronic diseases, specifically highlighting IBS as an underdiagnosed yet significant early marker of systemic inflammation and a precursor to conditions like diabetes and cardiovascular disease. By addressing gaps in the literature, IBS could be positioned as a singular screening tool for chronic disease risk, aligning with Whole Health systems like 'Ayurveda'.[1] Using a hypothetical case study of college students, this review explores the potential economic savings and public health benefits of early IBS diagnosis and preventative strategies to mitigate future chronic disease risks.

## METHODS

A comprehensive literature search was conducted on the PubMed database to identify relevant studies for this literature review. The search terms included keywords and phrases as outlined in Tables 1 and 2. The study designs of the publications were restricted solely to meta-analyses, systematic reviews, and randomized control trials within the past 10 years. 81 articles were chosen out of the 133 results that were screened for relevance to the subject, omitting 49 articles unrelated to the topic or included animal studies.

## RESULTS

### 1) WHAT CONDITIONS SHOULD BE CONSIDERED AS EARLY INDICATORS OF CHRONIC DISEASE RISK ?

Of eleven articles that have been reviewed over the past year results indicate a relationship between metabolic disorders, such as Cushing's syndrome, PCOS, obesity, and NAFLD, and chronic diseases. Individuals with polycystic ovary syndrome (PCOS) were found to be at a higher risk for cardiovascular disease, due to the inflammatory nature of the symptoms of PCOS.[2] There was also an association between metabolic syndrome and both cardiovascular disease and fatty liver disease. In metabolic syndrome, the accumulation of fatty acids in hepatocytes leads to chronic inflammation and oxidative stress, which eventually contributes to the increased risk of cardiovascular disease, type 2 diabetes, and renal failure.[3,4] In addition, metabolic dysfunction, which includes obesity as a possible symptom, was found to increase the risk of chronic kidney disease and liver carcinoma.[5,6] Various systematic reviews and meta-analyses deduced that metabolic dysfunction-related diseases indicated a higher risk of developing chronic conditions such as cardiovascular disease, kidney disease, and liver dysfunction.

### 2)WHAT EVIDENCE EXISTS LINKING POOR GUT HEALTH TO THE RISK OF CHRONIC DISEASES AND CHRONIC DISEASE TO LONGEVITY?

In our literature review of 81 papers, we identified associations between gut dysbiosis and chronic diseases such as cardiovascular disease, stroke, cancer, diabetes, chronic

kidney disease, Alzheimer's, and liver disease. Gut health is a critical predictor of future health due to its influence on the immune system, metabolism, mental health, cardiovascular health, and digestive health.[7] Maintaining a balanced and diverse gut microbiome through a healthy diet, probiotics, and lifestyle choices can contribute to better overall health and reduce the risk of various diseases.[8] Research conducted at various levels indicates that the microbiota of the gut is involved in pathogenesis and can be considered the causative agent of several chronic diseases.[9] According to our literature review, decreased diversity of the gut microbiome is often present in individuals with chronic disease, which suggests a possible correlation between the two. For example, Individuals with hypertension were found to have a reduced variety of gut bacteria.[10, 11] Dysbiosis is thought to lead to cardiovascular disease through the increased production of atherogenic factors.[12] Changes in the gut microbiome also intersect with stroke risk factors, such as hypertension and atrial fibrillation. Stroke patients also have a decreased diversity of gut microbiota, thus affecting their mortality rates.[13] Trimethylamine N-Oxide is a gut metabolite that can be a biomarker for cardiovascular events, which can result in an increased risk of stroke. ,[14] Obesity-related chronic diseases such as diabetes are shown to correlate with poor gut health as well. One study found that gut microbiota transplants help increase insulin sensitivity, which suggests that the gut microbiome is part of the pathogenesis of diabetes.[15] Using the gut microbiome as a biomarker is also helpful in identifying cancer as a study found that Gut OncoMicrobiome Signatures can be monitored for indications of cancer, meaning that the microbiota can be used as a predictor as well as for immunotherapy in patients.[16]

Environmental factors such as air pollution can affect the diversity of the gut microbiome. It was found that microbial differences have a causal correlation with asthma, indicating that individuals with altered gut microbiota are at a higher risk of developing the respiratory condition.[17, 18] In addition, changes in gut microbiota and trimethylamine N-oxide concentrations were observed in chronic kidney disease patients.[19] Alzheimer's patients and liver disease patients also experience gut dysbiosis and damaged gut barrier function, further indicating the relationship between the gut and chronic disease.[20,21]

## 3) WHAT ARE THE KEY FINDINGS FROM EXISTING STUDIES ON IBS AND GUT HEALTH?

Our literature review suggested a relationship between the gut microbiome and the pathophysiology of irritable bowel syndrome. Decreases in the biodiversity of the gut microbiota can affect the production of substances in the gut such as bile acids and neurotransmitters, which contribute to the symptoms of IBS.[22] Environmental factors play a role in the pathogenesis of IBS by altering the gut microbiome composition, thus disturbing immune and inflammatory pathways through the gut-brain axis.[23,24] It was also found that certain probiotics can help mitigate the symptoms of IBS by altering the gut microbiome, which further suggests the correlation between the pathogenesis of IBS and gut bacteria. Along with probiotics, elimination diets also help patients manage IBS symptoms by changing the populations of certain bacteria in the gut and can be personalized for the patient based on fecal bacterial markers to increase efficacy.[25] This comprehensive analysis of gut microbiota in IBS revealed reduced microbial diversity and specific shifts in bacterial populations, underscoring the role of dysbiosis in IBS.[26]

By observing the relationship between IBS and dysbiosis, as well as the correlation between dysbiosis and chronic disease, it can be postulated that symptoms of IBS could be a precursor to the development of chronic disease in the future. According to the literature review we conducted, altered diversity of gut microbiota was a common observation in both IBS and chronic disease patients. Further research on this topic could yield promising results about the possible preventative measures that can be taken against chronic disease in the future.

## 4) WHAT IS THE PREVALENCE OF IBS IN THE GENERAL POPULATION AND SPECIFICALLY IN COLLEGE STUDENTS?

IBS has a variety of frequencies across different countries and demographics. According to the Rome criteria, approximately 11.2% of the worldwide population is affected by IBS, while the prevalence in the United States has been found to be around 6.1% of the population.[27,28] Studies show that IBS is especially prevalent among university students around the world. It was found that among medical students in Saudi Arabia, 31.7% of students suffered from symptoms of IBS.[29] This was also found among Chinese university students, and it was suggested that the higher prevalence could be attributed to unhealthy lifestyles and increased stress.[30] Overall, there is still a paucity in studies regarding IBS in the United States, and many cases could be undiagnosed, which may also affect the results of the studies being conducted.

## 5)WHAT ARE THE UNDERLYING MECHANISMS CONNECTING IBS, GUT DYSBIOSIS, AND CHRONIC DISEASES?

Although the specific pathophysiology of IBS is still somewhat unknown, studies found that it is a condition that often coexists with obesity and other symptoms of metabolic dysfunction. It was found that patients with IBS have a higher incidence of metabolic syndrome, characterized by higher levels of LDL cholesterol and triglycerides, which are common in those with obesity and hypertension.[31] In addition, cytokine imbalances and inflammatory symptoms were observed in IBS patients with comorbid obesity, which displays an immune pathway for the disease.[32] A relationship between PCOS and IBS was found as they have common mechanistic pathways such as dysregulation of neurotransmitters like serotonin, as well as systemic inflammation and oxidative stress. The systematic review also observed the role of the gut-brain axis in the pathophysiology of both IBS and PCOS, and noticed that dysbiosis contributes to the symptoms of both conditions.[33] Ad-

**Table 1.**

| Question 2 | HTN | Heart Disease | Stroke | Diabetes | Cancer | COPD | Asthma | Chronic Kidney Disease | Alzheimer's | Liver Disease |
|---|---|---|---|---|---|---|---|---|---|---|
| Review Period (years) | 5 | 5 | 5 | 1 | 1 | 5 | 5 | 5 | 1 | 1 |
| Search Keywords | Gut dysbiosis + Hypertension | Gut dysbiosis + Heart disease | Gut dysbiosis + Stroke | Gut dysbiosis + Diabetes | Gut dysbiosis + Cancer | Gut dysbiosis + COPD | Gut dysbiosis + Asthma | Gut dysbiosis + Chronic Kidney Disease | Gut dysbiosis + Alzheimer's | Gut dysbiosis + Liver disease |
| Excluded studies | 7 | 5 | 0 | 4 | 8 | 0 | 1 | 1 | 0 | 1 |
| Final selection | 8 | 4 | 3 | 13 | 5 | 0 | 4 | 6 | 7 | 7 |

**Table 2.**

| Question | Q1 | Q3 | Q4 |
|---|---|---|---|
| Review Period (years) | 1 | 5 | 10 |
| Search Keywords | Chronic Disease + metabolic syndrome | Gut dysbiosis + Irritable bowel syndrome | Gut dysbiosis + College students |
| Excluded studies | 19 | 3 | 0 |
| Final selection | 11 | 12 | 4 |

ditionally, psychological stress is a contributing factor as individuals with IBS are more prone to depression and anxiety, and a correlation was found between mental disorders and both PCOS and IBS due to the gut-brain pathway. It was also found that NAFLD, a type of metabolic dysfunction, is linked with mental disorders, which can indicate a possible connection between metabolic syndrome, IBS and, transitively, chronic disease.[34]

### 6)WHAT ARE THE GAPS IN CURRENT RESEARCH?

Studies focusing on specific populations like college students or US residents are limited. There is also a lack of direct studies focusing on the connection between IBS in college students and the development of diseases in the future. Various pathways of IBS have been observed in recent research, so detecting a link between those pathways and chronic disease would likely benefit this area of study. The paucity of easily measurable biomarkers makes IBS a diagnosis of exclusion, as microbiome testing remains expensive and unreliable. Future research should focus on identifying cost-effective, reliable biomarkers to improve diagnostic accuracy and accessibility

## DISCUSSION

This review highlights a strong connection between gut dysbiosis, IBS, and the long-term risk of chronic diseases, suggesting that IBS may serve as an early indicator of systemic dysfunction. The overlap in microbiome alterations seen in both IBS and metabolic disorders supports its potential role as a screening tool for chronic disease risk. Given its high prevalence among college students and its association with stress and lifestyle factors, early identification and interventions such as dietary changes, probiotics, and stress management could help mitigate future health complications. The correlation between gut microbiome composition and conditions like cardiovascular disease, diabetes, and Alzheimer's further emphasizes the need for integrative healthcare approaches prioritizing gut health. Despite these insights, the precise mechanistic pathways linking IBS to chronic disease remain unclear, necessitating longitudinal studies, cost-effective biomarker development, and public health initiatives to educate young adults on gut health's role in disease prevention. IBS should be recognized as an early warning condition, similar to metabolic syndrome, PCOS, NAFLD, and obesity, as it is increasingly linked to systemic inflammation and chronic disease risk. By addressing gaps in the literature, IBS could be screened as a singular gut disorder, irrespective of other ICD-9 diagnoses, to infer an elevated risk of developing chronic diseases in the future, much like the holistic diagnostic approaches of Whole Health and Ayurveda. The economic impact of chronic diseases, including projected increases in healthcare costs for heart disease and stroke[35] and significant expenditures on chronic kidney disease and diabetes,[36,37] underscores the importance of early intervention. This review aims to show how these economic burdens can be diminished with early diagnosis of IBS as we suggest that it is a precursor for the aforementioned chronic diseases. Overall, early detection of IBS would decrease healthcare costs and benefit more patients by allowing them to initiate regulatory measures sooner,[38] ultimately contributing to a more proactive and preventative healthcare system.

**Hypothetical Scenario Analysis: IBS Recognition and Chronic Disease Prevention in College Students** This analysis demonstrates the significant economic and health benefits of early IBS screening and intervention. Without intervention, 15% of the target population (1,500 students) remains undiagnosed, leading to a projected $731 million lifetime healthcare cost **d**ue to increased risks of diabetes, cardiovascular disease, chronic kidney disease, and stroke. However, implementing IBS screenings, educational workshops, and stress management programs could diagnose 70% of cases, reducing chronic disease risks and yielding $316.8 million in healthcare savings (Table 3). Additionally, intervention would increase life expectancy, preventing an estimated 4,500-7,500 years of cumulative life loss across the affected population (Table 4). Tables 5 and 6 further illustrate the cost-effectiveness and overall health impact of IBS recognition as a preventative strategy.

## POSSIBLE PREVENTION STRATEGIES

Technology is a useful tool in promoting public health by allowing for the rapid spread of health information (Jafar et al. 2023). There is evidence that the use of social media for health promotion campaigns can be used to promote behavioral change and has the potential to create long-term changes in health behavior if applied accordingly (Ghahramani et al. 2022). Raising awareness for IBS and its possible long-term effects through technology and social media campaigns targeting college students could be an effective way to improve their health and prevent chronic disease. To

**Table 3.**

| **Hypothetical Economic Impact** | | | | |
|---|---|---|---|---|
| **Condition** | **Hypothetical Percentages (%)** | **Lifetime Cost Per Case Without Intervention ($)** | **Cases Prevented With Intervention** | **Total Cost Saved With Intervention ($)** |
| Diabetes | 30 | 750000 | 225 | 168750000 |
| Cardiovascular Disease | 20 | 1000000 | 120 | 120000000 |
| Chronic Kidney Disease | 10 | 500000 | 45 | 22500000 |
| Stroke | 5 | 250000 | 22 | 5625000 |
| Total | - | - | - | 316875000 |

**Table 4.**

| **Hypothetical Longevity Impact** | | | | |
|---|---|---|---|---|
| **Condition** | **Life Expectancy Reduction Without Intervention (Years)** | **Cases Prevented With Intervention** | **Life Expectancy Increase With Intervention (Years)** | **Total Years of Life Lost/ Saved (** |
| Diabetes | 10 years per case | 225 | 10 years per prevented case | 2,250 years saved |
| Cardiovascular Disease | 5-10 years per case | 120 | 5-10 years per prevented case | 600-1,200 years saved |
| Chronic Kidney Disease | 5-7 years per case | 45 | 5-7 years per prevented case | 225-315 years saved |
| Stroke | 7 years per case | 22 | 7 years per prevented case | 154 years saved |
| Total | 5-7 years (average) | - | 3-5 years (average) | 4,500-7,500 years saved |

**Table 5.**

| **Hypothetical Healthcare Cost Analysis of IBS Intervention** | | | |
|---|---|---|---|
| **Category** | **Without Intervention ($)** | **With Intervention ($)** | **Savings ($)** |
| **IBS Management (Annual)** | **3,000,000** | **1,050,000** | **1,950,000** |
| **Lifetime Chronic Disease Costs** | **731,250,000** | **414,375,000** | **316,875,000** |
| **Total Savings** | - | - | **318,825,000** |

**Table 6.**

| | **Summary of IBS Intervention Benefits** | |
|---|---|---|
| **Metric** | **Without Intervention** | **With Intervention** |
| **IBS Diagnosis Rate** | **15% (1,500 students undiagnosed)** | **70% (1,050 diagnosed)** |
| **Chronic Disease Risk** | **995 cases** | **583 cases (412 cases prevented)** |
| **Cumulative Life Years Lost/Saved** | **~10,000 years lost** | **4,500-7,500 years saved** |

enhance IBS prevention and chronic disease risk reduction, innovative strategies can be implemented on college campuses, including:

*Personalized Gut Health Programs( Microbial diversity month ):* Offer Rome criteria-based screening for IBS while excluding other conditions and offering dietary guidance. Promote microbial diversity through nutrition initiatives by advocating for prebiotics and probiotics.

*Digital Health Innovations*: Gut health can be effectively tracked using mobile apps. Cara Care, Bowelle, mySymptoms Food Diary, Nerva, and Zoe are examples of gut health mobile apps that help users track symptoms, diet, and lifestyle factors to improve digestive wellness. Incentivizing college students with food coupons for prebiotic and probiotic purchases, as well as offering course credits and tuition discounts for participation in gut health checks, app usage, and mind-body wellness practices, presents a novel approach to reducing future healthcare costs. Introduce VR stress management tools and AI-powered virtual health coaches.

*Educational and Behavioral Initiatives:* Provide gut-brain axis workshops, IBS-friendly cooking classes, and biofeedback or mindfulness-based cognitive therapy sessions.

*Environmental and Policy Changes*: Designate stress-free study zones, implement gut-friendly dining menus, and incentivize healthy behaviors through "Gut Health Passport" programs.

*Social and Peer Support:* Establish IBS support groups and host interactive events like trivia nights or probiotic tastings to foster community engagement.

*Creative Approaches:* Utilize art therapy, comedy, and theater to destigmatize IBS and engagingly educate students.

*Cross-Sector Collaborations:* Partner with food brands, fitness companies, and health apps to promote IBS awareness and provide resources.

Research and Community Outreach: Host gut health hackathons like *Hack Your Health*, featured on Netflix, to explore the microbiome's impact on overall wellness. Engage in citizen science through initiatives like the *American Gut Project*, where individuals contribute microbiome data to advance research. Strengthen alumni involvement, as seen at UC San Diego, where graduates co-founded the *American Gut Project*, leveraging expertise and networks to expand microbiome studies. These strategies integrate technology, community, and interdisciplinary efforts to holistically address IBS and its broader health implications.

## LIMITATIONS

This review is limited by selection bias, as it includes only PubMed-indexed studies from the past 10 years, potentially excluding relevant older research. Variability in IBS diagnostic criteria, microbiome analysis methods, and study populations may affect the generalizability of findings. While strong correlations between gut dysbiosis and chronic diseases are identified, causality remains uncertain due to the observational nature of most studies. Additionally, research on IBS in college students and its long-term health impact is sparse, requiring further longitudinal studies. Standardization of gut microbiome assessments and the development of reliable biomarkers are needed to enhance diagnostic accuracy and risk prediction.

## CONCLUSION

Our comprehensive literature review highlights the substantial link between gut health and the risk of chronic disease. Poor gut health, marked by decreased microbial diversity and dysbiosis, is linked to conditions such as cardiovascular disease, stroke, cancer, diabetes, chronic kidney disease, Alzheimer's, and liver disease. In addition, the association between IBS and gut health suggests that symptoms of IBS could be early indicators of future chronic diseases. Our review indicated connections between IBS and its comorbid diseases such as metabolic syndrome and mental disorders, which are known precursors for chronic diseases. This further supported our speculation about a link between IBS and chronic disease. Despite these findings, there remains a significant gap in research specifically addressing the younger generation and the early detection of IBS as a preventive strategy against future chronic diseases in adulthood. Raising awareness among college students about the link between IBS and the risk of future chronic diseases is crucial. However, further research in the pathophysiology and prevalence of the condition is necessary to explore these connections and develop effective strategies for early intervention and prevention.

Bridging the gaps in both research and awareness by utilizing multimodal platforms, including technology, could significantly enhance public understanding, improve diagnostic practices, and expand treatment options. This approach, as explored in the hypothetical scenario presented, has the potential to lower healthcare costs and improve health outcomes in countries with a youthful population

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